

*My aim in this paper is to provide a brief review of some of the main issues covered in research on writing and to indicate where this research may be found. For convenience of presentation the paper is divided into four overlapping sections: 1) the nature of writing; 2) learning to write; 3) computers and writing; and 4) evaluating written products.*

*A fifth topic, the uses of writing, is covered in more detail by Freedman et al (1987), and readers who are particularly interested in social aspects of writing, and how cultures and activities are shaped by, and have been shaped by writing, are especially referred to this paper. Other review papers on more specific topics have been provided by Applebee, 1984; Chandler, 1991; Cochran-Smith, 1991; Durst and Newell, 1989; Fitzgerald, 1987; Freedman et al, 1987; Hayes and Flower, 1986; Humes, 1983; and Huot, 1990. There are, in addition, many books and book chapters on writing, and several of these will be referred to in this review.*

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### **The Nature of Writing**

- *Process-approaches to writing*

Developments in cognitive psychology, hand-in-hand with developments in computer technology, have had a profound effect on research on writing. The research carried out today addresses different issues and different questions from those asked some twenty years ago. Nonetheless, this does not mean that the earlier research is irrelevant: there is a past literature which it is fruitful to explore in considering where we are now, and where we are going next.

If one compares early educational psychology textbooks with those of the present day, it is also clear that there has been a shift of emphasis in educational practice as far as writing is concerned. In the 1920s the emphasis was on handwriting skills, in the 1950s it was on the grammatical quality of the written products, and today, in the 1990s, it

is on the process of writing—how writers arrive at their end products.

Indeed, it is now commonplace to talk of ‘process-approaches’ to teaching writing. Thus, instead of analyzing classic examples of good practice, and learning the rules that govern it, process-approaches allow learners to explore subcomponents of the writing process in a variety of different contexts. Popular teaching techniques today include those of pre-writing, outlining, group writing, writing for different audiences, and writing without assessment.

Bizzell (1986) describes how research on the process-approach to teaching writing began in the United States with the work of Emig (1971) and in Britain with the work of Britton et al (1975). Emig noted at the time, “of the 504 studies written before 1963 that are cited in the bibliography of *Research on Written Composition* only two deal even indirectly with the process of writing among adolescents.” So her work marked a significant change of emphasis.

Britton et al and Emig worked independently, but they were aware of each other’s work. One of the key ideas that they shared was that the processes used to produce text depended upon the nature of that text. Britton et al distinguished between three main text genres along a continuum: poetic (written for oneself), expressive (written for an intimate friend) and transactional/expository (written for a less personal audience, such as the teacher). Emig described two main kinds of writing—‘reflexive’ (paralleling Britton’s expressive) and ‘extensive’ (paralleling Britton’s transactional).

In carrying out their research Britton et al examined about two thousand essays written by British schoolchildren between eleven and eighteen years of age, and Emig interviewed eight nineteen-year-olds about their writing and provided a detailed case-history, including think-aloud protocols, of the writing processes of one of them. Britton et al and Emig found that their participants generally spent far more time on transactional writing than on expressive writing, but Emig found that her American students much preferred, and spent more time (at home) on expressive writing.

School (transactional) writing was well learned, but it was a mechanical activity. Bizzell (1986) concludes that these

influential research workers brought to the fore two important themes: 1) the process of writing depends upon the nature of the text; and 2) to study writing one needs to examine writers at work.

Table 1 suggests that there are indeed numerous kinds of writing. Writing has different purposes, audiences and genres. And, as we shall see in the following sections of this review, this is important when it comes to examining the acquisition and evaluation of writing skills.

- *The Hayes and Flower model*

There have been many studies of writing processes following this pioneering work (see Freedman et al for references). However, probably the most influential approaches have been those of Hayes and Flower (e.g. Hayes and Flower, 1980a,b; 1983; 1986) and Bereiter and Scardamalia (e.g. Bereiter and Scardamalia, 1987; Scardamalia and Bereiter, 1983; 1985).

Hayes and Flower used think-aloud protocols to develop their cognitive process model of writing. They described the method as follows:

“In protocol analysis the subject is asked to perform a task and to ‘think aloud’ while performing it. In think-aloud studies of writing the writer is asked not only to think aloud but to read and write aloud as well . . . The data from think-aloud studies are contained in the verbatim transcript of the taperecording (with all the um’s, pauses and expletives), together with the essay and all the notes that the writer had generated along the way. The transcript is called a protocol. These materials are then examined in considerable detail for evidence that may reveal something of the processes by which the writer has created the essays. In general, the data are very rich in such evidence. Subjects typically give many indications of their plans and goals, e.g., ‘I’ll just jot down ideas as they come to me’; about strategies for dealing with the audience, e.g., ‘I’ll write this as if I were one of them,’ or about criteria for evaluation, e.g., ‘We’d better keep this simple.’ The analysis of this data is called protocol analysis.” (Hayes and Flower, 1986.)

Using protocol analysis Hayes and Flower constructed the process model of writing shown in figure 1. It can be seen that there are two major areas that impact on the central ‘box’: the task environment, and the writer’s long-term memory.

