

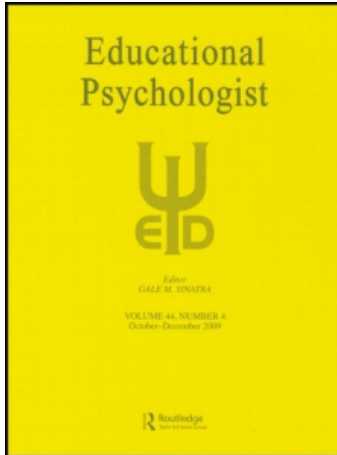
This article was downloaded by: [University of California Los Angeles]

On: 23 August 2010

Access details: Access Details: [subscription number 912893020]

Publisher Routledge

Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK



Educational Psychologist

Publication details, including instructions for authors and subscription information:

<http://www.informaworld.com/smpp/title~content=t775653642>

Training Advanced Writing Skills: The Case for Deliberate Practice

RONALD T. KELLOGG^a; ALISON P. WHITEFORD^a

^a Department of Psychology, Saint Louis University,

To cite this Article KELLOGG, RONALD T. and WHITEFORD, ALISON P.(2009) 'Training Advanced Writing Skills: The Case for Deliberate Practice', *Educational Psychologist*, 44: 4, 250 – 266

To link to this Article: DOI: 10.1080/00461520903213600

URL: <http://dx.doi.org/10.1080/00461520903213600>

PLEASE SCROLL DOWN FOR ARTICLE

Full terms and conditions of use: <http://www.informaworld.com/terms-and-conditions-of-access.pdf>

This article may be used for research, teaching and private study purposes. Any substantial or systematic reproduction, re-distribution, re-selling, loan or sub-licensing, systematic supply or distribution in any form to anyone is expressly forbidden.

The publisher does not give any warranty express or implied or make any representation that the contents will be complete or accurate or up to date. The accuracy of any instructions, formulae and drug doses should be independently verified with primary sources. The publisher shall not be liable for any loss, actions, claims, proceedings, demand or costs or damages whatsoever or howsoever caused arising directly or indirectly in connection with or arising out of the use of this material.

Training Advanced Writing Skills: The Case for Deliberate Practice

Ronald T. Kellogg and Alison P. Whiteford

*Department of Psychology
Saint Louis University*

The development of advanced writing skills has been neglected in schools of the United States, with even some college graduates lacking the level of ability required in the workplace (National Commission on Writing, 2003, 2004). The core problem, we argue, is an insufficient degree of appropriate task practice distributed throughout the secondary and higher education curriculum. We draw on the power law of skill acquisition, the role of deliberate practice in expert performance, and the uniquely intensive demands that advanced written composition place on working memory to make this case. A major impediment to assigning enough writing tasks is the time and effort involved in grading papers to provide feedback. We close by considering possible solutions to the grading problem.

Too many high school seniors in the United States appear to lack the writing skills needed for college (National Assessment of Educational Progress, 2007) and even some college graduates are unprepared for the advanced writing tasks required in the workplace (National Commission on Writing, 2004). The core problem, we argue, is an insufficient degree of appropriate task practice distributed throughout the primary, secondary, and higher education curriculum. Our thesis is that the curriculum must move from one based on instructing writers to one of training writers. Although training includes instruction, it goes beyond it with sufficiently high degrees of task practice. We make this case based on the power law of skill acquisition, the role of deliberate practice in expert performance, and the uniquely intensive demands that advanced written composition places on working memory.

Effective writing skills are central in both higher education and in the world of work that follows. One's ability to compose an extended text is the single best predictor of success in course work during the freshman year (Geiser, 2001). Gains in informative and analytical writing ability are, moreover, taken as a good indicator of the value added by higher education (Benjamin & Chun, 2003). Finally, a large share of the value added by businesses in a knowledge-based economy is codified in written documents, placing a premium on a highly literate workforce among college graduates (Brandt, 2005). Effective writing skills are critical for both entering

into the workforce and as a means for advancement (National Commission on Writing, 2004).

Considering the importance of learning to write well, the 2007 National Assessment of Educational Progress (NAEP) painted an alarming picture of the writing preparedness of American high school students for college-level work. Nearly 7 out of 10 high school seniors failed to achieve the benchmark of proficient writer based on their NAEP score; more precisely, 57% of high school seniors scored at the lower level of basic writer, and an additional 12% failed to meet even this criterion. Only about 1 in 5 high school seniors scored at or above the level of proficiency, with a mere 1 in 50 exhibiting advanced skills. These figures showed no improvement over the 2002 NAEP scores.

It could be argued that a single sample of writing obtained in a high-stakes testing environment does not portray an accurate picture of the writing preparedness of students entering college. However, opinion surveys of college faculty reinforce the normative testing data, with one reporting that 50% of high school graduates are not prepared for college writing (Achieve Inc., 2005). In another, 44% of college faculty members said that students are not well prepared for what the faculty expect of them in writing skills (Sanoff, 2006); of concern, less than one fourth as many high school teachers held the same view (10%).

Although students may enter college behind the curve, they may still catch up prior to graduation as a result of their college instruction. Encouragingly, Haswell (2000) documented important gains from the freshman to senior year in several specific rhetorical devices commonly found in the

Correspondence should be addressed to Ronald T. Kellogg, Department of Psychology, Saint Louis University, 211 North Grand Boulevard, St. Louis, MO 63103. E-mail: kellogg@slu.edu

written work of professional writers. But demonstrating that the curriculum has added value to the students' education does not fully address whether the graduating seniors are as prepared as they need to be for the writing that awaits them in the workplace. Moreover, other methods used to evaluate the value added in writing skills by the college curriculum have shown no gain at all (Curry & Hager, 1987; White, 1989). According to the National Commission on Writing (2004), 35% of employers believe that only one third or fewer of their new hires have the writing skills most valued by their companies. The Commission estimated that American businesses invest more than \$3.1 billion in remedial writing instruction for employees each year. That any college graduates lack the writing skills needed for employment is presumably inconsistent with the goals of our institutions of higher education.

We contend that to prepare all college graduates to write at an advanced level requires a higher degree of practice than the students are now receiving in secondary and higher education. Just as high school and college musicians and athletes must practice intensively to compete effectively, so, too, must writers. Becoming an expert writer entails gaining control over perceptual, motor, and cognitive processes so that one can respond adaptively to the specific needs of the task at hand, just as a professional violinist or basketball player must do. This occurs by reducing the demands that relevant processes make on the limited resources of executive attention and working memory storage. For the skill as a whole to be well controlled, its component processes must become *relatively* automatic and effortless through practice. The term *deliberate practice* refers to practice undertaken with a specific goal to improve. The learner mindfully engages in practice designed by an instructor, coach, mentor, or tutor, who further provides corrective feedback and encouragement to excel.

Deliberate practice has proven effective in improving performance on tasks related to written composition, such as typing (Keith & Ericsson, 2007), chess (Charness, Tuffiash, Krampe, Reingold, & Vasyukova, 2005), and musical performance (A. Ericsson, Krampe, & Tesch-Römer, 1993). Typing is one kind of motor output for writing, chess is another planning intensive task, and musical performance is a form of creative production. Considerable practice is required for expert or professional standing in any specific task. The very best violinists, for example, have accumulated more than 10,000 hours in solitary practice, whereas lesser experts (7,500 hr), least accomplished experts (5,000 hr), and amateurs (1,500 hr) have devoted proportionally less time to self-improvement (A. Ericsson et al., 1993).

Our article aims to build the case that additional task practice is needed at the high school and college level in deliberate forms aimed at improving advanced writing skills. First, we describe the power law that relates the degree of practice to task performance. Second, the development of expertise is discussed in relation to the key features of deliberate practice. Third, the need for training, as well as instructing, writers

is justified by documenting the uniquely intensive demands that advanced written composition places on cognition and working memory in particular. Fourth, we observe that appropriate instructional methods for composition courses and model programs for distributing practice throughout the curriculum seem to be now available; what is needed next is a broad commitment to increasing the amount of deliberate task practice. Finally, a major obstacle to such a commitment, we suggest, is the grading problem—the excessive time and effort required to evaluate lengthy written compositions to provide students with formative feedback. We end with a consideration of potential solutions to the grading problem.

THE POWER LAW OF SKILL ACQUISITION

The acquisition of skilled performance has been extensively studied in the field of cognitive psychology. More than 40 years ago, it was understood that human performance progresses through three stages (Fitts, 1964). In the early cognitive stage, the learner attempts to understand the domain and how a specific task should be performed. During the intermediate associative stage, specific inputs are associated with appropriate responses from the study of examples. In the final autonomous stage, the relevant component processes are automated through practice, thus reducing the degree of attention and effort required. Indeed, it is only through extensive practice that the skill can be performed without effortful cognitive processing.

The power law of practice embodies the finding that performance improves as a power function of the amount of practice, as the learner progresses from the cognitive to the autonomous stage. This means that performance improvements are initially rapid and then gradually lessen with higher and higher amounts of practice. Nonetheless, performance will continue to improve indefinitely, albeit at a slow rate, as long as practice continues. Although laws of cognitive psychology are rare, the power law is well established for both sensory-motor tasks, such as typing, and cognitive tasks, such as problem solving and learning a computer programming language (Anderson, 1982).

High degrees of practice are required for a skill to become relatively automatic and minimally effortful. There are several mechanisms that might underlie the shift from a controlled, effortful process to one that is less attention demanding. Anderson (1982) explained the change in terms of a transition in the format of the knowledge representation used to perform the task. There may be a shift from the use of declarative knowledge regarding what the learner knows about the task to procedural knowledge of how to do the task. Anderson adopted the metaphor of a computer program being recompiled into an executable file to explain this transition. Although declarative and procedural memory systems are known to exist and operate independently in the brain (Squire, 1992), other accounts are also viable.

For example, Logan (1988) marshaled evidence that as a skill becomes automatic there is a shift from using mental computation to determine appropriate responses to the direct retrieval of these responses from long-term memory. More recently, Schein and Schneider (2005) discovered that domain-specific brain regions active during task performance during early phases of skill acquisition remain active later when responding becomes automatic. No new neural pathways emerge as the skill develops. Instead, domain-general control processes, operating in the prefrontal cortex and dependent on limited executive attention, gradually become less involved as practice continues and the skill becomes automatic. Their findings are most germane to the argument that we put forward concerning the necessity of reducing the load on executive attention in advanced-level writers.

