3 A Review of Writing Model Research Based on Cognitive Processes

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Faced with many different levels of writing proficiency, composition instructors know all too well the extreme variations in ability between students. Typically inexperienced or novice writers do not take much time to develop detailed plans before writing, and when confronted with the need for revision, they consider any rewriting as punitive. This negative attitude toward correcting their text often means they focus on surface errors only, or if they do global revision, often it is less effective than their original text. Professional or expert writers, on the other hand, incorporate revision into every aspect of the writing process, looking at it as a positive opportunity for discovery as they write and rewrite. Since they view creating written text as a recursive activity, their revisions are typically global in scope.

Given this constant disparity between novice and expert writers, as well as the complexity of revision, over the last twenty-plus years composition researchers have tried to parse the process through different writing models. In 1980 Linda Flower and John Hayes proposed a shift from the traditional linear sequence models being used to describe various steps taken during writing to process-based models. By placing cognitive actions in a hierarchical format that reflected the recursive nature of writing, they initiated a new and highly productive approach to composition research. Dividing their model into three main parts, "the task environment, the writer's long-term memory, and the writing processes," Flower and Hayes hoped this basic cognitive model would lead to a clearer understanding of the key steps and thought patterns that occur throughout the writing process (369). With this knowledge,

they hoped composition researchers might then discover the most effective ways to instruct novice writers so that they could more easily learn and then use strategies that foster better overall revision, thereby developing writing expertise. To better understand what progress has been made in understanding the cognitive processes used in writing, and in particular in revision, it is helpful to review the key writing models that have evolved over the last twenty years. With a clearer understanding of how various cognitive abilities interact during the writing process, especially the role that evaluation skills and working and long-term memory play, it becomes much easier to determine what kinds of instruction techniques will help novice writers develop effective revision strategies, and therefore, writing fluency.

Early Models—Basic Processes and Their Key Sub-Categories

During the 1980s, researchers refined their analysis of the basic elements of the composing process model, in an attempt to discover how to help basic writers develop into more proficient writers by improving their revision strategies. Throughout the 1980s, Flower and Hayes continued to rework the components of their writing model to better understand why expert writers were better than novice writers in constructing effective global-based review of their texts, with the hope of helping inexperienced writers learn how to revise more effectively. The first reconfiguration of their initial model was made in 1981. In this model, three main processes of planning, translating and reviewing operate through a monitor function that allows access not only to these three activities but also the writer's long-term memory. Reviewing is divided into two sub-categories: 1) evaluation, which provided for specific appraisal of the written text, and 2) revision, which referred to the actual changes.

To better represent the recursive nature of revision, Carl Bereiter and Marlene Scardamalia expanded the evaluation and revising process suggested by Flower and Hayes in 1981 by developing a compare, diagnose and operate (CDO) planning stage in their 1983 model, which they later refined in 1985. Since most writers read their own mental version of what they planned to write, rather than the actual text on the page, Bereiter and Scardamalia theorized that when revising, writers first "compare" their mental text with what they have

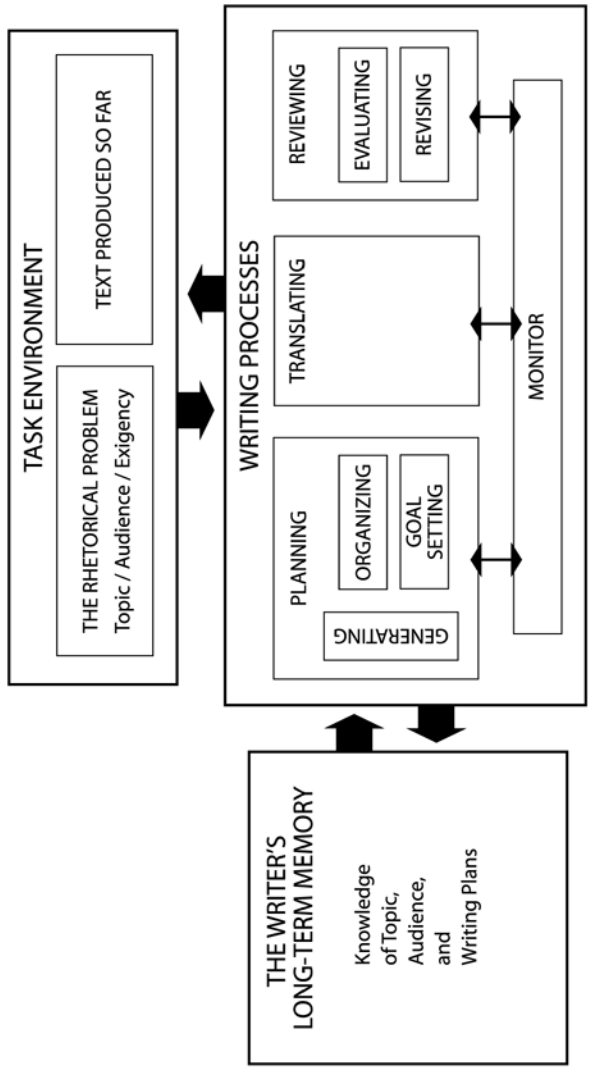

Figure 1. Flower and Hayes model of cognitive processes used during revision (370). ©1981 by the National Council of Teachers of English. Used by permission.

written. Then if they see a problem, they "diagnose" what needs to be changed and, after considering revision options, "operate" on the text to complete the revision. In one study, Bereiter and Scardamalia asked elementary-aged children to follow the CDO process as they first wrote and then reviewed their sentences. The children next decided if there were any problems with their text, by using a set of diagnostic cards, some offering evaluative comments, others revision suggestions.

The third step included doing any rewriting the children thought necessary to improve their sentences. Even though they couldn't explain why they selected a particular card, 74 percent of the children thought the CDO process made it easier for them to write. However, it should be noted that their revisions usually didn't improve their writing. The results of this study underscore the lack of diagnostic skills most novice writers possess.