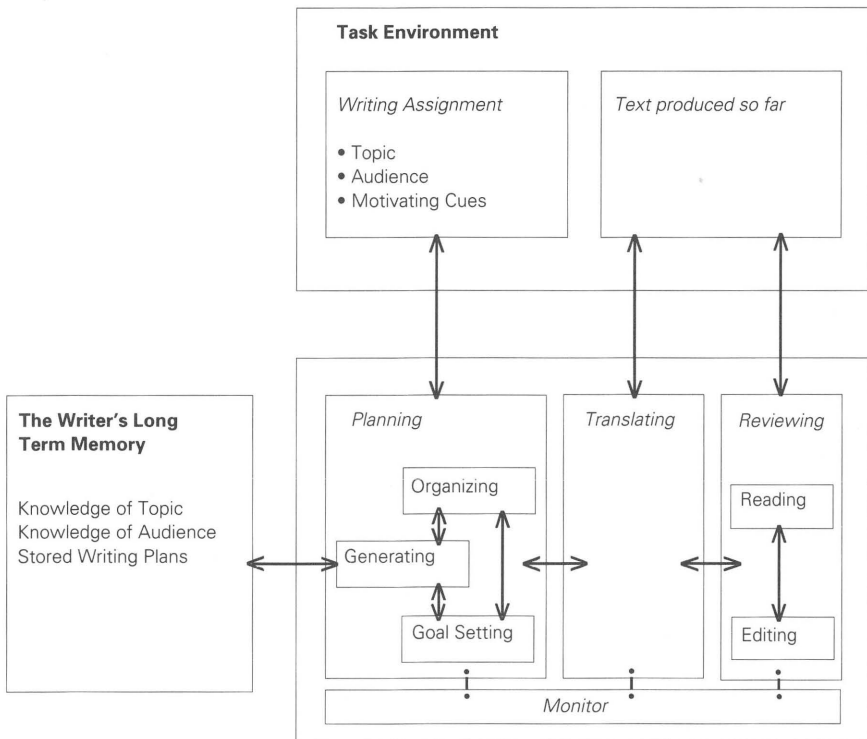
**TABLE 1.** Aims and examples of different kinds of writing.

<b>Cognition</b>		<b>Reproduce</b>		<b>Organize/Reorganize</b>			<b>Invent/Generate</b>	
<i>Dominant Intention/Purpose</i>	<i>Primary Content Main Audience</i>	<i>Facts</i>	<i>Ideas</i>	<i>Events</i>		<i>Things, facts mental states, ideas</i>	<i>Ideas, mental states, alternative worlds</i>	
To learn (metalingual)	Self	Copying, taking dictation		Retell a story (heard or read)		Note Resumé Summary Outline Paraphrasing	Comments on book margins  Metaphors Analogies	
To convey feelings (emotive)	Self Other	Stream of consciousness		Personal story	Personal diary Personal letter	Portrayal	Reflective writing • Personal essays	The traditional literary genres and modes can be placed under one or more of these four purposes
To inform (referential)	Others	Quote	Fill in a form	Narrative report News Instruction Telegram Announcement Circular		Directions Definition Technical description Biography Science report	Expository writing • Definition • Academic essay/article • Book review • Commentary	
To convince/persuade (connative)	Others	Citation from authority/expert		Letter of application	Statement of personal views, opinions	Advertisement Letter of advice	Argumentative/persuasive writing • Editorial • Critical essay/article	
To entertain, delight, please (poetic)	Others	Quote poetry and prose		Given an ending-create a story Create an ending Retell a story		Word portrait or sketch Causerie	Entertainment writing • Parody • Rhymes	
		Documentative discourse		Narrative	Constative discourse Explanatory	Descriptive	Interpretive (Expository/Argumentative/Persuasive)	Exploratory discourse Literary

The task environment includes, in addition to the setting, the writing assignment—the topic and the intended audience—and structural constraints (such as the amount of time available). The task environment also includes the text which the writer has produced so far. This is an important part of the environment because the writer refers to it repeatedly while composing.

The writer's long term memory allows the writer to produce the content based on his/her own knowledge (without constantly having to look things up) and it includes, for the expert writer, a familiarity with spelling, grammar, and writing genres such as those outlined in table 1. The task environment and the writer's long term memory provide the context in which the writing processes operate. Here, the key elements are: planning, translating and reviewing.

**FIGURE 1.** A schematic representation of Hayes and Flower's model of the writing process.



Planning involves generating content, organising it and setting up goals and procedures for writing. Hayes and Flower (1983) write: "We see Planning as a very broad activity that includes deciding on one's meaning, deciding what part of that meaning to convey to the audience, and choosing rhetorical strategies. In short, it includes the whole range of thinking activities that are required before we can put words on paper. It is important to note that 1) planning goes on throughout composing and 2) the plan may not be encoded in a fully articulated or even in a verbal form. (Plans may be visual images.)"

Translating is the term that Hayes and Flower use to describe the physical act of expressing the content of Planning. Hayes and Flower (1983) write: "Translating is the act of expressing the content of Planning in written English. Although one can reliably distinguish when writers move from Planning (which may produce notes and doodles) to Translating (the attempt to produce prose), this does not mean that writers have a fully formed meaning that they simply express in words. Rather, writers have some more or less developed representation encoded in one form. The act of translating this encoded representation to another form (i.e. written English) can add enormous new constraints and often forces the writer to develop, clarify, and often revise that meaning. For that reason, the act of translating often sends writers back to planning. Often these processes alternate with each other from one minute to the next."