It is important to understand that the three stages outlined by Fitts (1964) are based on relatively simple tasks studied in the laboratory. For complex tasks, real-world tasks such as serious composition one can only *relatively* automate individual high-level processes, such as planning ideas, generating language, and reviewing the products (Kellogg, 1994). They cannot be rendered completely effortless and autonomous, the way simple perceptual-motor movements or even the highly orchestrated movements of typing can be. The goal of practice is reduce, not eliminate, the demands of component processes in writing to free attention for their coordination and control (McCutchen, 1988). Mindless, automatic writing is certainly not the aim. Rather, 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 (A. Ericsson, 2006).

Because most tasks studied in the laboratory can be learned well enough to become automatic in several hours or days of practice, there is reason to wonder whether advanced composing skill, learned over years, follows the power law. An intriguing case study examined Isaac Asimov's learning curve for writing books and discovered that it indeed did (Ohlsson, 1992). Asimov was a prolific writer, publishing nearly 500 books over a writing career of more than 40 years. Ohlsson examined the time it took to write a book as Asimov become more practiced over the course of his career. Because books varied in length and complexity, Ohlsson blocked his productivity into groups of 100 books. The assumption is that over a large sample of 100 books the variability in length and complexity would be averaged out as irrelevant to the shape of the learning curve. As Ohlsson noted, "Asimov completed his first block of practice trials (100 books) in 237 months, his second block in 113 months, and his third in 69 months" (p. 381). Although the publication record was less clear for Asimov's last books, Ohlsson calculated that his fourth block took approximately 46 months, whereas the final block took only 42 months. Thus, Asimov's speed of production continued to increase over a period of more than 40 years, with the largest gain occurring in the first 20 years. Plotted on a

log-log scale, the data fell very closely to a straight line, as expected of a power function.

Other researchers have not looked for a precise quantitative relationship, but they have uncovered other kinds of evidence on the necessity of extensive practice over a period of many years, at least a decade to attain expert standing (A. Ericsson, 2006). For instance, an early study of scientists and authors showed that they achieved their best work in their mid-30s, approximately a decade after their first work was published around the age of 25 (Raskin, 1936). Wishbow (1988) similarly examined the biographies of 66 poets listed in the *Norton Anthology of Poetry*, locating their approximate starting date for reading and writing poetry. For 83% of the sample, the earliest work to appear in that text came 10 years after this date or later. Successful poets and fiction writers developed mechanics and cognitive writing skills for 15 to 20 years before first publishing (Kaufman & Gentile, 2002). Childhood story writing was so commonly mentioned in Henry's (2000) ethnographies that "people who were attracted to writing after childhood may even refer to themselves as 'late bloomers'" (p. 37).

Anecdotal reports of professional writers corroborate the view that intense practice over a period of years is critical to success. For example, Joyce Carol Oates deliberately practiced as a college student by writing a novel in longhand, then turning the pages over and writing another novel on the flip side. Both novels would then be tossed in the trash. Since high school she began "consciously training myself by writing novel after novel and always throwing them out when I completed them" (Plimpton, 1989, p. 378). Norman Mailer (2002) also credited his eventual success as a writer to self-motivated practice.

I think from the time I was seventeen, I had no larger desire in life than to be a writer, and I wrote. . . . I learned to write by writing. As I once calculated, I must have written more than a half a million words before I came to *The Naked and the Dead*. (pp. 13–14)

Attaining advanced writing skills requires more than a decade, if one starts the clock at the age of 4 to 6, when spoken language and the scribbling that precedes handwriting are well developed in preliterate children (Lee & Karmiloff-Smith, 1996). By the age of 14 to 16 years, children have spent a decade mastering the mechanics of handwriting and spelling and achieving fluency in written as well as spoken production. As Bereiter and Scardamalia (1987) documented, during childhood and adolescence writers employ a strategy of knowledge telling. The author thinks of an idea, expresses it linguistically, and then thinks of another idea. When asked to think aloud while composing, the text produced is either the same or slightly rephrased from the thought expressed aloud moments earlier.

Advanced college-level writing, by contrast, requires the use of writing to transform knowledge not merely tell it. The

writer works through content problems of what to say and rhetorical problems of how to say it. These problem-solving efforts occur both mentally and physically in the production of drafts as well as outlines, diagrams, and notes. With knowledge transforming comes the capacity to use writing as a means for thinking about a topic and actively constituting knowledge rather than simply as a means for communicating what one already knows (Galbraith, 1999). Reviewing the text often triggers more planning that transforms the author's ideas about the topic. Think aloud protocols reveal extensive interactions among planning, language generation, and reviewing in this stage of development (Bereiter & Scardamalia, 1987). The text actually produced is a greatly condensed version of the author's thought processes rather than a re-statement of those thoughts as occurs with knowledge telling.

Once the student is fluent in knowledge telling, it takes several more years of practice to achieve an ability to use writing as a means to transform knowledge, at least for domains and topics about which the writer has adequate depth of knowledge. Bereiter and Scardamalia (1987) turned to graduate student writing to provide clear illustrations of knowledge transforming, although less developed forms of it are certainly evident in the writings of high school and undergraduate students. Thus, a decade and half or more is needed to attain the capacity to constitute or transform knowledge rather than merely tell it in the act of writing.

EXPERT PERFORMANCE AND DELIBERATE PRACTICE

Contrasts between less experienced and expert writers have played a central role in the history of the process approach to composition. For example, a seminal process study documented the differences in how college undergraduates revised their texts in comparison with working professional writers (Sommers, 1980). Also, a highly influential theoretical model of writing processes assumed that experts and novices differed in their strategies for attending to planning, sentence, generation, and reviewing (Hayes & Flower, 1980), and that these processing differences could account for the superior written products produced by experts (Flower, Hayes, Carey, Schriver, & Stratman, 1986). As Carter (1990) observed, the process approach was based on the assumptions that experts had mastered a wide range of general problem-solving strategies or heuristics that novices had not, that general knowledge is more powerful than local knowledge, and that general knowledge can be applied to any domain.

The process approach, with its emphasis on cognition, drew criticism in the field of composition studies for ignoring the critical importance of the discourse community within which the writer is embedded (e.g., Bizzell, 1982; Faigley, 1986; Nystrand, 1989). It was rightly contended that composition must be viewed from a social rather than a purely

cognitive perspective. For social theorists, expertise in writing cannot be reduced to processing strategy differences with general applicability. Rather, an expert writer possesses the localized knowledge of a specific domain without which effective communication within a specific discourse community is impossible. Thus, one might qualify as an expert writer in biology but not in composing theology or even writing within another scientific domain such as physics. A college student can begin to attain sufficient domain knowledge to write competently in, say, biology. But it takes further graduate study and postdoctoral experience to learn the highly localized disciplinary knowledge needed for true expertise as a professional biologist (Alexander, 1997). The concept of writing novice might best be defined as a basic college writer who has not yet acclimated to any of the discourse communities required for success in the core curriculum of an undergraduate education, let alone gained proficiency in one or more (Dickson, 1995). He or she lacks not so much general strategies as adequate local knowledge.

The concept of expertise underwent a similar progression within the field of cognitive science (Carter, 1990). Comparisons of skilled performance in numerous professional domains and on measures different from writing showed that experts differ from novices in terms of local knowledge as well as general cognitive strategies. For example, chess masters could recall meaningful patterns of pieces on the game board after looking at them for a few seconds with far greater skill than novice chess players (Chase & Simon, 1973). This was not because they had a better memory strategy, but rather because they had specific knowledge of patterns from chess games studied and played. When the pieces were placed randomly on the board, there was no difference in recall between the masters and novices. Local knowledge is thus a key source of intellectual power, not just general cognitive strategies. Novices who are still acclimating to a domain of knowledge must rely on general strategies, precisely because they lack the local knowledge needed. Even experts may draw upon such strategies when they encounter a novel problem that lacks a solution using previously acquired local knowledge of a specific domain (Perkins & Salomon, 1989). Thus, in cognitive science today it is taken as axiomatic that both general strategies and domain-specific knowledge are required for expertise. The same position has been advocated in composition studies (Carter, 1990) and education more broadly (Alexander & Judy, 1988).

The focus of research on expertise in cognitive science has shifted to the means by which general strategies and domain-specific knowledge are acquired over a period of many years. A. Ericsson (2006) proposed that a novice becomes an expert by means of deliberate practice regardless of whether the domain involves physical or cognitive tasks. Thus, the kinds of training undertaken by an athlete, a musician, or a chess player differ in content but share the same underlying form of deliberate practice. It involves (a) effortful exertion to improve performance, (b) intrinsic motivation to engage in

the task, (c) carefully tailored practice tasks, (d) feedback that provides knowledge of results, and (e) high levels of repetition over several years. The term *deliberate* indicates that one must undertake the practice with an explicit goal of learning the skill and improving one's performance. Practice in the sense of putting in the time, but just going through the motions, is not enough. The learner must be sufficiently interested to endure the effort required by deliberate practice.

As Alexander (1997) pointed out, becoming first competent in an academic domain and then advancing to the status of expert requires a strong interest in its topics. Interest sustains the motivation to learn. Without sufficient motivational interest, one never moves beyond the stage of acclimating to the concepts of the domain and learning at a relatively shallow level. The same observation can and should be made about whether an individual will deliberately practice a task. The effortful exertion and the long-term commitment required by deliberate practice highlight the importance of motivation and place an upper bound on its usefulness in training college student writers. It could be, for example, that a student would show sufficient interest to master writing within his or her major field, but not in other academic disciplines.

THE COGNITIVE CHALLENGE OF ADVANCED WRITTEN COMPOSITION

It may be jarring to some in the field of composition studies to think of writing as a cognitive skill that must be trained through deliberate practice. Why should learning how to compose written texts be seen as similar to musical instrument or athletic training? Composition is after all a variant of language production. It is chiefly concerned with making meaning in a social context rather than automating component processes through exercises in an artificial context. It calls for creativity not regimen. Exactly these arguments were made against training exercises during the 1970s and 80s as a new social constructivist view of composition replaced the cognitive view (Connors, 2000). From the social constructivist view prevalent still today, the analogy to skill training may seem a step in the wrong direction.