Another study Bereiter and Scardamalia conducted in 1983, focused more specifically on the diagnostic element of the CDO process. Sixth and twelfth graders evaluated essays by color-coding any *detected* problems, either with a green mark if they knew exactly what the problem was or a red mark if they were unsure. Next students used 13 diagnostic cards with different suggestions, like "Hard to tell what the main point is" or "Incomplete idea," to *diagnose* which tactic best applied to the essay, either as a whole or for a specific paragraph or sentence. Then, rather than actually rewriting the text, students offered revision suggestions. Results confirmed that students do increase their diagnostic skills through support techniques that offer evaluative comments or tactical cues for revision work.

Scardamalia and Bereiter also tracked how advanced planning might help students increase their reflective thinking. Focusing on how students used planning cue cards, whether self selected or proposed by an experimenter or peer, Scardamalia and Bereiter hoped to discover what writing tactics worked best and when these methods had the most productive effect on the writing process. In order to do this, as students planned and then wrote essays, they were handed cue cards whenever they paused. Some cues, the "go-on" ones, encouraged students to expand their planning ideas, while others, the "reflective" ones, led students to reconsider what they had already decided to do (317). Again, while the quality of the writing itself didn't improve, there was an increase in reflective thinking, especially when experimenters gave cue cards to students. The results of Bereiter and Scardamalia's CDO-based studies helped to demonstrate just how complex the reviewing process really is, and in addition, to highlight the need for further research in how various cognitive processes function, especially in relation to detection and diagnosis, within the basic writing model.

To further augment this focus on the diagnostic operations that occur during revision, Flower, et al. in 1986 and Hayes, et al. in

1987 modified their writing models to include two new sub-stages: 1) processes, which involved reading to evaluate, selecting a strategy, and executing the revision; and 2) knowledge, which included task definition, criteria for planning and text, problem representation, and revision procedures. In this way, they tried to represent more specific cognitive paths followed during the evaluation and revision processes. For the first time, the writer's knowledge and intentions are both included in the model. In addition, reading takes on added importance, as it becomes the key to discovering text problems, which in turn leads to revision, whether on a local or global level. During revision, in the 1987 model writers read the written text to evaluate whether it matches their intended purpose. If they detect or diagnose a problem, then they decided what strategy to use for correcting the situation.

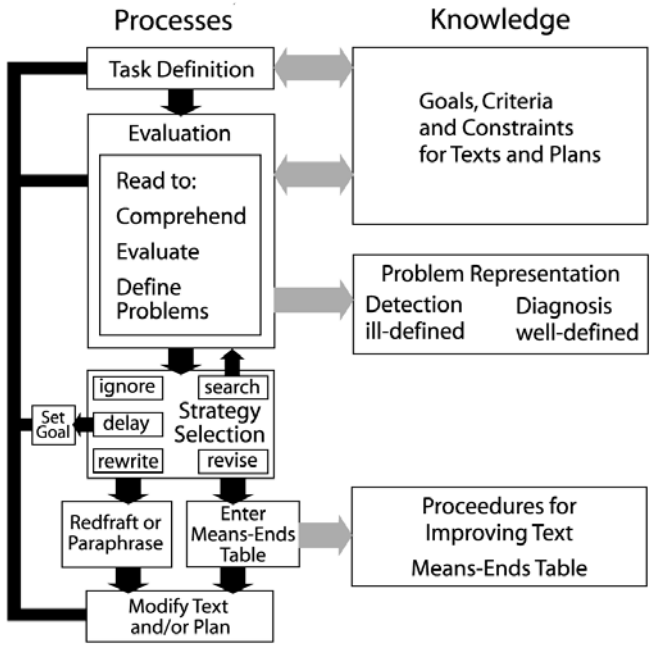

Figure 2. Flower, et al. model of key interactions between processes and knowledge used during revision (24). © 1986 by the National Council of Teachers of English. Used by permission.

In an effort to specifically track where and how detection and diagnosis facilitate or block the revision process, Flower, et al. designed a study which compared revising approaches implemented by students, teachers and professional writers when confronted with a revision

task—to create a freshman student handout from a letter dealing with college sports participation written by a college coach for a colleague. While the expert writers only detected 58 percent of the "planted problems," when their revisions were completed, 91 percent of these problems had disappeared (39). Flower, et al. attributed this to one of two rules: 1) precedence, where once a global problem is discovered, it becomes the main priority so the search for other errors stops; and 2) density, where once a great deal of problems surface, it becomes more efficient to merely rewrite everything. The students in this study had more difficulty detecting the "planted" problems, even adding many new problems as they tried to rewrite the letter, pointing to weak detection skills—especially as they tried to determine what key intentions to focus on for planning and then selecting appropriate revision strategies. The expert writers, however, knew immediately that they had many choices, such as totally ignoring a problem, dealing with it later, revising it immediately, or doing a total rewrite.

From the research results reported by Flower, et al. it is evident that diagnostic skill is often the most important factor in successfully revising texts, both on a surface and global level. In fact, Flower, et al. clearly demonstrate the advantage an expert writer has over the novice, when following one of the two basic reviewing strategies: Detect/Rewrite and Diagnose/Revise. Choosing the rewrite option is the simplest solution to problematic text, but can also overload working memory if the writing task is complex, since the writer must juggle various planning and translating ideas before beginning to compose any new text. The revise option hinges on the writer's ability to first recognize an error and then place it in an appropriate category so that workable revision choices can be reviewed. Picking the best solution depends on the writer's knowledge, which is stored in long-term memory. Novice writers tend to select the rewrite option because they assume it will be easier, not realizing how much the generation of new text will tax their memory capacity. In addition, novice writers don't have the ability to categorize problems—"to see a problem in the text as a meaningful, familiar pattern" (48)—like more experienced writers. To help illustrate this point, Flower, et al. noted that in a study analyzing how chess players plan their moves, "[t]he masters planned no further ahead than normal players—they simply made better plans; they planned the *right* moves" (47). This kind of ability also separates novice writers from expert writers. Since they have a large repository

of past writing experiences stored in their long-term memory, expert writers can implement "a rapid interplay of conscious and automatic processes" as they revise, without overloading either their working or long-term memory capacity (48).