Reviewing involves evaluating either what has been written or what has been planned. Reviewing often (but not invariably) leads to revision. Hayes and Flower draw a distinction between revision (making substantial changes) and editing (polishing).

Finally, writing must be monitored. Hayes and Flower (1983) write: "The Monitor is the executive of the writing process that determines when to switch from one writing process to another, for example, when one has generated enough ideas and is ready to write. The monitor may function differently from writer to writer and from writing task to writing task. Some people move into translation as soon as possible in writing a paper, whereas others will not write a word until they are reasonably certain that planning is complete. Further, a writer undertaking an easy task, for example, a short letter, may do little or no planning before writing the first sentence, whereas the same writer undertaking a difficult task, for example, a

philosophical treatise, may plan for months before writing a word.”

Hayes and Flower (1986) provide more detailed descriptions of the processes of planning, translating, and reviewing together with an account of the research that has stemmed from this approach. Freedman et al summarize their view as follows:

- 1) The writing process is a hierarchically organized, goal-directed, problem-solving process.
- 2) Writing consists of several main processes—planning, transcribing text, reviewing — which do not occur in any fixed order; rather, thought in writing is not linear but jumps from process to process in an organized way which is largely determined by the individual writer's goal.
- 3) Experts and novices solve the problems posed by the task of writing differently.

- *Limitations of the Hayes and Flower model*

Although the Hayes and Flower model has generated much research (which will be discussed below) the model has certain limitations. These seem to be as follows:

- 1) It is not clear how the model was arrived at. There are vague references to studying student writers, but the context in which the model was developed has never been outlined clearly.
- 2) The model is purely descriptive.
- 3) The model says nothing about the effects of the writing medium (pen, typewriter, word processor) on the writing process.
- 4) The model is concerned with a single writer, working in isolation.
- 5) The model ignores (along with the greater part of psychological research on writing) certain other important concerns—such as individual differences in writers' composing styles and their feelings and emotions.

Points four and five are important ones. Writing, we should note, even though it is often a solitary activity, does not take place in a social vacuum. We are usually writing for someone else. Children see writing taking place between their peers, parents, other adults and teachers: they watch and listen to a variety of media, each of which has its accompanying text. Furthermore, there has been an explosion of research on the social nature of writing. There have been studies of writing in pairs and in groups, with and without computers, in industry and in education (e.g. see Barrett, 1989a; Daiute, 1985a; 1988; Duin, 1991; Forman, 1991; Hartman et al, 1991; Irish and

Trigg, 1989; O'Donnell et al, 1987; Rada et al, 1989; Underwood et al, 1990; Webb, 1990). Collaboration between authors and colleagues is becoming increasingly common in academic writing (Faver and Fox, 1982; Over, 1982a), particularly with the development of electronic mail (Murray, 1991; Wilkins, 1991).

Green and Wason (1982) note that most psychological research on expository writing is conducted in a purely cognitive paradigm. However, these two cognitive psychologists maintain that the fundamental problems of writing are emotional, rather than cognitive. One such problem in writing is the so-called 'writer's block'—an inability to get started, or even to write at all. Such a problem is not uncommon: in a questionnaire study of sixty-five academic writers, Hartley and Knapper (1984) found that nearly all of them claimed to have experienced writers' blocks at some time or other. Smith (1982) suggests that blocks occur because writers can be defeated by the magnitude of the task and/or by the fear that the product will fail to measure up to some standard. Smith writes, "This fear has an historical basis. Sitting on the shoulders of many writers is the wraith of a schoolteacher, waiting to jump on every fault of punctuation or spelling, on every infelicity of expression. Writing is so personal and so tangible that we can be questioned on every comma."

Writing with colleagues may resolve some of the difficulties. For the lone writer, Wason's suggested technique of putting down something, even if it is only a set of alternative beginnings to see what each one looks like, might overcome psychological blocks (Wason, 1980). Indeed, the most common form of advice given in this respect by professional writers is to resolve the block by writing—at least something—every day. Some suggest that one should get into the habit of writing something every time that one sits down at a certain place. Others suggest trying to achieve a great deal by rewarding oneself for the achievement of particular goals, however small at first. Blocks, it is argued, can be resolved by lowering one's expectations about what one is likely to produce—initially at least.

Finally, some writers suggest that it is always useful to finish a period of work at a point where it is useful or necessary to rewrite it before carrying on, or to stop in the middle of a section rather than at its end, or even to start by writing the last paragraph that was written the time before. The point of these suggestions is that once writing has started, it is easier to carry on. However, the most

common way of tackling blocks seems to be to leave the material for a while, to do something entirely different, and then to return and try again. Boice (1992, 1983, 1990) has written extensively on these matters, particularly in an academic context, and his 1990 text outlines several procedures that writers can use in order to reduce these problems. Becker (1985) and Wolcott (1990) provide useful, more general, guides.