To illustrate the point, consider the history of imitating of model texts and sentence combining as training methods. Classical rhetoric was built on the principles of imitation and practice (Corbett, 1971). As for sentence combining, Connors (2000) traced its use back more than 100 years ago and speculated it, like imitation, had its origins in antiquity. As recently as 25 years ago, sentence combining in particular was still recognized as a valuable training technique appropriate even for college students. Why such exercises fell out of favor is a complex historical question, but two factors cited by Connors suffice for our point here. The first was a reaction against exercises that took writing out of a natural social context, stripping it of meaning in the name of programming students to write efficiently. Winterowd's

(1975) words expressed this objection well: "From my point of view, 'efficient' exercises in sentence building, for instance, are downright morbid because they miss the point concerning the creative act of producing meaningful language in a rhetorical situation" (p. 90). The second was a concern that exercises undertaken to automate the generation of language were "perceived as a-rhetorical, uncreative, and, in some senses, destructive of individuality" (p. 114), as Connors phrased it. Imitation exercises were sheer drudgery, where what was needed was freedom of expression. Sentence combining exercises were dummy runs, where what was needed was authentic discourse. Attempts to automate component processes of written composition through exercises and dummy runs were seen as counterproductive.

These were and are valid sentiments. Exercises can be drudgery and do seem unnatural. Yet, we would point out that these downsides also apply to practicing scales on a piano or imitating repetitively the dismount of an Olympic gymnast off, say, a side horse. Pianists and gymnasts nevertheless undertake such exercises to master their skills. And both sentence combining and the imitation of model texts continue to enjoy strong empirical support as beneficial in the training of writers (Graham & Perin, 2007). We are not suggesting that all skill training for writers need involve drudgery, but rather that any and all training techniques must be put to work, if they are known to be effective. To see our point, it is important to understand in depth what educators are up against in preparing students to write effective texts at an advanced level. As documented in the remainder of this section, advanced written composition is a massive challenge to human cognition. If musicians and athletes need effective and sustained training, then writers need it even more in our view.

The Challenge of Advanced Composition

Serious, effective composition is at once a severe test of memory, language, and thinking ability. It depends on the rapid retrieval of domain-specific knowledge about the topic from long-term memory (Kellogg, 2001). It depends on a high degree of verbal ability to generate a cohesive text that clearly expresses the ideational content (McCutchen, 1984). It depends on the ability to think clearly about substantive matters (Nickerson, Perkins, & Smith, 1985). Finally, and the central argument for why deliberate practice is essential, it depends on the author's ability to manage the burdensome demands made on working memory by the task of written composition.

Composition requires the author to engage in the concurrent planning of ideas, generation of text, and reviewing of ideas and text, a juggling task that heavily taxes executive attention and working memory (Hayes & Flower, 1980; Kellogg, 1996). At the same time, the mental products of planning, sentence generation, and reviewing must be maintained in working memory. These products can be described

in terms of three kinds of representations—those of the author, those of the text, and those of the reader. These products of writing processes—the representation of the author’s intended ideas (product of planning), the meaning of the text as it is written (product of sentence generation), and the possible meanings of the text as construed by the imagined readers (product of reviewing)—must be stored in working memory and maintained by allocating attention to them (Traxler & Gernsbacher, 1992). The author’s ideas, comprehension of what the text currently says, and the interpretations of an imagined reader may be quite different representations. Thus, executive attention must be available to juggle not only the basic processes of planning, sentence generation, and reviewing but also the three alternative representations of content.

Given the high degree of cognitive effort required to complete a serious writing task, the availability of adequate working memory resources and the capacity to allocate them appropriately to planning, sentence generation, and reviewing become important constraints on writing ability. As is documented next, not only do planning, generation, and reviewing compete for limited executive attention and storage in working memory, but the interactions of these basic writing processes must also be coordinated and controlled. Our argument is that the necessary coordination and control cannot succeed without reducing the relative demands that planning, generation, and reviewing make on working memory. The writer cannot flexibly and adaptively coordinate planning, generating, and reviewing when the needs of any single process consume too many available resources. The writer cannot be mindful of the whole while struggling with the parts. Training through deliberate practice would appear to be the only way to provide the writer with sufficient attention and storage in the working memory system to cope with the demands of advanced composition.

Storage and Attention Demands

With respect to the specific demands on working memory, mental representations must be transiently maintained in the verbal store and, to a lesser extent, in the visual and spatial stores during written sentence generation. Kellogg, Olive, and Piolat (2007) established this conclusion by having college students respond as rapidly as possible to a secondary task that required storage in verbal, visual, or spatial working memory while they concurrently generated handwritten sentences. Responses to each task were also collected in a control condition when it was performed in isolation without concurrent writing. Their responses were slowed the most by writing, relative to control responses, when the secondary task involved verbal working memory and the least for spatial working memory.

However, the central executive component of working memory is most heavily involved in text production, because its limited resource of attention must be divided among planning ideas, generating language that expresses planned

content, and reviewing both ideas as well as generated text (Kellogg, 1996). Detecting an auditory “beep” that occurs while writing and responding rapidly to it provided a way to assess the load placed on the central executive (Kellogg, 1994). That is to say, tone detection required attention, but not the storage of information in a verbal, visual, or spatial code. Thus, the slower the response time to the tone, relative to control responses, the more attention the concurrent writing task required at the moment the tone occurred. Immediately after responding to the tone, the writer categorized his or her thoughts at the moment the tone occurred as instances of planning, generating, reviewing, or thoughts unrelated to text production. These directed retrospective categorizations were similar to think aloud protocols and allowed one to assess the relative demands on attention of each process (Olive, Kellogg, & Piolat, 2002).

Kellogg’s (1994) results showed significant slowing of response times by writing, relative to control responses, when participants reported generating sentences. This response time interference implies that sentence production requires executive attention. Ferreira and Pashler (2002), using an alternative measure, found that even the production of a single isolated word requires the limited attention of the central executive. Nonetheless, sentence generation is the least demanding of the three writing processes; planning and reviewing demanded still more attention relative to generating sentences based on the higher degrees of response time interference associated with these processes. Kellogg (1994) also assessed the attention demands of other cognitive tasks, such as reading or memorizing, and found that all three composition processes are markedly more intensive in their demands on attention as indexed by response time interference. In fact, the only task found that was comparable to the attention demands of a college student composing an essay of few hundred words was an expert chess player evaluating a move in mid-game.

Moreover, mature writing requires numerous transitions among planning, generation, and reviewing, as the author attempts to solve the content problem of what to say and the rhetorical problem of how to say it (Bereiter & Scardamalia, 1987; Scardamalia & Bereiter, 1991). Levy and Ransdell (1995) used both think aloud protocols and directed retrospection to track the cognitive processes used by college student writers. They clearly documented that composition does not unfold in a linear sequence of planning, generating, and reviewing. Instead, these processes intermix throughout the production of the text. A meta-cognitive monitor must oversee the interaction and transitions from one process to the next (Hayes & Flower, 1980). Such monitoring makes its own demands on limited executive attention and prevents composition from becoming entirely automatic, regardless of how adept one becomes with each individual writing process (McCutchen, 1988).

Empirical support for the importance of working memory resources, especially executive attention, in the development

of advanced writing skills is strong. First, a measurement of overall working memory capacity in college students correlates with their writing performance (Ransdell & Levy, 1996). Vanderberg and Swanson (2007) extended such findings by discovering that it is individual differences in central executive capacity that reliably accounts for variability in writing skills among 10th graders in high school. Controlled executive attention, rather than the storage of representations, is most critical in explaining individual differences in skill. Converging experimental results show that distracting executive attention with a concurrent task of remembering six digits disrupts both the quality and fluency of text composition (Ransdell, Levy, & Kellogg, 2002).

Working Memory Constrains Writing Development

The advancement of writing skills from beginner to advanced levels depends on the availability of adequate working memory resources and the capacity to allocate them appropriately to planning, sentence generation, and reviewing. McCutchen (1996) reviewed a large body of evidence in support of this view. For example, children's fluency in generating written text is limited until they master the mechanical skills of handwriting and spelling (Graham, Berninger, Abbott, & Whitaker, 1997). Learning the mechanics of writing to the point that they are automatic during primary school years is necessary to free the components of working memory for planning, generating, and reviewing. Mastery of handwriting and spelling is also a necessary condition for writers to begin to develop the control of cognition, emotion, and behavior that is needed to sustain the production of texts as adolescents (Graham & Harris, 2000).

Revision is constrained or even nonexistent in developing writers because of working memory limitations. Revision requires detecting a problem, diagnosing its cause, and finding an appropriate way to correct it (Flower et al., 1986). If revision fails because of working memory limitations, as opposed to knowledge of what revision entails, then providing cues to detect problems in the text should benefit revision, because writers can then devote resources solely to diagnosis and solution. Cuing in fact does improve the revision of even college students (Hacker, Plumb, Butterfield, Quathamer, & Heineken, 1994).

As Beal (1996) observed, very young writers have trouble even seeing the literal meaning of their texts. The beginning author focuses on his or her thoughts not on how the text itself reads. Maintaining the author's ideas in working memory requires much, if not all, of the available storage and processing capacity of working memory in during childhood and early adolescence. This prevents the student from reading the text carefully and maintaining a clear representation of what it actually says that is independent of what the author intended to say. Reviewing is ineffective without stable

representations of the author's intentions and the actual text produced thus far that may be compared.

Sommers (1980) documented that professional writers routinely and spontaneously revise their texts extensively and globally, making deep structural changes. They express concern for the "form or shape of their argument" as well as "a concern for their readership" (p. 384). By contrast, college freshmen made changes primarily in the vocabulary used to express their thoughts. Lexical substitutions predominated rather than semantic changes. The students did not seem to "see revision as an activity in which they modify and develop perspectives and ideas" (p. 382). Little interaction between a representation of what the text says versus a representation of the author's ideas was apparent in her sample of college freshmen, let alone a focus on how a prospective reader might interpret the text. As discussed earlier, measurements of the attention demands of planning, generating, and reviewing show that each makes heavy demands on the central executive (Kellogg, 1994, 1996; McCutchen, 1996; Vanderberg & Swanson, 2007), reducing resources needed to focus on author, text, and reader representations.