As researchers began to better understand how knowledge worked with intentions throughout the revision process, working memory and long-term memory capacity became an integral piece in explaining why novice writers usually attempt surface corrections, instead of more challenging globally-oriented revisions preferred by most expert writers. Psychologist Alan D. Baddeley facilitated this shift in focus in 1986, when he formulated the first model of working memory, which includes the central executive function, and two slave systems: the visuo-spatial sketchpad and phonological loop. By analyzing what kinds of knowledge and types of activities are done in working memory, especially automatic ones that then help to ease the cognitive load that writing requires, researchers now hoped to track differences in how novice and expert writers used these processes. Throughout the 1980s, composition researchers analyzed how cognitive processes interacted during writing. The results of their studies expanded the initial three-part Flower and Hayes model of planning, translating and reviewing, shifting the focus so that more emphasis was devoted to the reviewing process, especially detection and diagnosis strategies.

Task-centered Models—Assessing the Role of Reading and Memory in Revision

The 1990s saw a shift in focus, as new models were developed to further in-depth analysis of working memory and long-term memory and their role in writing proficiency, in addition to addressing social and motivational aspects of the writing process. Three new models developed by Ronald T. Kellogg, John Hayes, and Huub van der Bergh and Gert Rijlaarsdam are presented in *The Science of Writing: Theories, Methods, Individual Differences, and Applications.* Kellogg concentrated on adapting Baddeley's working memory model to the overall writing process, Hayes focused on developing more detailed sub-processes used during revision in his task schema model, and van der Bergh and Rijlaarsdam inserted the element of time into their writing model.

Kellogg, in his essay "A Model of Working Memory in Writing," reinterpreted the basic parts of the writing model setting up three pro-

cesses that operate in conjunction with the working memory functions, the visuo-spatial sketchpad, central executive and phonological loop. His first process, formulation, involves planning and translating rhetorical goals into text. The second, execution, is comprised of actually creating the text, either by writing it out by hand or word processing it. In the final process, monitoring, reading and editing are used to evaluate and then revise text. According to Kellogg, these processes operate simultaneously and, depending on the tasks involved, affect the capacity of working memory, especially the central executive, since it is activated during most of these activities. Claiming that writing fluency, but not necessarily quality, is affected by different skill levels, Kellogg analyzes six areas researchers have studied in relationship to writing models and working memory: output modes, planning strategies, capacity differences, irrelevant speech, simultaneous articulation, and loading of the central executive. Most of these studies show that expert writers usually have better overall memory capacity, because they have more developed skills needed to effectively compose or revise texts which operate automatically, thereby easing any overload on their central executive as they write. Students, on the other hand, often get stuck as they try to revise their writing because they have weak skill levels, in addition to minimal practice in planning or translating their ideas into words, which in turn affects the over all capacity of both their working memory and long-term memory capacities.

Hayes, too, was interested in how a writer's skills affected fluency and quality of text. Focusing on the evaluation of text in the reviewing stage in his essay "A New Framework for Understanding Cognition and Affect in Writing," he devised a task schema with two main categories: 1) fundamental processes, which include text processing, reflection and text production; and 2) resources, which are stored either in working or long-term memory. During revision, once a problem is discovered through fundamental processes like critical reading or reflection, writers select an appropriate resource stored in their long-term memory and activate it in their working memory. Hayes stresses the importance of critical reading skills in his schema, focusing on three key areas: content comprehension, task definition, and text revision. Because expert writers have stronger reading skills, have more audience awareness, and have a better understanding of their writing topic, they produce more successful texts as they draft/revise to meet their

rhetorical goals, probably because they utilize their working memory capacities more effectively than novice writers.

Neither Hayes nor Kellogg include the element of time in their writing models, an omission van der Bergh and Rijlaarsdam feel is an integral part of writing that must be accounted for in any writing model. To incorporate time into the writing process, they designed a model in 1994, refining it in 1999, for monitoring when various cognitive activities occur. According to van der Bergh and Rijlaarsdam, in "The Dynamics of Composing—An Agenda for Research into an Interactive Compensatory Model of Writing: Many Questions, Some Answers," cognitive activity is initiated through four interrelated functions: 1) the writing assignment, 2) rereading written text, 3) translation of meaning into text, and 4) generation of ideas. Activation of any of these activities, which may happen at any time during the writing process, increases the likelihood of additional discovery for generating writing.

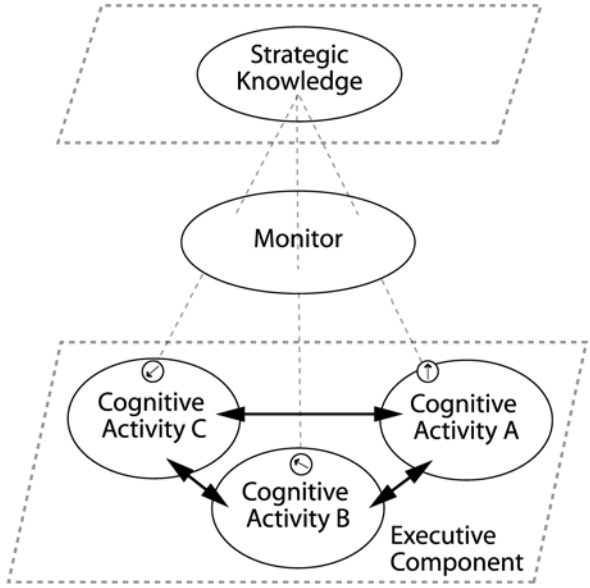

Figure 3. Writing model developed by van der Bergh and Rijlaarsdam to incorporate the element of time into the writing process (Levy and Ransdell 108). Used by permission.