In addition to research on feelings and emotions there is also research on attitudes to writing, and on personality types associated with differences between individuals on how they tackle the writing task. In a study of eighty-eight highly productive academic psychologists, for instance, Hartley and Branthwaite (1989) found it useful to distinguish (i) between anxious and enthusiastic writers, and also (ii) between those that they termed 'thinkers' and 'doers'. Anxious writers displayed much more self-doubt than did the enthusiastic ones, and they were more likely to experience writers' blocks. The anxious writers produced significantly fewer books and papers than did the enthusiastic ones. 'Doers' were much more mechanical in their ways of working than were 'thinkers.' 'Doers' were more likely to complete one section of a research article at a time, to work in sequence, to spend less time thinking, and to write fewer drafts than did the 'thinkers.' 'Doers' had a significantly higher productivity rate than 'thinkers,' and the enthusiastic doers were the most productive.

Similar distinctions have been drawn between serialists and holists (see Lowenthal and Wason, 1977) and between neat 'Mozartians' and messy 'Beethovians' (Chandler, 1991). Other differences between writers that have been discussed are, regrettably, beyond the scope of this paper. However, the following references may be of interest for readers concerned with discussions of age, personality, and sex differences: Astin and Davis, 1985; Boice and Kelly, 1987; Kyvik, 1990; Jackson and Rushton, 1987; Over, 1982b and 1982c; White, 1984. Chandler (1991) comments that these individual differences undermine any unitary model of the writing process. Unitary models cannot meet the needs of all writers or suit all writing tasks. There is, therefore, a need for more research on how the nature of writing differs for groups of people with different writing styles.

### **Learning to Write**

- *The mechanics of handwriting*

Most children (in the Western world) learn to write at

home and in the preschool, using pencils, felt-tipped pens and biros. Few, if any, children start to learn with electronic keyboards, although Moore (1962) advocated this in the early 1960s. Thus the mechanics of handwriting still occupy a great deal of research attention. Bailey's (1988) review of current research covers topics such as the grasp of the pen, pressure on the writing instrument and surface, and the use, or not, of lines on writing paper, and Blote's (1987) monograph pays particular attention to posture and control. The emphasis on the mechanics of handwriting is particularly strong in the field of the learning disabled, and Maarse et al (1991) report on advances in computer recording in this context. Digitizers with pressure-sensitive pens are being developed that allow for the automatic recording and analysis of handwritten scripts. The development of computer-based systems for teaching handwriting skills (e.g., see Macleod and Proctor, 1979) has not (to my knowledge) yet received serious attention, although there are possibilities in this respect. Commentators are, however, beginning to suggest that children should be taught word-processing skills in the primary or secondary school (e.g., see Chandler, 1991).

- *Pre-writing*

A concern with the mechanics of handwriting, however, is not the only concern of studies of very young children learning to write. Young children recognise and make sense of print from an early age, and they enjoy 'reading' books with adults (Farr, 1985; Mason, 1990). Several researchers have traced the emergence of lettering from children's drawings and scribbles (see e.g., Beard, 1984; Dyson, 1985; Graves 1979; Sarachno, 1990). Bissex (1980), Chomsky (1971) Graves (1979) and Read (1986), among others, have shown how speech and phonetic forms dominate children's early written messages. Hannon and Jones (1990) have described how parents of pre-school and infant children are much involved in teaching their children to read and write, and how parental views often conflict with those of teachers in this respect. Such parental activities are important because measures of children's literacy development at school entry appear to be good predictors of children's subsequent educational development (Wells, 1987; Tizard et al, 1988). Juel (1988) showed that the probability that a poor reader at age six would remain so at age nine was very high, but that early writing skills did not predict later writing skills to the same extent.

- *Developmental changes in writing processes*

Many teachers and researchers have discussed develop-

mental changes in the acquisition of writing processes. (See, e.g. Beard, 1984; Bereiter & Scardamalia, 1987; Daiute, 1985b; Farr, 1985; Martlew, 1983.) Studies in the United Kingdom suggest that primary school children spend about a third of their time on one kind of writing activity or another (although there are wide variations). It appears that much of this writing is of the expressive and narrative kind, rather than expository in nature. Furthermore, most writing is done for the teacher rather than for any other audience. There are also criticisms that junior school pupils spend too much time copying from textbooks and worksheets, and that they learn to regard neatness as the main criterion for success (e.g., see Bennett, et al, 1980; DES, 1978, 1982; Galton et al, 1980).

At the secondary level in the United Kingdom the Assessment and Performance Unit of the Department of Education and Science monitored the writing skills of eleven and fifteen year old pupils between 1979 and 1983. (See White, 1986 for a brief account.) Approximately 2,400 pupils were involved and many different types of writing were tested, including the pupils' abilities to explain, instruct, narrate, report, give an opinion, describe imaginatively, express feelings satirically, and persuade. The results were assessed by a group of experienced teachers working with the research team. The results showed:

- 1) Many pupils found writing difficult—although the majority received marks in the middle of the range. Many fifteen year olds were unable to match the best writing achieved by some of the eleven years olds.
- 2) There was a wide variation in performance according to the nature of the task. There were few tasks which were uniformly hard or easy for each age group, but the hardest task was the use of an appropriate style. For most fifteen year olds, writing a story was easier than making good notes.
- 3) The pupils' own judgment about how to improve their writing were often based on conceptions of neatness and correctness rather than on matters of subject matter, style, or purpose.
- 4) Girls generally performed better than boys. More boys than girls of each age group showed negative attitudes towards writing, and negative attitudes were voiced more strongly by the older pupils (see White, 1987).