The transition from knowledge telling to knowledge transforming occurs relatively late in a writer's development. After mastering handwriting, spelling, and other mechanics, the developing writer gradually moves beyond simply telling the reader what the author knows (Bereiter & Scardamalia, 1987). By late adolescence or early adulthood, authors also can transform their own ideas as a consequence of generating text and reviewing their ideas and text. Knowledge transforming requires coordinating interactions among planning, generating, and reviewing and maintaining in working memory representations of both the author's ideas and the meaning of the text as it is currently written. Thus, before making the transition from knowledge telling to knowledge transformation, the developing writer must become proficient in planning, sentence generation, and reviewing so as not to overwhelm the executive attention and storage components of working memory.

The slow transition from knowledge telling to knowledge transforming may reflect in part the late maturation of the frontal lobe of the brain on which the central executive functions of working memory depend. This brain region continues to develop throughout adolescence and is not fully mature until the mid-20s (Sowell, Thompson, Holmes, Jernigan, & Toga, 1999). Increased executive control and the capacity for self-regulation appear to be fundamental to the brain changes that occur during the second decade of life (Kuhn, 2006). This assertion underscores the importance of extensive practice to minimize the demands that planning, generation, and reviewing individually make on limited executive attention. Through adequate training the developing writer might automate to a degree all three processes, freeing attention for the monitoring of their interactions, as is necessary in knowledge transforming. Extensive practice in juggling planning, generation, and reviewing in adolescent writers can potentially

facilitate the emergence of knowledge transforming just as the mastery of handwriting in childhood sets the stage for it.

Finally, even professional writers functioning at an advanced stage of expertise must carefully self-regulate their cognitive and emotional resources to sustain their involvement in the writing task over the long hours that serious composition often requires (Graham & Harris, 1994; Zimmerman & Bandura, 1994). Binge writing, for example, can severely deplete attention producing the state of dysphoria and lack of concentration characteristic of writer's block (Boice, 1985). Strategy use, self-monitoring of goals and task engagement, appropriately spaced work scheduling, and writing rituals are commonly reported by highly experienced writers to regulate their investment of attention and to maintain the level of effort needed (Graham & Harris, 2000; Zimmerman & Risemberg, 1997).

Summary

Arguably, then, instruction alone may produce knowledge about writing, but not adequate writing skill. The power law of practice and the tenets of deliberate practice appear relevant to the preparation of high school and college-level writers. In-depth knowledge of correct spelling, punctuation, grammar, diction, thesis statements, topic sentences and cohesive links within a paragraph, and global organization of texts, for example, are necessary but not sufficient for effective writing at an advanced level. Writers, just like musicians and athletes, must be trained so that what they know can be readily retrieved and creatively applied during composition (Kellogg, 1994). Trenchant use of knowledge would seem to require that students in secondary and higher education deliberately practice the craft of writing extended texts. Without training to use what they know, their knowledge too often remains inert during composition.

Our focus here is on the training of advanced writing skills and a discussion of high school and college students, but this should not be taken to mean that practice has no role in primary grades. For example, the mastery of handwriting and spelling in elementary school requires practice. Deliberate practice of skills in the primary grades sets the stage for training in secondary education, which in turn sets the stage for training in college. Indeed, as noted earlier, professional writers report honing their skills through practice for 15 to 20 years before publishing (Kaufman & Gentile, 2002).

KNOWN TRAINING METHODS

It could be countered that, although the need for training is understandable in theory, such an approach is impractical because the methods for providing it are unavailable. Although we would concur that research on the effects of specific training regimens are needed in high school and particularly college populations, it would be inaccurate to

suggest that suitable methods are lacking. Consider in turn the literatures on effective instructional approaches for high school students and writing intensive programs in colleges.

High School and Freshman Composition

In a meta-analysis of the literature, Graham and Perrin (2007) identified numerous writing interventions that have been proven effective with adolescent and high school students and could be likely adapted to freshman composition courses. The effect sizes of these interventions are highly encouraging; they show promise of providing suitable training for advanced writers when combined with the tenets of deliberate practice. Here some examples of Graham and Perrin's recommended interventions are briefly described (with weighted mean effect sizes given in parentheses) and related to the notion of making component processes more automatic through practice.

The first example is explicit teaching of strategies for planning, revising, and editing their compositions (.82), both general-purpose strategies and those tailored to specific genres. Such strategies often benefit the quality and fluency of writing by reducing the degree to which one must simultaneously juggle planning, sentence generation, and reviewing. The strategies funnel limited attention and storage to only one or two processes momentarily (Kellogg, 1989). For example, the prewriting strategy of creating a topic outline funnels working memory resources to planning and to a lesser extent reviewing while postponing the need to compose complete sentences (Kellogg, 1988).

The time-tested practice of sentence combining (.50) is another example. Students are taught how to combine sentences; it involves exercises in which two or more basic sentences are combined into a single sentence. The goal of sentence combining is to train writers to construct more complex and sophisticated sentences. At the level of specific techniques, Zimmerman and Kitsantas (2002) found that college students learned to combine sentences best when they practiced after observation of a model performing a procedure for combining two sentences and when external feedback was provided. From our perspective, sentence combining exercises help by reducing the attention and storage demands of generating syntactically complex sentences through repetition. It is precisely such sophisticated sentences that place the greatest demands on working memory and would most benefit from deliberate practice. This, or any other method for training students to produce complex sentences, would be helpful. Studying models of effective texts that can be imitated in their own writing (.25) offers an alternative way to enhance not only individual sentence construction, but also establishing cohesive links among sentences.

Explicitly teaching summarization skills (.82) is another example of an effective intervention. From our theoretical perspective, the method is helpful in two ways. First, it trains

writers to read a text for the main ideas or gist of text. This is a useful reading skill that can be put to work in reviewing their own compositions and in attempting to represent in working memory how their imagined readers would interpret the words as written. Second, once the gist is extracted from the text, summarization requires that it then be translated into concise language, effectively expressing all the important ideas. Thus, summarization provides rigorous training not only in reading but also in language generation, both at the level of producing sentences that express multiple ideas and in composing cohesive sentences that constitute a coherent paragraph. Presumably, both reading and language generation become more fluent and more automatic through the practice of summarizing texts.

Four other effective interventions provide scaffolds for student writing that temporarily lighten the demands of the task. These are requiring the use of prewriting activities (.32), inquiry activities that develop content (.32), collaborating with other students in planning, drafting, and revising compositions (.75), and setting explicit goals for the text during planning (.70). These can be thought of as “training wheels” that help the student to manage the heavy demands that composition makes on working memory. As the students gain greater control over their writing processes through sufficient deliberate practice, the scaffolds can be withdrawn over time.

Last, the process writing approach (.32) provides personalized instruction involving several instructional activities in a workshop environment. Emphasis is placed on the social dimension of composition by having students write for authentic audiences. With respect to the cognitive dimension, students learn how to engage in cycles of planning, generating, and reviewing. A key element of the process writing approach, we believe, is the stress it places on providing students with extended opportunities to practice composition in realistic contexts.

Programmatic Practice

The worry that high schools and colleges do not require enough serious writing is not new. The National Commission on Writing (2003) recognized the same need in recommending that the time devoted by students to writing be doubled, with much of it coming from homework and writing in disciplines other than English. At the college level, the increase in practice should similarly come from courses beyond freshman composition. Although not fully articulated by the Commission, there are three sound reasons for their position.

First, high school students usually already receive their most extensive writing practice in their English classes, as do college students in freshman composition for at least one if not two semesters. Second, it is essential that students learn to compose a text appropriate to a particular discourse community, and this is best achieved by writing papers across

the curriculum and within a college student’s major and minor fields of study. The development of writing intensive college courses through programs for writing across the curriculum (WAC) and writing within the discipline (WID) over the past several decades responded to these realities and respected the need for an authentic social context in writing (Fulwiler & Young, 1990). Although documenting the value that they add to a college education has been technically difficult in the past (White, 1989), WAC and WID programs are readily available as vehicles for deliberate practice.

Third, distributing writing practice throughout the curriculum rather than massing it in composition courses is good from a cognitive as well as a social perspective. Long-term retention of writing skill should in theory be enhanced through distributed practice. A desirable learning difficulty is a factor that slows the acquisition of a skill while boosting long-term skill retention, which is, of course, the ultimate goal of instruction and training (Schmidt & Bjork, 1992). In several task domains, distributed practice has been shown to harm the speed of learning relative to massed practice, but with a major benefit in the form of long-term retention.

It is now clear that well-designed, intensive practice within the major discipline can improve undergraduate writing. Johnstone, Ashbaugh, and Warfield (2002) found that superior writing skills correlated reliably with the degree of repeated practice and, controlling for practice, with writing in the professionally relevant domain of greatest interest to the student. Accounting students who took two business writing intensive courses in their junior year (1 year of practice) and two more in their senior year (2 years of practice) gained significantly in their writing skills in comparison with an assessment taken at the end of their sophomore year (see Figure 1). The data show writing skill assessment scores collected in the sophomore year (Time 0), junior year (Time 1), and senior year (Time 2). By sharp contrast, the control group of students in business majors other than accounting, who did not take the writing intensive courses in their specific discipline, slightly declined in performance from their sophomore to their senior year. The writing assignments in the treatment group were designed to challenge the students by requiring that they write as accounting professionals for a professional audience. The feedback that students received was consistent and thorough, including grading of grammatical conventions, organization, professionalism of presentation, technical accuracy of the accounting, and the quality of the analysis.

Current Levels of Practice

Despite the availability of WAC and WID programs as means of providing adequate writing practice in the college curriculum, there is reason for concern regarding their status. Bok (2006) alleged that WAC programs and other writing intensive courses reached their peak popularity about 20 years ago and have since been in decline at American universities. The National Survey of Student Engagement (NSSE;

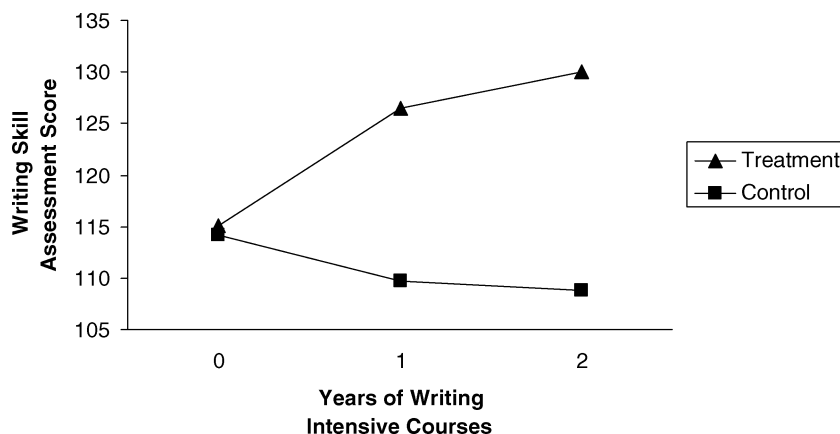


FIGURE 1 Mean writing skill assessment score as a function of practice in writing intensive courses (data from Johnstone, Ashbaugh, & Warfield, 2002).