Placing the most emphasis on the role cognitive strategies play during the writing process, van der Bergh and Rijlaarsdam's model has three basic modules: the executive component, monitor and strategic

knowledge. The executive component module includes basic writing activities such as organizing content, generating text or evaluating ideas; the monitor module manages the transfer of knowledge domains; and the strategic knowledge module stores cognitive strategies that can be summoned by the monitor module when needed by the executive component during the writing process. In this model, memory of different cognitive strategies is contingent on different learning activities done in the executive component module. Writing activities can be based on three different approaches: trial and error, specific instructions or self-construction. The act of writing increases a writer's ability to learn different cognitive strategies. As writers gain more writing skills, they learn how to transfer them in a productive way when faced with an unfamiliar writing task. Because of this capacity to adapt skills over time, van der Bergh and Rijlaarsdam make distinctions between weak and good novices, rather than novice and expert writers.

No matter what terminology is used, during the 1990s cognitive strategies and working memory capacity became the central focus for analyzing how writing expertise develops. It became very apparent to researchers that the well-developed reading ability and extensive writing experience expert writers possess expands working memory capacity and long-term memory knowledge. However, more research was still necessary to better understand how to increase these capabilities in novice writers.

Recent Research—Continued Analysis and Testing to Validate Revision Models

As a result of the redevelopment and refinement of so many cognitive-based writing models during the 80s and 90s, research data based on well-designed studies was needed to confirm their validity. Therefore, much recent composition research has been devoted to not only analyzing the key aspects of these models, but also devising studies that can effectively measure the cognitive activities that novice and expert writers use as they write/revise texts, to see if the models accurately predict what happens from initial planning of the writing task assignment to the completion of the written text.

In *Through the Models of Writing,* Denis Alamargot and Lucile Chanquoy present an exhaustive review of cognitive writing models

to determine exactly how writers can develop expertise in writing, concluding that expertise comes with maturity and practice. Dividing their discussion into three main parts, they first review cognitive writing-model designs and then closely analyze how planning, translating and revising processes function in these models. Part II follows with an examination of how cognitive processes are controlled, how working memory operates within the key writing models, and how writers develop into expert writers. In conjunction with their main conclusion that maturity and practice are the two key components that lead to better writing ability, Alamargot and Chanquoy offer several points for further study, as they analyze the different mechanisms implemented during the writing process, looking specifically at implications created by differences in working memory capacity between inexperienced and expert writers. Capacity is affected by how knowledgeable writers are about the subject matter, in addition to their ability to activate appropriate linguistic resources and rhetorical strategies. Being more familiar with topic data enables writers to more easily select ideas from long-term memory and organize them into an effective structure; this results in less working memory capacity being expended on the planning and translating processes. Expanding linguistic resources enables writers to become more fluent, since their selection of lexical and syntactical structures becomes more automatic, while increasing the range of rhetorical strategies allows writers to construct texts that address overall goals more quickly, again because their increased knowledge frees up working memory space.

While most recent writing models seem to indicate that working memory capacity improves as writers mature or gain writing experience, Alamargot and Chanquoy suggest that this narrow focus may be too restrictive. The two commentaries offered by Kellogg and Hayes in Part III of *Through the Models of Writing* reinforce this point. Kellogg suggests that the highly interactive nature of writing processes places extensive demands on working memory capacity, that these complex tasks indicate the need for a multicomponent model of working memory, and that the time expended during writing tasks may be just as important as the working memory load. Hayes comments on the importance of analyzing how writing ability develops in children, of learning how to increase metacognition, of continuing to develop means for expanding awareness of task, audience, and persona. He also calls for continued efforts to connect research results with practi-

cal applications, so that theory and practice can produce a clearer understanding of cognitive strategies.

In this vein, based on results from their 2001 study of writing fluency in students who are learning a second language, John Hayes and N. Ann Chenoweth propose a new version of the 1996 task schema that includes three levels: control, process and resource. While the control level is identical in both models, the process level, designated as the fundamental processes in the 1996 version, is now divided into two main components, to underscore the importance repertoire of writing strategies and long-term memory capacity play in writing fluency. First, there is external; this includes the written text, the audience for the writing task, and any materials used to draft/write the text, from reference texts like dictionaries or style books to notes or peer comments. The second component is internal; it may initiate four possible actions: 1) proposing, 2) translating, 3) revising, and 4) transcribing. In order to create text, any of these internal actions may activate working memory, long-term memory, or critical reading, the three components stored in the final resource level. With this model, then, at the process level, various internal actions work with specific external elements, calling on stored resources as needed to complete the writing task goals. Since the results of their study showed increased language skills facilitated writing fluency, Chenoweth and Hayes recommend that teachers give students ample opportunity to practice writing in order to increase their lexical and strategic proficiency, so that retrieval of these skills becomes more automatic. Any kind of writing task that helps students increase their ability to use new writing strategies will increase their fluency. Chenoweth and Hayes favor assignments that will not be interrupted by revision, so students can practice "the strategy of 'write it down, even if flawed, and revise it later'"(96). This kind of writing practice not only helps students expand their repertoire of writing strategies, but also increases their long-term memory capacity, necessary task schema components for building better fluency.