Parallel results were found in a similar study of 1,400 fifteen year olds reported by Gubb, Gorman and Price (1987). White (1986) concluded her booklet with a series of recommendations. She suggests that pupils could be helped to

improve their writing skills in the following ways:

- 1) by producing less writing in total;
- 2) by being encouraged to write for a wider range of purposes and for a more varied readership;
- 3) by building on their existing skills as speakers of the language and being made aware of the contrasting demands of speech and writing;
- 4) by constructing for themselves, either as individuals or in groups, a definite purpose for what they write;
- 5) by being given regular constructive and systematic feedback about the quality of their work;
- 6) by being made aware of the place of writing in the process of learning and of the value of notemaking and exploratory drafting; and
- 7) by having opportunities to work collaboratively through stages of composition and revision.

White does not mention computers in her report, but the implementation of some of her recommendation (particularly the last three) could probably be made more effective through computer-aided composition.

- *Expert and novice writers*

Freedman et al, in their account of the acquisition of writing skills, are at pains to point out the complexity of the process. Their review shows that although it is useful to give simple descriptions and prescriptions of the kind listed by White above, there are deeper concerns. Freedman et al point to individual variability in pupils' knowledge of writing processes and particularly to the differences between 'experts' and 'novices.' In the context of learning to write, this interest focuses not so much on the characterizing the differences between them—but more on the processes by which these two different kinds of groups achieve their products.

Freedman et al describe groups of novices which reviewers do not always distinguish among: 1) students at all levels whose skills are developing; 2) basic writers who are behind their peers or age group; and 3) young writers. Freedman et al argue that these different groups have different needs.

Hayes and Flower suggest that good (or expert) writers create 'reader-based' prose, whereas poor (or novice) writers create 'writer-based' prose. Good writers think about how their readers will follow the text, and this helps them to plan their writing better: they use more cohesive ties than poor writers, more links, and more signals to help the reader grasp the structure of the text. Poor writ-

ers, on the other hand, tend not to think so much about their readers while they are writing: they focus less on the meaning and more on the spelling, grammar and punctuation. Good writers have mastered and automated these skills: poor writers have not. Very young writers may follow an orderly procedure as they write, but often they lose their train of thought because they have to attend to more mechanical concerns, such as letter formation, handwriting and spelling.

The amount of knowledge that a writer has about a subject also affects the writer's planning. People who are experts in their subject matter will have greater knowledge about it than the nonexperts. The problem is, of course, that such subject matter experts may have difficulty in conveying this knowledge to others—especially if they are novice writers. Expert writers, according to Hayes and Flower (1986), create more elaborate plans with more interconnecting networks than do novices. Schriver (1986) shows that experts can be taught to predict novice's comprehension problems with text and to adjust their writing accordingly.

A great deal of attention has been paid to differences between good and poor writers in terms of their revision strategies (e.g., see Cochran-Smith, 1991; Fitzgerald, 1987; Kurth, 1987; Hawisher, 1989). Hayes and Flower (1986) summarize findings of the research on revision as follows:

- 1) There are large differences between writers in the amount of revising that they do. Experts revise more than novices. Expert revisors attend to more global problems (e.g., resequencing, restudying, rewriting large units of text) than do novices.
- 2) Experts are better than novices at detecting problems in their text, diagnosing the causes of the problems, and choosing appropriate remedies.
- 3) Writers find it harder to detect problems in their own texts than they do in other people's texts.

One implication of this last point is that better quality writing might be produced if authors collaborate in revising texts. Another, perhaps, is that writers may change their revision strategies if they are assisted by computer technology. Both the reviews of Fitzgerald (1987) and Hawisher (1989) are not, however, optimistic in this respect. Despite numerous studies, it is not yet obvious whether using a word processor affects either the amount or the quality of the revisions. Cochran-Smith (1991) provides a useful discussion of the complexity of the issue.

- *Teaching writers to become more expert*

At this point in the discussion we should draw particular attention to the work of Bereiter and Scardamalia. (See, for example, Bereiter & Scardamalia, 1987.) This work is important because of its concern with how to teach novices to become experts. Bereiter and Scardamalia also distinguish between 'knowledge telling,' or writer-based prose, and 'knowledge transforming,' or reader-based prose. Knowledge telling is more typical of novices: it does not require a great deal of thinking. Knowledge transforming, on the other hand, is more typical of experts: it requires the writer 1) to think in terms of the reader, 2) to diagnose problems that arise from considering the relationship between the text produced so far and the reader, and 3) to evaluate success at resolving these problems. Bereiter and Scardamalia typically provide students with prompts which will help them to execute these strategies while they are learning to write: the ultimate goals being 1) generalization to a wide variety of similar tasks; 2) the withdrawal of these prompts (as they become internalised); and 3) the automatization of these prompted skills through practice so that the writer is freer to concentrate on higher order goals.