2007) provided data on the frequency with which college students are assigned papers of fewer than 5 pages, papers between 5 and 19 pages, and papers more than 20 pages during an academic year (based on student self-reports). The means provided in Table 1 reflect the overall averages, but it should be noted that there was some variation across different types of institutions of higher education.

It appears that most of the written work assigned in college requires fewer than 20 pages in length. As shown in Table 1, 83% of 1st-year and even 51% of senior students were never given an assignment that requires 20 or more pages. Specific majors revealed some fluctuation around these overall averages. For example, 62% of seniors in the physical sciences never composed a paper of 20 or more pages, whereas only 45% in the social sciences and 39% in engineering had not composed at least one such extended paper. A small but troubling percentage of 1st-year students (15%) and seniors (9%) never composed a paper of 5–19 pages in length. When large numbers of papers were assigned (11–20 or more than 20), they were typically fewer than 5 pages in length for both freshmen and seniors. On a somewhat more positive note, some of the data indicate that more lengthy and complex texts are being assigned to seniors in their major and minor

field of studies compared with 1st-year students. For example, about three times as many seniors (41%) wrote 1 to 4 papers of 20 or more pages compared with freshmen (13%). Seniors were also somewhat more likely than freshmen to be asked to regularly prepare papers of 5 to 19 pages in length, although it is difficult to assess these columns from a practice perspective because the page range is wide. It should be noted that these data are not atypical and are highly similar to those given in the previous NSSE annual report (NSSE, 2006).

College seniors in particular should be at a stage of skill development where relatively frequent assignment of long papers would be most appropriate. This implies that the responsibility for grading long papers would lie chiefly with faculty in the students' major department rather than with those teaching freshmen composition. Faculty would thus need to tend to the writing skills of their undergraduate majors with much the same care as they do now with their graduate students. From the perspective of providing sufficient deliberate practice, one would hope to see 100% of seniors receiving at least one to four assignments of 20 pages or more.

Additional data are now available at the high school level. Kiuahara, Graham, and Hawkin (2009) surveyed high school teachers to learn which types of writing activities students were assigned most frequently. A majority of the teachers reported using activities that involved (a) writing without composing (e.g., completing worksheets), (b) writing to understand material read (e.g., summarizing text), (c) personal writing (e.g., personal narratives), (d) informative writing (e.g., five-paragraph essay), and (e) persuasive writing (e.g., persuasive essay). But, nonnarrative composition of essays was uncommon, with only 26% assigning a five-paragraph essay on a monthly basis and 12% on a weekly basis. The comparable figures for persuasive essays were 17% and 5%. Granted, more language arts and social studies teachers reported using these on a monthly or weekly basis compared with science teachers, but taken overall the data suggest that

TABLE 1
Frequency of Writing Assignments of Various Lengths for First-Year and Senior College Students

No. of Written Papers	20 Pages or More		5–19 Pages		Fewer Than 5 Pages	
	First Year	Senior	First Year	Senior	First Year	Senior
20 assigned	1%	1%	1%	4%	11%	14%
11–20 assigned	1%	2%	6%	11%	20%	17%
5–10 assigned	3%	6%	24%	31%	34%	28%
1–4 assigned	13%	41%	53%	45%	32%	35%
None	83%	51%	15%	9%	3%	7%

Note. From National Survey of Student Engagement (2007b) *Annual Report 2007*. Reprinted with permission.

serious, multiparagraph writing about topics other than personal experience are not required often enough. The conclusion of Kiuahara et al. reinforces the findings of Applebee and Langer (2006): High school students are too rarely assigned activities of the complexity and length that would prepare them for AP classes, college, and higher salaried jobs.

How much practice is enough? With respect to practice within a student's major discipline, some guidance comes from the study by Johnstone et al. (2002). The accounting students in their treatment group completed eight writing assignments over a series of four courses that were above and beyond the other writing assignments that business students in the control group received. Although the paper lengths were not specified in their report, all assignments required students to research the relevant accounting literature for a topic and to analyze critically an issue using their findings. They prepared documents appropriate to the profession, such as a memorandum or a professional report. Moreover, as seniors the accounting students completed three times as many business-writing assignments (17.4) as they did as sophomores (5.7). The other business students in the control group also increased their business-related writing from the sophomore (4.3) to senior (11.6) year, but by less of a margin. Thus, ramping up from about 6 to 17 assignments per year from the sophomore to senior year yielded the reliable gain in writing skill scores shown in Figure 1.

However, the broad question of how much practice is enough remains to be answered in detail by future research. The power law of practice indicates that the greatest gains in skills come from early and middle stages of practice. But it must be remembered that the complexity of the writing task increases as one develops as a writer. The advanced college writer who uses composition as a means of constituting knowledge is performing a far more complex task than the young adolescent writer operating at the level of knowledge telling. Similarly, the young adolescent who has mastered the mechanics of writing and can compose at a level of fluency similar to spoken production is performing a more difficult task than the young child still struggling with handwriting and spelling to compose just a few sentences. So, for the freshman college student, mechanics and knowledge telling strategy may be in its late stages of practice, whereas knowledge transforming is still novel and unpracticed. It must also be acknowledged that the cognitive and educational science of written composition is not yet well enough understood to provide a precise answer to the question of how much is enough. More research directed at different stages of writing development could yield the precision desired.

THE GRADING PROBLEM

The principle of deliberate practice assumes that the writing mentor, coach, tutor, or instructor provides the student with informative feedback. A sizeable literature now informs the design of such feedback. For example, students prefer comments that explain why the instructor likes or dislikes a fea-

ture of the writing and those that suggest ways to improve the text (Beach & Friedrich, 2006). Highly specific comments that guide revision are more helpful than global statements, such as "tighten up" or "weak argument." Writing practice with specific feedback (errors marked and tallied) has been shown to reduce significantly the proportion of spelling and grammar errors on a posttest compared with pretest performance; this reduction was reliably larger than that obtained with receiving a global grade only (Dorow & Boyle, 1998). These results are consistent with a meta-analysis of the effects of feedback in a wide variety of learning domains; providing solutions to errors results in better learning than providing correct/incorrect information by itself (Bangert-Drowns, Kulik, Kulik, & Morgan, 1991; Kluger & DiNisi, 1996). They are further consistent with the conclusion that feedback in educational environments is most effective when it informs the learner how to do the task better as opposed to providing praise for correct performance or punishment for mistakes (Hattie & Timperley, 2007).

In a recent review of the literature, Schute (2008) identified three cognitive mechanisms by which formative feedback can benefit learning. First, it alerts the student to a gap between the current level of performance and the desired level of performance or goal. Assuming that the student is performing below the goal, feedback can serve to motivate higher levels of effort at the task and continued practice. Second, formative feedback can reduce the cognitive load of a learner by providing a scaffold that assists with performing the task. For example, providing students with an outline to work from or a series of topic sentences could be ways of providing supportive feedback designed to decrease the cognitive load of composition. The use of formative feedback as a scaffold would be especially important for novice or struggling students who might become completely overwhelmed by the task demands and quit altogether rather than continue with practice. Third, "feedback can provide information that may be useful for correcting inappropriate task strategies, procedural errors, or misconceptions," according to Schute (2008). This is the most obvious value of feedback in that it corrects the learner's errors, at least when the format of the feedback is specific and explains how the errors should be fixed.

Although appropriate feedback is widely accepted as a powerful learning aid, it poses special problems in the context of grading written texts. Although there are probably many reasons why more writing is not routinely assigned, the time and effort required by instructors to provide useful feedback surely ranks high on the list. Feedback that fits the criteria and purposes just outlined is not easy to provide. Holistic grading can be done faster than analytic grading that evaluates different features of the text, such as mechanics, coherence, and content (Huot, 1990). Yet even holistic grading can be excessively time-consuming in large classes.

The practical difficulty of grading large numbers of long papers likely suppresses their assignment below desirable

TABLE 2
Frequency of Writing Assignments in Typical High School History Class

Type of Writing Assignment	Once a Month or More	Once or Twice a Semester	Once a Year	Never
Researched essays (≤2,000 words)	47%	35%	2%	12%
Concise research papers (2,001–3,000 words)	11%	50%	9%	27%
Extended research papers (3,001–5,000 words)	3%	27%	6%	62%
Major research papers (≥5,000 words)	0%	9%	7%	81%

Note. From “The Concord Review Study,” conducted for The Concord Review, Inc., by the Center for Survey Research & Analysis, 2002. © The Concord Review, Inc. Reprinted with permission.

levels from the standpoint of the need to train as well as instruct writers in secondary and higher education. For example, the Center for Survey Research and Analysis (2002) found that 95% of high school history teachers view writing a research term paper as important, but only 19% assign a paper of more than 5,000 words. As shown in Table 2, any assignment of more than 3,000 words is never assigned by 62% of those surveyed. The most frequent assignment is 2,000 words or less. The central reason cited by the teachers as to why they did not assign lengthy term papers related to the excessive time and effort that it takes to grade them. A related secondary reason is that the grading needed to be taken from personal time, because no provision was made in the normal school day or year for them to read and evaluate serious research papers. The National Commission on Writing (2003) similarly observed that secondary school teachers in English, history, and biology, for example, “face between 120 to 200 students, weekly if not daily” (p. 20). Grading even a weekly one-page assignment is daunting, let alone assigning lengthier papers on a regular basis. At research universities, WAC and WID programs generally play some role in undergraduate education. Yet improving undergraduate writing skills receives relatively meager rewards compared with faculty publication, mentoring of graduate students, and sponsored research. It is certainly plausible that the hard, unrewarded work of grading could contribute to the relative paucity of lengthy college writing assignments requiring 20 or more pages, as reported in the NSSE (2007) findings.