Alice S. Horning, in her 2002 book *Revision Revisited,* also focuses on writing fluency, but her study analyzes the processes nine expert writers from various professions use as they revise text. She suggests that writing expertise, especially revision, is contingent on well-developed metarhetorical, metastrategic and metalinguistic awareness, in addition to four basic writing skills: 1) collaboration, 2) genre, 3) text and context, and 4) tools. These categories of awareness are em-

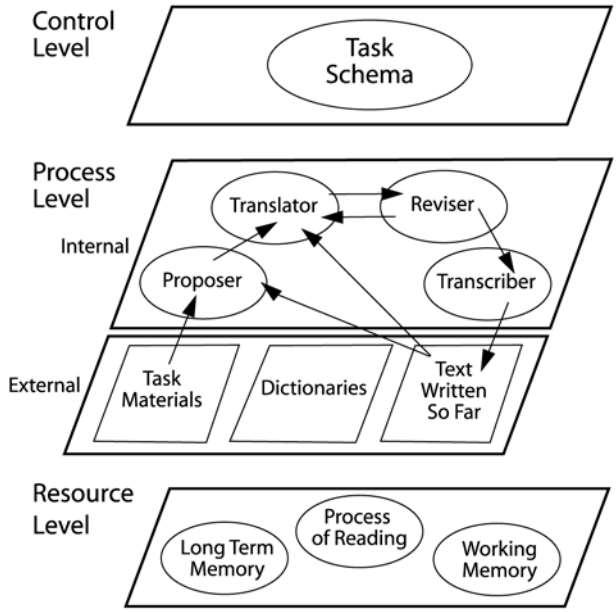

Figure 4. Chenoweth and Hayes model of four basic writing actions (84). Used by permision.

bedded in various writing models, especially when the task schema is considered. Starting with the 1987 Hayes, et al. model, metarhetorical, metastrategic and metalinguistic awareness would encompass the process of text evaluation and strategy selection, when the need for revision is detected. The four writing skills would be equated with the writer's knowledge. Specifically, collaboration and genre would parallel task definition; genre would also parallel criteria for plan and text; text and context would parallel problem representation; and procedures for fixing text problems would parallel tools. In the most recent 2001 Chenoweth and Hayes model, metarhetorical, metastrategic and metalinguistic awareness would be part of the internal process, activated when writers propose, translate, revise or transcribe text, while the collaboration, genre, text and context, and tools would operate as part of the external process.

Horning's contention that expert revision often employs unconscious knowledge of the three kinds of awareness she defines, along with conscious knowledge or activation of the four basic skills, underscores the role working and long-term memory play during the writing process. With extensive resources for both technical skills and cognitive

awareness stored in long-term memory, the load on working memory capacity is eased, especially when many writing activities become automatic. The professional writers who participated in Horning's study, not only had highly developed lexical skills, but also the ability to assess the task definition, choose the most appropriate genre, and then create text using either preferred and non-preferred strategies, based on what best fit the writing task/goal. Since these writers gained their expertise through many years of practice, this study helps to substantiate Alamargot and Chanquoy's hypothesis that maturity and practice are two necessary elements needed to develop writing expertise.

Linda Allal, Lucile Chanquoy, and Pierre Largy continue the discussion of how cognitive and metacognitive abilities operate during revision in *Revision: Cognitive and Instructional Processes.* Starting with a review of various definitions of revision used since Fitzgerald's 1987 definition, they conclude that revision "transformations," the actual changes to written text, seems to result from two main actions: 1) the detection of some problem with the internal or external text, or 2) some discovery made during the process of envisioning and then creating written text. Because of this key difference in how revision is initiated, Allal, Chanquoy, and Largy suggest that studying various instructional techniques to determine how they increase cognitive processing might help writing instructors assist novice writers in gaining appropriate skills needed to revise on both a local and global level.

Serving as an introduction to the studies Allal, Chanquoy, and Largy include in Volume 13, the most recent addition to the *Studies in Writing* series, Hayes introduces the question of how novice writers detect the need for revision by reviewing the basic cognitive writing models. Since most novice writers have difficulty finding problems, especially on a global level, he suggests that more research is needed to determine how students can expand the their criteria for evaluating written text, especially since many of the traditional instruction methods, like teacher comments on drafts or the use of models, fail to help novice writers successfully revise their writing.

This situation recalls Flower, et al.'s work with detection and diagnosis during the mid-1980s; however, almost twenty years later, the use of computer technology has helped refine data collection and analysis. For example, in order to study the relationship between revision and low- or high-working memory capacity, Annie Piolat, et al. monitored undergraduate psychology students as they worked with three versions

of a psychology magazine article, to which various spelling, syntactical or coherence problems had been added. This computer-based experiment was done in two stages. In the first session students were evaluated on how well they read and then answered questions about the text content. Depending on their responses, students were then divided into two groups based on whether they exhibited low or high working memory capacity. The second session involved having students detect problems, find solutions, and then revise the problematic text. Piolat, et al. determined that cognitive effort does not seem to be affected by working memory capacity, because no matter what the level of working memory, participants took whatever time was needed to resolve the revision problems. However, this study did show that reading text for basic understanding is much less taxing on working memory than reading to discover problems that may require revision. Here then, the results reflect research data reported by Flower, et al. in 1986, where detection of a problem becomes the key determiner for the direction any revision work might take.

Instructional Techniques

Since this kind of highly demanding cognitive activity is not easy to learn, many of the other studies included in Allal, Chanquoy, and Largy's book focus on various instructional techniques. For example, David Galbraith and Mark Torrance monitor two basic methods of drafting: one where the writer plans his or her text by creating an outline *before* writing, the other where the writer begins to write, developing his or her text through discoveries made *during* the writing process. In their study, they track four drafting strategies: 1) organized sentences, similar to rough drafting; 2) unorganized sentences, like multiple drafting; 3) organized notes, equated to outlining; and 4) unorganized notes. While their results confirm Kellogg's research that developing an outline before writing yields the most successful text, they suggest that individual differences might influence successful use of these four strategies, a hypothesis Horning raises in *Revision Revisited,* as she illustrates how personality type influences implementation of various metastrategies during writing.