Perhaps it might be helpful at this point to provide an example. Scardamalia & Bereiter (1983), for instance, instructed ten to fourteen year olds how to use a set of procedures to help them revise their written compositions. The participants were asked to consider each sentence of something they had written and to check it, first against the list of evaluation statements, and second against the list of directives shown in table 2. The aim of such an approach was to help the learners see what revision entailed, and then to make it a matter of routine. This example demonstrates the advantages of the procedure (it forces teachers to spell out what is meant by revision) and the disadvantages (not everyone will agree that this is what revision entails).

Bereiter and Scardamalia have experimented with giving children similar sorts of prompts and what they term 'consequential composing activities' (see, e.g., Bereiter and Scardamalia, 1987; Scardamalia et al, 1981). For example, when nine to eleven years olds were given appropriate prompts to help them write opinions, they produced more structured elements (reasons, examples, elaborations) than when they attempted to do the same task simply by talking. Similarly, when children were given a choice of 'ending sentences' to strive for in their compositions, this

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**TABLE 2.** Evaluative and directive phrases used to help 10-14 year olds to revise in the study by Scardamalia and Bereiter. Pupils check each of their sentences in turn, first against the list of evaluative phrases, and next against the list of directive statements.

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**Evaluative phrases**

People won't see why this is important  
People may not believe this  
People won't be very interested in this part  
People may not understand what I mean here  
People will be interested in this part  
This is good  
This is a useful sentence  
I think this could be said more clearly  
I'm getting away from the main point  
Even I am confused about what I am trying to say  
This doesn't sound quite right

**Directive phrases**

I think I'll leave it this way  
I'd better give an example  
I'd better leave this part out  
I'd better cross this sentence out and say it a different way  
I'd better say more  
I'd better change the wording

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was found to be more useful than being given a choice of 'sentence openers.' In another study children were encouraged to list 'relevant' words as a part of their planning process. Children adopting this technique doubled the length of their essays and tripled their use of unusual words.

There have now been a number of such studies of learners improving their abilities at writing by using such self-instructional strategies (e.g., see Beal, Garrod and Bonitatus, 1990; Brown & Day, 1983; Graham and Harris, 1989; Wallace and Bott, 1989). Studies by Daiute and Kruidenier (1985), Graham and MacArthur (1988), MacArthur, Schwartz and Graham (1991), and Zellermyer et al (1991) show such procedures can be further implemented by the use of computer technology.

- *Writing and thinking*

More generally, the kinds of procedures described above often take place in the context of studies that are concerned with enhancing children's metacognitive skills (i.e., their knowledge of their own thinking processes). A number of researchers now see writing as a major tool for encouraging the development of thinking skills. Freedman et al write:

"Initially children's language and thinking is embedded in ongoing events. During the preschool and early school

years, children's language becomes free of what they can see and manipulate and thus becomes a tool for thinking and referring to the present, the past and the possible future. Recently researchers have emphasized the contribution of schooling and written language to the freeing of both language and thinking from immediate experience. In school, written language, and much of oral language, exists apart from a familiar social and physical setting—such language is 'decontextualized.' Children must reason about meanings conveyed primarily through words alone.

This ability to transform an experience into language and then think about it, compare it to previous experience, and, perhaps, reinterpret it—is seen as the heart of higher-level cognitive functioning by researchers and theorists who have significantly affected current views on both cognitive and linguistic growth. The goal of education must be, in part, a reflective human being who is capable of 'intellectual self-control'—of monitoring ongoing thinking, stopping and giving pause, considering possibilities and alternate routes, of taking necessary steps to disentangle confusions and make sense. A concern with the development of such a reflective citizenry is evident in the current interest in metacognitive skills, of individuals' knowledge about and control of their own thinking." (Freedman et al, 1987; references omitted)

Several writers have commented on how writing aids thinking (e.g., see Langer and Applebee, 1987; Wason, 1970, 1980; Wolcott, 1990). Writers, with their text in front of them as they produce it, are able to reorganize it, to clarify what it is that they are trying to say, and sometimes to recognize that what they started out by saying is now clearly no longer appropriate and needs changing. Debates concerning the roles of reading, writing and speech in the development of thinking skill have, according to Freedman et al, formed the impetus for the current enthusiasm for 'writing across the curriculum' programs in our schools (e.g., see Fulwiler and Young 1982; Gray, 1988) and the processes-approach to instruction described earlier.

The need to separate out different processes, practice, and integrate them that is advocated in process-approaches to teaching writing is supported by psychological research on the acquisition of other cognitive and motor skills. Authors such as Elbow (1973) and Wason (1970; 1980) recommend separating out composition (thinking) from transcription (writing): they advocate quick rough draft-

ing, and then final polishing, rather than attempting to produce polished prose at the first attempt. However, the evidence to support such recommendations is mixed (Glynn et al 1982; Kellogg, 1988).

Finally, in concluding this section of this review, we should note that some authors (e.g. Applebee, 1986; Hill-ocks 1984, 1986) have criticized the zealous nature of some advocates of the process-approach to teaching writing. Applebee (1986) re-emphasizes that Hayes and Flower's descriptive accounts emerge from the analysis of skilled writers solving difficult problems. In school-based situations, Applebee notes, a process-approach to instruction often means providing novice learners with false tasks, which are then practiced in isolation from the 'real world.' Thus Applebee considers that, 'rather than suggesting a range of strategies for solving problems, process instruction will become just another series of practice exercises.'