Implementing a training approach to the college writing curriculum, with a significant amount of deliberate practice, would shift the values shown in Tables 1 and 2 to more frequent papers of all lengths and more frequent long papers in particular. This would, in turn, appear to require significant investments of time and effort by the faculty in grading the papers to provide formative feedback. Marking specific errors, showing students solutions to problems with the text,

and explaining why an instructor likes or dislikes a specific section of the text takes a great deal of time and effort. How is it possible to double the amount of writing assigned in schools and colleges, as recommended by the National Commission on Writing (2003), when instructors already struggle grading papers for large numbers of students? Obviously, reducing the ratio of students to faculty in writing intensive courses is one solution. But are there other solutions to the grading problem that would further remove it as an obstacle?

Intermittent Feedback

Although regular formative feedback is generally thought of as beneficial, it is not widely appreciated that providing feedback only intermittently can be beneficial. There are several reasons for not grading and commenting on every paper assigned to students in high school and college.

First, performance appraisals and grades can actually impair, as well as benefit, performance (Kluger & DiNisi, 1996, 1998). When writers focus their attention on what they ought to do to meet the expectations of instructors and peers, receiving negative feedback about their writing efforts motivates them to improve. Receiving positive feedback, in contrast, can have the effect of reducing effort at the task as the writer brings performance down to match the socially prescribed task standard. Grades, in particular, can reduce performance because they may direct an individual’s attention away from the task and toward the self (Butler, 1987). This presumably occurs because grades provide normative feedback that indicates how well one is doing relative to others, leading one to think about the self rather than improving at the task.

Second, less might be more when it comes to instructor evaluations of the written work of students. It is not entirely clear that students read, comprehend, and learn from extensive feedback. Formative comments made on a first draft might be most helpful; once the final draft is turned in there may be less incentive to process the information at a deep level and try to incorporate it into future writing assignments. The practice obtained in preparing papers on a frequent basis may be what is most important, as long as feedback is provided on some intermittent basis. In the same vein, it is important to ask how much feedback should be provided for any one assignment. Although, as documented earlier, the literature provides guidance on the most useful kinds of feedback, it has not addressed the problem of overloading students with corrections and comments that would be tempting to ignore as a student.

Third, in a variety of tasks, intermittent feedback has been shown to slow the acquisition of a skill during training compared with continuous feedback, but it has the benefit of enhancing long-term retention of the skill (Schmidt & Bjork, 1992). In other words, intermittent feedback is another

example of a desirable learning difficulty. Because the ultimate goal of training should be to write well over the long term, rather than acquire the skill quickly, one can argue that, in theory, intermittent rather than continuous feedback is preferable.

There is presently no direct evidence that intermittent feedback benefits the writing skills in the long term. The outcome of a large-scale study of college students' skill acquisition is at least consistent with this perspective, however. Astin (1993) found that self-reported gains in writing skills across the freshman to senior year in college depended on both the amount of practice required and the feedback provided. Aside from grade point average and hours spent studying, the two strongest partial correlations with writing skill improvement were the number of writing-skills classes taken (partial $B = .31$) and the amount of feedback given by instructors (partial $B = .12$). But note that the amount of feedback was less important than the number of opportunities to compose in writing classes. Again, for a different reason, less may be more when it comes to providing feedback on written work

Peer Feedback

Peer feedback offers another means for increasing the amount of writing assigned without increasing the instructor's grading time and effort. Such feedback can be arranged effectively through study or writing groups within a class (Light, 1992). It can also be implemented on a large scale using computer technology. SWoRD (scaffolded writing and rewriting in the discipline) is a Web-based reciprocal peer review system designed to support practice at writing assignments in the major (Cho & Schunn, 2007). Peer reviewers are given guidance on how to provide effective feedback using detailed scoring rubrics. It adopts the journal publication process as a model. Students write and publish a paper online, receive feedback from reviewers, revise the paper and respond to the reviewers, and then publish the final draft. Each student is both an author and a reviewer of the work of others and is evaluated on both tasks. Of significance here, Cho and Schunn found that the mean writing quality improvement between the first and final drafts was greater when feedback was provided by a single peer relative to when it was provided by the instructor. The most improvement came from feedback provided by multiple peers. Hence, by turning to multi-peer evaluations as a means of providing feedback using Web-based technology, faculty could increase the amount of practice that their students receive. Moreover, by serving as reviewers, all students would learn from evaluating the papers of others as well as serving the role of author. Of importance, Cho and Schunn provided evidence of sound reliability and validity of peer review when implemented through SWoRD.

Automated Essay Scoring

SWoRD is one example of how feedback technology might be brought to bear to on the grading problem as an obstacle to enhanced task practice. Automated essay scoring offers a different potential technological fix, but as with automated peer review it is still a work in progress. Shermis and Burstein (2003) reviewed several computer-based scoring and feedback methods derived from cognitive psychology and computational linguistics. Students might benefit from the immediate knowledge of results that software can provide, given that human evaluation often takes several days. Also, computer-based feedback on preliminary drafts could motivate students to improve their scores before turning in the papers for feedback from peers or instructors. It should not be assumed that the use of automated feedback completely eliminates human feedback. As long as some time and effort savings are gained, the use of automated essay scoring may be helpful to the training of advanced writers.

Early efforts at automatic scoring of objective text features relied on the readability formulas and tabulation of problems with spelling, grammar, and vocabulary (MacDonald, Frase, Ginrich, & Keenan, 1982). They were limited in providing feedback regarding more complex, higher level features of writing quality and made no claim to matching holistic grades assigned by instructors. The promise of the current generation of software stems from its success in the immediate scoring of essays in a way that parallels human readers. For example, the Educational Testing Service developed the e-rater system using text characteristics specified in holistic scoring guides for the Graduate Management Admissions Test. The output of e-rater shows 87 to 94% agreement with expert graders, a level similar to that of two well-trained human evaluators (Burstein, 2003). Agreement is defined as e-rater judging an essay within one point of a human grader on a 6-point holistic scale. As another example, the Intelligent Essay Assessor uses latent semantic analysis to provide a holistic essay score that correlated .81 with a human grader averaged across many essays (Landauer, Laham, & Foltz, 2003). This is comparable to the correlation between two human raters (.83). A third example uses computational linguistics to analyze the potential coherence of a text. Coh-Metrix analyzes multiple measures of the cohesive devices used in a text, which can be used to infer whether a reader will successfully construct a coherent representation of its meaning (Graesser et al., 2004). The software extracts from a text more than 200 types of cohesion relations and measures of language, text, and readability. In sum, there have been significant advances in readability assessment and in providing automated feedback as a consequence of recent progress in computational linguistics and cognitive science more broadly.

Some in the field of college composition have strongly objected to the use of automated essay scoring, however. Their criticisms are well expressed in a volume edited by Ericsson

and Haswell (2006), and they raise important caveats. McGee (2006), for example, critiqued the Intelligent Essay Assessor for being insensitive to cohesive links among sentences, syntactical mistakes, and errors in factual content. P. F. Ericsson (2006) observed that automated essay scoring is inherently oblivious to the fact that composing is a meaning-making activity within a social context. She worried that “students who learn to write for these machines will see writing and composing as a process of getting the right words in the ‘bag of words’ without a concern for a human audience for any legitimate communicative purpose” (p. 37).

Haswell (2006) found the traits used by e-rater to arrive at a holistic score, such as prompt-specific vocabulary; development and organization of ideas; and surface errors in spelling, punctuation, and grammar, too limiting. He wondered “why these few traits were chosen out of the plentiful supply good writers utilize, such as wit, humor, surprise, originality, logical reasoning, and so on” (p. 70). The meaning of the holistic score arrived at by e-rater is also opaque and uninformative about a given student’s strengths and weaknesses, according to Haswell. His own longitudinal study of growth in writing skill in college student documents analyzed 100 variables, and then through factor analysis he discovered nine independent dimensions of text quality that characterized competent workplace writing: coherent and bound ideas, idea elaboration and substantiation, local cohesion, establishment logical boundaries, free modification, fluency, and vocabulary (Haswell, 2000). The correlations among these dimensions were generally very weak, implying that students progressed from their freshman to junior year at different paces along the nine dimensions. Thus, the use of any single holistic evaluation of writing skill is less descriptive of an individual’s progress than is desirable.

Although recognizing the predicaments of automated essay scoring, it must be noted that problems also arise with human text evaluation. For both holistic scoring and more complex scoring schemes, human evaluators must be extensively trained to reach adequately high levels of interrater reliability. Fatigue, mood, and motivation add variability to the outcome in ways that are hard to control (Freedman & Calfee, 1983). College composition instructors may be well prepared to provide useful feedback, but this is not always the case with instructors outside of the English department when evaluating assignments made in their courses. Instructors in a discipline may refer to domain-specific knowledge that their students do not share and provide unclear feedback that is relatively unhelpful (Cho & Schunn, 2007). This may explain, in part, Cho and Schunn’s findings that peers provided better feedback, from the writer’s point of view, than did the course instructor. Most high school teachers in social studies and science also report being inadequately prepared by their teacher education program to teach writing skills (Kiuvara et al., in press). The problem is most severe for science teachers who report that neither their teacher education program nor inservice training programs prepared them ad-

equately for writing instruction. By contrast, only a minority of language arts teachers felt unprepared.

The debate over the use of technology to provide feedback on writing in higher education on a wide scale has scarcely started. The objections to automated essay scoring voiced in the volume by Ericsson and Haswell (2006) deserve a full hearing. However, we would suggest that the grading problem is such a significant obstacle to increased writing practice that such new technologies deserve a careful look. This is especially the case for instructors who wish to offer writing intensive courses in WAC and WID programs but lack the experience and evaluation skill of composition instructors. Although automated essay scoring may prove inappropriate in English writing courses, it might still find some helpful application in other disciplines, assuming it is at least as effective as the feedback that the instructors themselves can offer. Automated peer review, on the other hand, could well play a pervasive role in courses throughout the curriculum including composition classes. Indeed, such technology would seem to make highly salient to students that they are writing for a real audience of importance to them—their peers as well as their instructor.