While a writer's personality may dictate writing strategy choices, for novice writers, the need for additional instruction in a number of other basic writing skills plays a far greater role in increasing their

ability to make effective revisions. Learning to understand text from the reader's perspective, for instance, can help writers view text more globally, leading to better revision. David R. Holliway and Deborah McCutchen created a study where fifth and ninth grade writers wrote and evaluated descriptions of tangram figures in three ways: 1) giving feedback only; 2) giving feedback plus a rating; and 3) giving feedback by assessing how successful the descriptions were from a reader's perspective. The results of this study indicated that peer response work is most effective when there is a real purpose for the written text. In addition, if peer responses are based on very specific evaluation criteria, then the peer reviewers are much more likely to apply these skills to their own writing.

Similar results were reported by Angela Conner and Margaret R. Moulton when they attempted to increase eighth grade students' revision and editing skills by having them publish two genres of writing for two different audiences. First, students created research-based booklets and poetry books for the sixth grade students. Then they wrote a short story, news article or poem as part of a local writing competition. While the students did increase their writing ability, Conner and Moulton were disappointed in the extent of the improvement. Their realization that they needed to more actively teach editing and revision skills underscores the importance that task schema resource knowledge plays in developing writing expertise. However, because these students had closer contact with their readers, especially the sixth graders, they were much more motivated to do revision work. Also, because of the positive feedback they received, they increased their self-confidence, viewing themselves as better writers. Charles A. MacArthur, Steve Graham and Karen R. Harris reported similar conclusions about the need for well-developed evaluation criteria in their study of writers with learning disabilities. Their results showed that working with peers can offer motivation by adding a social element, but there is still need for fairly specific instructions, as well as help in selecting what kinds of cognitive strategies will work best.

Increasing linguistic fluency also seems to play a major role in effective revision. Amos Van Gelderen and Ron Oostdam look at this aspect of revision by first reviewing the fundamental task schema model and then proposing a four-level revision process model. The first level, proposed text, is where the specific form of the words is reviewed; the second, local externalized text forms, is where editing is done to fix

form errors; the third, local externalized text meaning, is where the meaning of the proposed text is checked against text already written; and the fourth, global externalized text meaning, is where proposed text content is compared to the entire piece of writing. Noting that each level increases the cognitive cost, especially for novice writers, Van Gelderen and Oostdam offer some recommendations for how to increase skill levels in the classroom, in particular using exercises that offer both implicit and explicit practice in identifying both linguistic forms and content meaning.

Since peer responses have proven to be beneficial in helping students revise their writing, recently more attention has been directed to assessing the use of integrated sociocognitive (IS) instruction. Allal compares the IS approach to the componential skills (CS) method to see if the type and sequence of writing tasks affect instruction, and in particular if one format is more beneficial in helping second and sixth graders gain better writing skills. In this two-part study, students first initiated their prewriting work by defining the specific writing task. Then, after looking at models and analyzing basic elements like genre, purpose, and so forth, students worked in groups to facilitate sharing ideas about content, which in turn helped generate some guidelines for the assigned writing task. The second part of the process involved on-line revision, based on help from teachers or peers, with text transformations made either during the actual writing process or delayed to another writing session. In addition, some of the skill instruction work involved explicit, separate exercises that were not part of the writing process, while others were implicit, embedded in the various writing activities connected to the writing tasks.

Allal's study pointed to three key effects IS has on student revision. First, it increased the number of transformations made on students' drafts. Second, fewer errors were found in drafts, especially for students who were better at translating their ideas into concepts or had more skill in revising as they word processed text. Third, since most of the revisions dealt with form and organization and not semantics, most of the revision work done by novice writers was still made at the local level. Based on her findings, Allal concludes that many children enter high school with few writing strategies to address revision needs. Therefore it is important for these beginning writers to get more practice using a combination of instruction techniques, from the explicit

exercises used in CS to the implicit learning that results when IS instruction is integrated into the classroom.

The last two studies presented in Allal, Chanquoy, and Largy's book focus on the collaborative element found in IS instruction. By analyzing how children interact while revising narratives, Pietro Boscolo and Katia Ascorti determined that these beginning writers use two typical methods that teachers also rely on to help students revise. The first involves the collaborator *requesting* a change in the text to make the writer more aware of the reader's understanding of the narrative. The second entails *suggesting* concrete ideas to make the text more reader-oriented. Peers tended to suggest more than request when the narrative was based on fact, apparently feeling that this kind of writing needed to be accurate unlike a totally invented story, and therefore it was their responsibility as collaborators to help make sure the narrative fulfilled their expectations as readers. Not only does this kind of directed revision, where collaborators are given a specific task to analyze, activate the use of more cognitive processes, but it also encourages students to analyze their own writing in light of the same kinds of suggestions they make about their fellow students' narratives.

Yviane Rouiller also finds collaborative revision to be very effective for novice writers, because it leads to more transformations, both in spelling and ordering of idea content. It also increases student motivation. When students take a more positive view of revision and feel that they have equal roles in the revising process, they usually view their revision tasks more globally, and also show better cognitive awareness since they can describe what they are revising and why it needs to be changed. To help novice writers improve their collaborative revision skills, Rouiller suggests four teaching approaches. First, it is important to have students work collaboratively on more than one assignment. It is also helpful to vary the make-up of the pairs or peer groups, so that students interact with as many different students as possible, allowing them to discover a wide range of individual differences in revision strategies. Second, to help students understand these different strategies, it is necessary for them to have enough time to fully discuss everyone's ideas so that they can adequately compare the strengths and weaknesses of each approach. Repeating this kind of activity also increases students' metacognitive skills, by enabling them to be less sensitive when a particular method they might have used to revise their writing is critiqued by their peers. Third, it is important to care-

fully structure this kind of interactive work so that students receive optimum benefit from this kind of interaction. Well-designed group activities can lead to more productive cooperation among peers, better motivation and growth in self esteem. It can also encourage students to be more responsible in a group setting. And finally, collaborative revision can allow the teacher greater flexibility on whether individual or group instruction is implemented in the classroom.