### **Computers and Writing**

Throughout this paper remarks have been made concerning how computer-aided writing may change the way in which writers learn to write, or even the nature of writing itself. Indeed, a common question posed by colleagues is 'Does using a word-processor change the way you write?' In attempting to answer such a broad question we need to consider several issues.

First of all we can distinguish between different levels or degrees of computer-aided writing. Three such levels might be:

- 1) Using word-processors simply to process text—making deletions and substitutions, moving text about, and printing it in an attractive format.
- 2) Using computer programs to aid the composition of word-processed text. Spell-checkers provide a limited example at this level, but programs such as Bell Telephone's Writer's Workbench (see below) provide more sophisticated examples.
- 3) Using computer programs to further aid the composing process at a higher level. Programs such as Writer's Assistant or Writer's Partner, which help with planning and organizing, are currently in their infancy, but some discussion of possibilities in this respect is provided below.

Next we need to consider further what we mean by whether or not computer-aided writing changes the ways

in which we write. Here there are two issues of concern:

- 1) Do we mean, because writing consists of various skills, some skills will perhaps receive more aid than others in computer-assisted writing? Perhaps the balance of attention changes, say, from doing more planning and less revising (with pen and paper) to doing less planning and more revising (with a word processor). Perhaps the amount of attention given to various tasks will vary but the way in which these tasks are carried out will not change a great deal. In other words the skills and strategies may remain the same but the computer helps us to perform some of them more effectively.
- 2) Or do we mean that using word-processors will, in fact, change the ways that people think when they are writing and thus, in fact, create new skills?

- *Word processors and writing*

There has been a great deal of research on using word-processors simply to process text, and it is beyond the scope of this paper to review it all. Representative reviews have been provided by Chandler (1991), Hansen and Haas (1988), Hawisher (1989) and Zvacek (1988).

The authors of studies of writing with word-processors at primary school draw particular attention to:

- 1) how much easier it is for young children to write with a keyboard than with a pen;
- 2) how much easier it is for young children to read printed text than handwritten text (see Figures 2.1 - 2.2);
- 3) how much easier it is for young children to make corrections (e.g., of spelling) on screen, compared with when writing with pen and paper. Every version is always neat.

Generally speaking, such authors predict that word-processors will lead to more drafting, longer texts, and texts of better quality. There is some evidence to support these claims, but not perhaps as much as one might wish. (See, for instance, Chandler, 1991; Cochran-Smith, 1991; Hawisher, 1989.)

One problem with many of the reported studies is that they take place over a relatively short period of time and one is not totally convinced that the participants have had sufficient experience with using the particular word-processor in question (compared with that of pen and paper). However, there are some exceptions to this caveat. Dalton and Hannafin (1987), for example, compared the end products of two groups of twelve year old writers after

**FIGURE 2.1** A sample of a child's handwriting.

Blind Drunk  
I was coming out of a pub, when ten  
men come up to me and said to me  
do you want to earn some money. I said yes  
and signed some pieces of paper. But I  
did not know what I had let my self in for because  
I was drunk the next day I found my self in  
captin Bill crowing and I felt sick so I what  
on deck were I found out what I had let my  
self in for. I set to inspecting the ship but I went  
to bed. the next day I felt beter so I went to get an  
apple and the cook chopped of his finger because I  
sprised him then I saw some people sitting they  
~~had~~ had seen france.  
The end by Adam

**FIGURE 2.2** A word-processed story by the same child.

#### A wild wind.

One day in the heart of the wild west I saw a man running through the street shouting a twister is coming, a twister is coming. All the people started running wild. In about 10 seconds the town was in a panic. I tried to ask a man what was wrong but he just ran away. Then I saw it. It was 80 metres high and 20 metres across. I was very frightened so I ran into a shop to hide And the next minute the roof fell off and I said to myself these shops aren't built very well. Then the wall collapsed on top of me but I was saved by a tin bath which fell on top of me and covered me up. Later I was rescued from the debris.

THE END BY ADAM

a year of instruction. Group 1 (N = approximately 40) completed two exercises weekly throughout the academic year, using an Apple IIe microcomputer equipped with FreeWriter. This program allowed users to delete and replace text, to move blocks of text around, and to format documents on screen, but it did not include any additional aids, such as a spelling checker. Group 2 (N = approximately 40) completed similar writing assignments using pen and paper. Both groups were tested on a common writing task, a one to two page essay, at the end of the year. All of the participants did this task by hand. The essays were then marked 'blind' by three judges, who rated them in terms of structure and organisation, correct usage of parts of speech, punctuation, capitalization and spelling.

There were two main results. First of all, there was no significant difference between the quality of the essays written by the two groups. The average mark for the word-processing group was 76 percent, and for the pen and paper group, it was 73 percent. However, there was an interaction with ability. The two treatments had similar effects for high-ability students (word processing 77 percent, pen and paper 78 percent) but word-processing significantly helped the less-able pupils (word-processing 74 percent, pen and paper 69 percent). Dalton and Hanafin comment particularly on how word-processing aided the revision process for the less-able students—'making it less tedious for low-ability learners.' They also suggest that the pupils with the word-processors spent less time planning and more time revising than did their counterparts, and that initially it took a long time for some of the participants to learn how to use the word-processors efficiently.