Whether feedback technology should involve Web-based peer review, automated essay scoring, or some mix of these approaches is now a pressing question for educational research in our view. We anticipate that the outcome of such design research could change the landscape of how technology is used in training high school and college writers. Just as the use of word processing, spell and grammar checking, and even plagiarism detection software are now commonplace, feedback technology could also play an important role in the future.

CONCLUSION

Extensive practice that aims to train writers, much as musicians and athletes are trained rather than merely instructed, is arguably essential for the adequate preparation of college level writers. As with the acquisition of other complex physical and cognitive skills, acquiring expertise in the writing of extended texts takes many years of deliberate practice under the guidance of an instructor, coach, mentor, or tutor. Such practice helps writers to gain cognitive control over text production by reducing the individual working memory demands of planning ideas, text generation, and reviewing ideas and text. A writer’s ability to use their linguistic and domain-specific knowledge in composing a text, solving the content and rhetorical problems posed by the writing assignment, depends on achieving such control.

That few high school seniors achieve an advanced score on the NAEP test of writing skill and that even some college graduates are unprepared for writing in the workplace is plausibly a consequence of insufficient practice. Here we have argued the case that sustained deliberate practice is

needed to train as well as instruct writers at the high school and college level. Evidence-based instructional methods for composition courses are available as the basis for such training, as are successful models for WAC and WID programs. The grading problem, a serious obstacle to more writing practice, also has some potential solutions, although further research is needed to determine their viability.

ACKNOWLEDGMENTS

We thank Steven Graham, another anonymous reviewer, and the editor, Gale Sinatra, for their helpful suggestions in revising an earlier draft of the manuscript.

REFERENCES

- Achieve, Inc. (2005). *Rising to the challenge: Are high school graduates prepared for college and work?* Washington, DC: Author.
- Alexander, P. A. (1997). Mapping the multidimensional nature of domain learning: The interplay of cognitive, motivational, and strategic forces. In M. L. Maehr & P. R. Pintrich (Eds.), *Advances in motivation and achievement* (Vol. 10, pp. 213–250). Greenwich, CT: JAI Press.
- Alexander, P. A., & Judy, J. E. (1988). The interaction of domain-specific and strategic knowledge in academic performance. *Review of Educational Research, 58*, 375–404.
- Anderson, J. R. (1982). The acquisition of cognitive skill. *Psychological Review, 89*, 369–406.
- Applebee, A., & Langer, J. (2006). *The state of writing instruction: What existing data tell us*. Albany, NY: Center on English Learning and Achievement.
- Astin, A. W. (1993). *What matters in college: Four critical years revisited*. San Francisco: Jossey-Bass.
- Bangert-Drowns, R. L., Kulik, C. C., Kulik, J. A., & Morgan, M. T. (1991). The instructional effect of feedback in test-like events. *Review of Educational Research, 61*, 213–238.
- Beach, R., & Friedrich, T. (2006). Response to writing. In C. A. MacArthur, S. Graham, & J. Fitzgerald (Eds.), *Handbook of writing research* (pp. 222–234). New York: Guilford.
- Beal, C. R. (1996). The role of comprehension monitoring in children's revision. *Educational Psychology Review, 8*, 219–238.
- Benjamin, R., & Chun, M. (2003). A new field of dreams: The Collegiate Learning Assessment Project. *Peer Review, 5*(4), 26–29.
- Bereiter, S., & Scardamalia, M. (1987). *The psychology of written composition*. Hillsdale, NJ: Erlbaum.
- Bizzell, P. (1982, Fall). Cognition, convention, and certainty: What we need to know about writing. *PreText, 3*, 213–243.
- Boice, R. (1985). Cognitive components of blocking. *Written Communication, 2*, 91–104.
- Bok, D. (2006). *Our underachieving colleges: A candid look at how students learn and why they should be learning more*. Princeton, NJ: Princeton University Press.
- Brandt, D. (2005) Writing for a living: Literacy and the knowledge economy. *Written Communication, 22*, 166–197.
- Burstein, J. (2003). The e-rater scoring engine: Automated essay scoring with natural language processing. In M. D. Shermis & J. Burstein (Eds.), *Automated essay scoring: a cross-disciplinary perspective* (pp. 113–122). Mahwah, NJ: Erlbaum.
- Butler, R. (1987). Task-involving and ego-involving properties of evaluation: Effects of different feedback conditions on motivational perceptions, interest, and performance. *Journal of Educational Psychology, 79*, 474–482.
- Carter, M. (1990). The idea of expertise: An exploration of cognitive and social dimensions of writing. *College Composition and Communication, 41*, 265–286.
- Center for Survey Research and Analysis. (2002, November). *The Concord Review Study*. Sudbury, MA: Author. Retrieved December 15, 2003, from <http://www.tcr.org/tcr/institute/historytcr.pdf>
- Chase, W. G., & Simon, H. A. (1973). The mind's eye in chess. In W. G. Chase (Ed.), *Visual information processing* (pp. 215–281). New York: Academic Press.
- Charness, N., Tuffiash, M., Krampe, R., Reingold, E., & Vasyukova, E. (2005). The role of deliberate practice in chess expertise. *Applied Cognitive Psychology, 19*, 151–165.
- Cho, K., & Schunn, C. D. (2007). Scaffolded writing and rewriting in the discipline: A web-based reciprocal peer review system. *Computers & Education, 48*, 409–426.
- Connors, R. J. (2000). The erasure of the sentence. *College Composition and Communication, 52*, 96–128.
- Corbett, E. P. J. (1971). The theory and practice of imitation in classical rhetoric. *College Composition and Communication, 22*, 243–250.
- Curry, W., & Hager, E. (1987). Assessing general education: Trenton State College. In D. F. Halpern (Ed.), *Student outcomes assessment: What institutions stand to gain* (pp. 57–65). San Francisco: Jossey-Bass.
- Dickson, M. (1995). *It's not like that here: Teaching academic writing and reading to novice writers*. Portsmouth, NH: Boynton/Cook.
- Dorow, L. G., & Boyle, M. E. (1998). Instructor feedback for college writing assignments in introductory classes. *Journal of Behavioral Education, 8*, 115–129.
- Ericsson, A. (2006). The influence of experience and deliberate practice on the development of superior expert performance. In K. A. Ericsson, N. Charness, P. J. Feltovich, & R. R. Hoffman (Eds.), *The Cambridge handbook of expertise and expert performance* (pp. 683–703). Cambridge, UK: Cambridge University Press.
- Ericsson, A., Krampe, R. T., & Tesch-Römer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review, 100*, 363–406.
- Ericsson, P. F. (2006). The meaning of meaning: Is a paragraph more than an equation. In P. F. Ericsson & R. H. Haswell (Eds.), *Machine scoring of student essays* (pp. 28–37). Logan: Utah State University Press.
- Ericsson, P. F., & Haswell, R. H. (Eds.). (2006). *Machine scoring of student essays*. Logan: Utah State University Press.
- Faigley, L. (1986, October). Competing theories of process: A critique and a proposal. *College English, 48*, 527–542.
- Feldman, D. H. (1993). *Nature's gambit: Child prodigies and the development of human potential*. New York: Basic Books.
- Ferreira, V. S., & Pashler, H. (2002). Central bottleneck influences on the processing stages of word production. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 28*, 1187–1199.
- Fitts, P. M. (1964). Perceptual-motor skill learning. In A. W. Melton (Ed.), *Categories of human learning* (pp. 243–285). New York: Academic Press.
- Flower, L. S., Hayes, J. R., Carey, L., Schriver, K., & Stratman, J. (1986). Detection, diagnosis, and the strategies of revision. *College Composition and Communication, 37*, 16–55.
- Freedman, S. W., & Calfee, R. C. (1983). Holistic assessment of writing: Experimental design and cognitive theory. In P. Mosenthal, L. Tamor, & S. A. Walmsley (Eds.), *Research in writing: Principles and methods* (pp. 75–98). New York: Longman.
- Fulwiler, T., & Young, A. P. (1990). *Programs that work: Models and methods for writing across the curriculum*. Portsmouth, NH: Boynton/Cook.
- Galbraith, D. (1999). Writing as a knowledge-constituting process. In M. Torrance & D. Galbraith (Eds.), *Studies in writing: Vol. 4. Knowing what to write: Conceptual processes in text production* (pp. 139–160). Amsterdam: Amsterdam University Press.