One interesting teacher-based activity suggested by Christyne A. Berzsenyi might be used in conjunction with peer collaborations. She designed her "Comments to Comments" system to help technical writing students better understand feedback on their papers. This method involves an instructor writing comments that prompt revision needs—either local or global—by asking questions about the problematic text. Students then must respond to the issues raised by explaining their reason for using a particular strategy/construction, etc. This comment technique helps to activate the planning function in the task schema, by having the students explain in detail what their reasons were for various choices they made as they planned and then wrote their text. As students revisit the task assignment and their earlier planning steps, in order to justify their choices to the instructor, they discover why certain strategies solve their revision needs better than others. In addition, since this sets up a positive dialogue between the instructor and student, revision is not viewed in a negative way, with the student merely correcting mistakes to please the teacher.

In the final section of Allal, Chanquoy, and Largy's book, Gert Rijlaarsdam, Michel Couzijn and Huub van den Bergh present an overview of revision—how it should be defined, why it continues to be a central focus of composition research, and how instructors can use revision activities to help novice writers gain more writing expertise. They note that since revision does not necessarily improve a written text, it may actually point to deficiencies in the cognitive abilities needed to use appropriate writing process strategies. In addition, revision can activate any number of cognitive processes following no set pattern and these actions can occur at any time, in many combinations through the entire writing process. Improved revision is also directly affected not only by how familiar revisers are with a particular writing task, but also by how capable they are at implementing the basic writing model processes of planning, translating and reviewing. To

explain the highly complex process of revision, Rijlaarsdam, Couzijn, and van den Bergh offer the following definition:

> The (co)author or revisor reviews (part of) the already-written text, to reach a certain goal (communication goal, learning goal), at a certain text level, at a certain moment (i.e., draft, final copy), with a certain effect (i.e., improvement,neutral, weakening effect), at a certain level (text, plan, learning), and with a certain cognitive cost. (193)

Here, then, revision involves *re-seeing* the entire writing process.

Computers and Their Impact on Writing Model Research

The second question Rijlaarsdam, Couzijn, and van den Bergh consider deals with why so much research attention has been devoted to revision. One reason they suggest has to do with how easy it is to track text transformations. Today writing activity can be tracked by using S-notation, Trace-It, JEdit and LS graphing, and when combined with think-aloud protocols, these methods give researchers a fairly accurate record of what writers do as they write or revise. As this kind of measurement is perfected, researchers hope to validate theoretical hypotheses about how cognitive processes operate in writing models. As early as 1996, C. Michael Levy and Sarah Ransdell documented some of the first computers techniques used in research, by analyzing keystrokes in order to track when writers added text, paused to reread text, deleted text, in addition to where they paused—within a word, sentence, or paragraph.

One of the most extensive reviews of present computer-based techniques available is Olive and Levy's 2002 book *Contemporary Tools and Techniques for Studying Writing.* Of particular note is Thierry Olive, Ronald Kellogg and Annie Piolat's successful use of the triple task technique to study how a writer's knowledge, planning abilities, writing methods and cognitive resources affect the writing process. By measuring the reaction time (RT) made by study participants to variable auditory signals while composing different writing tasks, Olive, Kellogg, and Piolat were able to monitor both the RT and capacity load on working memory. They reported on three basic areas that

affect writing expertise. The first is writer-specific and includes domain-specific knowledge plus working memory capacity. The second is situation-specific and involves pre-writing activities like outlining, and so forth. The third area includes both linguistic knowledge and the method used to produce text. Their results demonstrate that the amount of cognitive effort and the length of processing time needed to create text are affected most by the writing situation and the linguistic ability of the writer.

Similar results are reported in a recent study done by Chanquoy, where third and fifth graders were given an opportunity to revise their writing first as they composed the text, and second, after they had completed the text, in order to see whether postponing revision would lead to more in-depth revisions. Chanquoy assumed that with more time, there would be less of a load on working memory, and as a result the children would be able to make more content-based changes. While delaying revision work did lead to more revisions, most of them were surface corrections rather than extensive reworking of text meaning.

Another promising technique, S-notation, is presented by Py Kollberg and Kerstin S. Eklundh. Here computers track any changes made to a text, noting the sequence of the changes and also where they are made—at the word, sentence, or paragraph level. When this kind of record is combined with think-aloud protocols, a very representative picture of external writing processes can be traced, in particular the complex patterns that occur during revision work.

LS graphing, based on S-notation, is yet another way to monitor writing processes that Eva Lindgren and Kirk P.H. Sullivan recommend. Using keystroke-tracking software programs like JEdit, a computer file log of every keystroke action, whether it is an addition or deletion, can be created. Another software program, Trace-it, then allows writers to analyze their actions during a writing session. Here two windows are used, with one displaying the S-notation text, the other every change made during the entire writing session. By combining the information gathered using JEdit and Trace-it, an LS graph can be created which records variables, such as how many strokes have been made, when they were made, and so forth. This method allows researchers, teachers and writers to see various writing activities represented together in one LS graph, making it easier to compare actions that occur during a writing session. For example after a revision ses-

sion, novice writers might reflect on why they made text changes when they did, and then determine whether their planning was adequate. They might also review their LS graph with their instructor to open a dialogue about specific problems in their text related to prewriting work. Another option would be to compare their LS graph with one made by an expert writer completing the same writing task, in order to see what other kinds of activities were used, and to reinforce that fact that there is no one correct way to revise. Whether it is used to make a specific diagnosis or to initiate a dialogue among writers, LS graphing offers an opportunity for close analysis of the task schema external writing processes, helping to indicate concrete differences between novice and expert writers.