- Geiser, S., with Studley, R. (2001). *UC and the SAT: Predictive validity and differential impact of the SAT I and SAT II at the University of California*. Oakland: University of California Office of the President. Retrieved March 1, 2002, from http://www.ucop.edu/sas/research/researchandplanning/pdf/sat_study.pdf
- Graham, S., Berninger, V. W., Abbott, R. D., & Whitaker, D. (1997). Role of mechanics in composing elementary school students: A new methodological approach. *Journal of Educational Psychology, 89*, 170–182.
- Graham, S., & Harris, K. R. (1994). The role and development of self-regulation in the writing process. In D. H. Schunk & B. J. Zimmerman (Eds.), *Self-regulation of learning and performance: Issues and educational applications* (pp. 203–228). Hillsdale, NJ: Erlbaum.
- Graham, S., & Harris, K. R. (2000). The role of self-regulation and transcription skills in writing and writing development. *Educational Psychologist, 35*, 3–12.
- Graham, S. & Perin, D. (2007). A meta-analysis of writing instruction for adolescent students. *Journal of Educational Psychology, 99*, 445–476.
- Graesser, A. C., McNamara, D. S., Louwerse, M. M., & Cai, Z. (2004). Coh-Metrix: Analysis of text on cohesion and language. *Behavior Research Methods, Instruments, and Computers, 36*, 193–202.
- Hacker, D. J., Plumb, C., Butterfield, E. C., Quathamer, D., & Heineken, E. (1994). Text revision: Detection and correction of errors. *Journal of Educational Psychology, 86*, 1–15.
- Haswell, R. E. (2000). Documenting improvement in college writing: A longitudinal approach. *Written Communication, 17*, 307–352.
- Haswell, R. E. (2006). Automaton and automated scoring: Drudges, black boxes, and *dei ex machina*. In P. F. Ericsson & R. H. Haswell (Eds.), *Machine scoring of student essays* (pp. 57–78). Logan: Utah State University Press.
- Hattie, J., & Timperley, H. (2007). The power of feedback. *Review of Educational Research, 77*(1), 81–113.
- Hayes, J. R., & Flower, L. S. (1980). Identifying the organization of writing processes. In L. W. Gregg & E. R. Steinberg (Eds.), *Cognitive processes in writing* (pp. 3–30). Hillsdale, NJ: Erlbaum.
- Henry, J. (2000). *Writing workplace cultures: An archeology of professional writing*. Carbondale: Southern Illinois University Press.
- Huot, B. (1990). The literature of direct writing assessment: Major concerns and prevailing trends. *Review of Educational Research, 60*, 237–263.
- Johnstone, K. M., Ashbaugh, H., & Warfield, T. D. (2002). Effects of repeated practice and contextual writing experiences on college student's writing skills. *Journal of Educational Psychology, 94*, 305–315.
- Kaufman, J. C., & Gentile, C. A. (2002). The will, The wit, The judgment: The importance of an early start in productive and successful writing. *High Ability Studies, 13*, 115–123.
- Keith, N., & Ericsson, K. A. (2007). A deliberate practice account of typing proficiency in everyday typists. *Journal of Experimental Psychology: Applied, 13*, 135–145.
- Kellogg, R. T. (1988). Attentional overload and writing performance: Effects of rough draft and outline strategies. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 14*, 355–365.
- Kellogg, R. T. (1989). Idea processors: Computer aids for planning and composing text. In B. K. Britton & S. M. Glynn (Eds.), *Computer writing environments: Theory, research, and design* (pp. 57–92). Hillsdale, NJ: Erlbaum.
- Kellogg, R. T. (1994). *The psychology of writing*. New York: Oxford University Press.
- Kellogg, R. T. (1996). A model of working memory in writing. In C. M. Levy & S. Ransdell (Eds.), *The science of writing: Theories, methods, individual differences, and applications* (pp. 75–71). Mahwah, NJ: Erlbaum.
- Kellogg, R. T. (2001). Long-term working memory in text production. *Memory & Cognition, 29*, 43–51.
- Kellogg, R. T., Olive, T., & Piolat, A. (2007). Verbal, visual, and spatial working memory in written language production. *Acta Psychologica, 124*, 382–397.
- Kiuhara, S. A., Graham, S., & Hawkin, L. S. (2009). Teaching writing to high school students: A national survey. *Journal of Educational Psychology, 101*, 136–160.
- Kluger, A. N., & DeNisi, A. (1996). The effects of feedback interventions on performance: Historical review, a meta-analysis and a preliminary feedback intervention theory. *Psychological Bulletin, 119*, 254–284.
- Kluger, A. N., & DeNisi, A. (1998). Feedback interventions: Toward understanding the double-edged sword. *Current Directions in Psychological Science, 7*, 67–72.
- Kuhn, D. (2006). Do cognitive changes accompany developments in the adolescent brain? *Perspectives on Psychological Science, 1*, 59–67.
- Landauer, T. K., Laham, D., & Foltz, P. (2003). Automatic essay assessment. *Assessment in Higher Education, 10*, 295–308.
- Lee, K., & Karmiloff-Smith, A. (1996). The development of external symbol systems: The child as a notator. In R. Gelman and T. Kit-Fong (Eds.), *Perceptual and cognitive development* (pp. 185–211). San Diego, CA: Academic Press.
- Levy, C. M., & Ransdell, S. (1995). Is writing as difficult as it seems? *Memory & Cognition, 23*, 767–779.
- Light, R. J. (1992). *The Harvard Assessment Seminars. Second report. Explorations with students and faculty about teaching, learning, and student life*. Cambridge, MA: Harvard University.
- Logan, G. D. (1988). Toward an instance theory of automatization. *Psychological Review, 95*, 492–527.
- MacDonald, N. H., Frase, L. T., Gingrich, P. S., & Keenan, S. A. (1982). The Writer's Workbench: Computer aids for text analysis. *Educational Psychologist, 17*, 172–179.
- Mailer, N. (2002). *The spooky art: Some thoughts on writing*. New York: Random House.
- McCutchen, D. (1984). Writing as a linguistic problem. *Educational Psychologist, 19*, 226–238.
- McCutchen, D. (1988). Functional automaticity in children's writing: A problem of meta-cognitive control. *Written Communication, 5*, 306–324.
- McCutchen, D. (1996). A capacity theory of writing: Working memory in composition. *Educational Psychology Review, 8*, 299–325.
- McGee, T. (2006). Taking a spin on the Intelligent Essay Assessor. In P. F. Ericsson & R. H. Haswell (Eds.), *Machine scoring of student essays* (pp. 79–92). Logan: Utah State University Press.
- National Assessment of Educational Progress. (2002). *The Nations Report Card. Writing 2002 Major Results*. Washington, DC: National Center for Education Statistics. Retrieved September 23, 2003, from <http://nces.ed.gov/nationsreportcard/writing/results2002/>
- National Assessment of Educational Progress. (2007). *The Nations Report Card. Writing 2007 Major Results*. Washington, DC: National Center for Education Statistics. Retrieved December 15, 2008, from http://nationsreportcard.gov/writing_2007/
- National Commission on Writing. (2003, April). *The neglected "R": The need for a writing revolution*. Retrieved December 1, 2008, from http://www.writingcommission.org/prod_downloads/writingcom/neglectedr.pdf
- National Commission on Writing. (2004, September). *Writing: A ticket to work. . . or a ticket out: A survey of business leaders*. Retrieved December 1, 2008, from http://www.writingcommission.org/prod_downloads/writingcom/writing-ticket-to-work.pdf
- National Survey of Student Engagement. (2006). *Annual report 2006*. Retrieved December 1, 2008, from http://nsse.iub.edu/NSSE_2006_Annual_Report/docs/NSSE_2006_Annual_Report.pdf
- National Survey of Student Engagement. (2007). *Annual report 2007*. Retrieved December 1, 2008, from http://nsse.iub.edu/NSSE_2007_Annual_Report/docs/NSSE_2007_Annual_Report.pdf
- Nickerson, R. S., Perkins, D. N., & Smith, E. E. (1985). *The teaching of thinking*. Hillsdale, NJ: Erlbaum.

- Nystrand, M. (1989). A social interactive model of writing. *Written Communication, 6*, 66–85.
- Ohlsson, S. (1992). The learning curve for writing books: Evidence from Professor Asimov. *Psychological Science, 3*, 380–382.
- Olive, T., Kellogg, R. T., & Piolat, A. (2002). The triple task technique for studying the process of writing: Why and how? In T. Olive & C. M. Levy (Eds.), *Contemporary tools and techniques for studying writing* (pp. 31–59). Dordrecht, The Netherlands: Kluwer Academic.
- Perkins, D. N., & Salomon, G. (1989). Are cognitive skills context bound? *Educational Researcher, 18*, 16–25.
- Plimpton, G. (Ed.). (1989). *Women writers at work: The Paris Review interviews*. New York: Penguin.
- Ransdell, S., & Levy, C. M. (1996). Working memory constraints on writing quality and fluency. In C. M. Levy & S. E. Ransdell (Eds.), *The science of writing: Theories, methods, individual differences, and applications* (pp. 93–106). Mahwah, NJ: Erlbaum.
- Ransdell, S., Levy, C. M., & Kellogg, R. T. (2002). Effects of secondary task demands on writing. L-1: *Educational Studies in Language & Literature, 2*, 141–163.
- Raskin, E. (1936). Comparison of scientific and literary ability: A biographical study of eminent scientists and letters of the nineteenth century. *Journal of Abnormal and Social Psychology, 31*, 20–35.
- Sanoff, A. P. (2006, March 10). What professors and teachers think: A perception gap over students' preparation. *Chronicle of Higher Education*. Retrieved March 10, 2006, from <http://chronicle.com/free/v52/i27/27b00901.htm>
- Scardamalia, M., & Bereiter, C. (1991). Literate expertise. In K. A. Ericsson & J. Smith (Eds.), *Toward a general theory of expertise: Prospects and limits* (pp. 172–194). Cambridge, UK: Cambridge University Press.
- Schein, J. M., & Schneider, W. (2005). Neuroimaging studies of practice-related change: fMRI and meta-analytic evidence of a domain-general control network for learning. *Cognitive Brain Research, 25*, 607–623.
- Schmidt, R. A., & Bjork, R. A. (1992). New conceptualizations of practice: Common principles in three paradigms suggest new concepts for training. *Psychological Science, 3*, 207–217.
- Schute, V. (2008). Focus on formative feedback. *Review of Educational Research, 78*(1), 153–189.
- Shermis, M. D., & Burstein, J. (2003). *Automated essay scoring: A cross-disciplinary perspective*. Mahwah, NJ: Erlbaum.
- Sommers, N. (1980). Revision strategies of student writers and experienced writers. *College Composition and Communication, 31*, 378–387.
- Sowell, E. R., Thompson, P. M., Holmes, C. J., Jernigan, T. L., & Toga, A. W. (1999). In vivo evidence for post-adolescent brain maturation in frontal and striatal regions. *Nature Neuroscience, 2*, 859–861.
- Squire, L. R. (1992). Declarative and nondeclarative memory: Multiple brain systems supporting learning and memory. *Journal of Cognitive Neuroscience, 4*, 232–243.
- Traxler, M. J., & Gernsbacher, M. A. (1992). Improving written communication through minimal feedback. *Language and Cognitive Processes, 7*, 1–22.
- Vanderberg, R., & Swanson, H. L. (2007). Which components of working memory are important in the writing process? *Reading and Writing, 20*, 721–752.
- White, E. M. (1989). *Developing successful college writing programs*. San Francisco: Jossey-Bass.
- Winterowd, W. R. (1975). *Contemporary rhetoric: A conceptual background with readings*. New York: Harcourt Brace.
- Wishbow, N. A. (1988). Studies of creativity in poets (Doctoral dissertation, Carnegie Mellon University, 1988). *Dissertation Abstracts International, 51*(02), 0491A.
- Zimmerman, B. J., & Bandura, A. (1994). Impact of self-regulatory influences on writing course attainment. *American Educational Research Journal, 31*, 845–862.
- Zimmerman, B., & Kitsantas, A. (2002). Acquiring writing revision and self-regulatory skill through observation and emulation. *Journal of Educational Psychology, 94*, 660–668.
- Zimmerman, B. J., & Risemberg, R. (1997). Becoming a self-regulated writer: A social cognitive perspective. *Contemporary Educational Psychology, 22*, 73–101.