While all of these computer-based technologies offer researchers promising methods for gathering data, Rijlaarsdam, Cousijn, and van den Bergh still question what specific information there is beyond the transformation act itself. In Allal, Chanquoy, and Largy's book, the results of van der Bergh and Rijlaarsdam's 2001 study based on monitoring keyboard activity during writing sessions, first presented at the 2001 International IAIMTE Conference in Amsterdam, are summarized. As they tracked transformations, they noted that no matter how/where revisions were made, they usually occurred after some evaluative activity; but more often than not, whatever the nature of the evaluative activity, there was still little actual revision made to texts. Basically, then, tracking text transformations doesn't lead to many valid conclusions about how the revision processes operate before, during and after this activity. However, implementing more detailed tracking of cognitive activity did reveal more specific correlations between transformation behavior and the quality of the text, as well as when various writing processes occurred. As more research is done using computer tracking of transformations along with writing-aloud protocols, it will become easier to determine not only how the writing process is organized, but also when and why cognitive processes are activated over time.

Implications for Classroom Instruction

Since research has already shown that novice and expert writers employ different patterns throughout the composing process, more focused research with these aspects will lead to the development of writing

instruction specifically tailored to the needs of the writer/reviser. This leads to the third question raised by Rijlaarsdam, Couzijn, and van den Bergh—how does the study of revision benefit classroom instruction? Dividing their discussion into three parts, they first look at writing, then at how writing develops as a learning process, and finally at how revision instruction aids in the teaching of writing.

Rijlaarsdam, Couzijn, and van den Bergh suggest that since most children start to write by sharing stories, as they begin to create text there is little need for revision. Writing is seen as an enjoyable task. But soon mere story telling is changed as teachers begin to use classroom writing to develop basic skills. Now these novice writers need to not only think about their narrative content, but also whether they have spelled words correctly, used proper grammatical forms, and so on. At each grade level, new demands are made so that within a few years, writing tasks are used as multi-leveled teaching instruments—no longer easy and fun to create, but instead difficult, time consuming and cognitively demanding. Even though this is true, it is important to help students view revision as a starting point for generating communication with their readers, rather than a punishment for bad writing.

When the purpose of writing shifts from an explicit form of story telling to a mixture of explicit and implicit instruction used for learning different cognitive skills, students are confronted with a very demanding task that requires both productive and reflective ability. According to Rijlaarsdam, Couzijn, and van den Bergh, these difficulties arise for a number of reasons. First, these beginning writers need to devote much of their working memory capacity to producing the written text, because they are not practiced writers. Second, they have weak rhetorical skills so they are often not able to select the most appropriate pattern through which to present their content. Third, novice writers lack experience in understanding reader's needs, and thus remain very writer-oriented as they review their text. As a result, peer feedback is central to effective revision, because it provides students with a sense of audience, as well as increasing their motivation. More controlled feedback criteria that concentrate on a specific aspect also enables peers to offer better evaluative comments. In addition, commentary from a number of peers, especially when it is written down, helps writers gain a broader perspective of how different readers react to drafting strategies. This feedback then needs to be used in a constructive way, so that the information learned from peer responses can be applied to

a writing task—either as the basis for revising the evaluated text or for starting a new piece of writing. In this way, the writer gains needed experience in practicing the new skill, the first step in making it become a more automatic activity for future composing.

Research results, derived from tracking how the writing process operates within the task schema of the different cognitive writing models, have helped shed light on what type of emphasis instructors should place on planning, translating and reviewing as they work with novice writers. Even though half of the composing process is usually devoted to translating, it requires the least cognitive effort. Therefore most of the differences in process between novice and expert writers occur during planning and revising, both highly controlled activities. The more adept writers are at planning, especially in developing outlines for the writing task, the less stress there is placed on working memory. The more feedback writers receive throughout the writing process, the more aware they are of rhetorical considerations. Because peer commentary motivates writers to reevaluate both the form and content of their written text, feedback encourages them to implement additional planning activities, followed by translating these new ideas into revised text, thereby setting up the critical cyclical interaction that occurs within task schema models.

While planning and feedback operations are integral components of revision, genre also has a major effect on cognitive effort. Narrative writing, for instance, takes the least amount of effort, probably because writers at every ability level have practiced this genre since they started to write. In fact, the more practice a writer has with a genre, the less working memory capacity is taxed. Veteran journalists, as an example, may actually compose a news story text while still gathering information, since the inverted pyramid format stored in their long-term memory is easy for the central executive function to activate in their working memory. Because they are so well versed with this genre, they need little time for planning their final article, and therefore spend more time translating their ideas into text. On the other hand, beginning journalism students have no experience with the inverted pyramid genre, so they expend more cognitive effort deciding what fact is most important to the story and therefore should become the lead. Since their main focus is directed toward planning, once they have decided how to organize the information, they are able to translate their ideas into words fairly easily. Whatever the writing

task, then, the more knowledgeable writers are—in content, in genre, in linguistic skills, and so forth—the less effort they need for the planning process. Therefore, increasing planning skills seems to be one of the most important elements of the task schema for novice writers, with feedback being one of the best resources for promoting effective planning choices.

A bit more than twenty years ago revision was seen as a fairly simple task of reviewing which occurred at the end of the writing process. However, through the development and study of how cognitive models function, revision has proved to be a highly complex operation, now viewed as a starting point. Revision is an essential activity that initiates discovery, builds skill levels, and over time, as writers gain maturity through practice, creates writing expertise.