In passing, we might consider two further points here. First, a number of studies have specifically examined the use of word-processors with less-able children, and most report some success (e.g., see Graham and MacArthur, 1988; MacArthur et al, 1990, 1991; Vacc, 1987). Likewise Hartley's (1992) text contains papers that report on the successful uses of technology with writing by the blind, the deaf, the physically handicapped and the aged. Second, computers may facilitate writing in other problematic areas. If, for example, girls are better at writing than boys, but boys prefer computing to girls, then possibly computer-aided writing will facilitate the writing of boys (and negate the writing of girls)? Such speculation is, of course, premature and it is not in fact true that boys always have

more positive attitudes to computers than do girls (Trueman, 1990; Underwood and Underwood, 1990).

- *Computer-aided writing programs*

Several computer programs have been developed that writers can apply to their written productions in order to see how they might be improved (e.g., see Britton and Glynn, 1989). One typical suite of programs is The Writer's Workbench developed at Bell Laboratories in the United States. The number of programs available in this suite is constantly expanding, but Table 3 lists some of the major ones.

These programs were created to help technical writers, but the suite has been evaluated in different contexts. Gringrich (1983), for instance, observed two groups of technical writers, one more experienced than the other, using Writer's Workbench over a ten-week period. Both groups of writers found the programs helpful, they liked the immediate feedback the programs provided and the detailed suggestions on how to revise their texts. Interestingly enough, the writers thought they spent less time editing their documents when they used the Writer's Workbench programs although, Gringrich reports, the total time spent on writing and editing did not change.

Kiefer and Smith (1983) used a sample of the Writer's Workbench programs with students taking Freshmen English at Colorado State University. Students used the programs for about an hour a week for fourteen weeks. Their results on pre- and post-test editing and essay writing tasks were compared with those of control students. Both the experimental (N = 38) and control groups (N =

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**TABLE 3.** A sample of computer programs available in 'The Writer's Workbench' system developed at Bell Laboratories.

**Programs which indicate:**

- spelling errors
- punctuation errors
- word repetitions
- split infinitives
- use of passives
- use of nominalizations
- use of abstract words
- acronyms
- long sentences
- sexist phrases
- awkward choices of words/phrases (with suggested improvements)

**Programs which give:**

- parts of speech for each word
- readability scores
- average length of sentences
- number of sentence types (simple, complex, compound, compound-complex)
- comparison figures on details such as those for other 'model' technical texts

**Programs which:**

- summarize the content—by listing headings
  - summarize the content—by giving the first and last sentence of each paragraph
  - segment the lines of the text according to line-length requirements and syntactic rules
-

46) performed equally well on editing 'errors of mechanics,' but the computer group outperformed the control group on 'revision for simplicity, directness and clarity.' There was no significant difference between the scores of the two groups on the overall quality of the post-test essays. The students expressed very positive attitudes towards computer-assisted writing, after using the program.

Sterkel, Johnson and Sjogren (1986) used programs from the Writer's Workbench suite with business studies students for three terms over an academic year. At the end of each of the three terms experimental and control students were compared on their editing skills (detecting errors in provided materials) and on an end of term assignment (writing a business letter).

In terms of editing skills there was no significant difference between the two groups at the end of each term, but both groups improved significantly (comparing terms one and three). In terms of the writing assignment, there were no significant differences between the groups in terms one and two, but in term three, the computer-aided group outperformed the conventional group on their overall scores, and on subscales of 'concreteness' and 'conciseness.'

In this study the time the students reported that they had spent on subcomponents of their writing assignments were recorded. In the first two terms the computer-aided groups spent significantly longer on their assignments, but in the third term this position was reversed: the computer-aided group performed slightly faster than the control group. The data suggest that with sufficient experience the computer-aided students were beginning to spend less time on outlining and making the first draft and slightly more time on revising. And, as in both of the previous studies, the student reported favorable attitudes towards computer-aided writing.

These three studies indicate that computer-aided writing programs are popular, and given time and practice, they seem to produce marginal gains for the end-products: the documents are improved. However, in a sense, the computer programs used in the studies reported above are limited: they tend to focus more on aiding transcription and revision than on planning and composing. Some critics remark harshly on the assumptions involved in creating packages of this kind (e.g., see Collins, 1989; Theisemeyer, 1989) perhaps forgetting that they are meant to assist relatively competent writers rather than novices.

A number of investigators are now considering how programs might be written that will aid the composing process. Kellogg (1986) for instance discusses three main difficulties that writers face: i) 'attentional overload'—having to cope with too many processes all at once; ii) 'idea bankruptcy'—a failure to generate usable ideas; and iii) anxiety and emotion. Kellogg describes a variety of computer programs that help to deal with these fundamental difficulties. 'Funnel' programs channel the writers' attention into only one or two processes at a time. 'Inventor' programs help writers to form and relate concepts; and 'therapist' programs give feedback and reassure the writer. Several computer programs are outlined under each heading, as well as programs that combine these different functions. Frase (1987) provides a similar list of functions and programs—although they are classified a little differently. Frase discusses programs that help writers generate ideas, organise thoughts, compose, and obtain feedback.

In the United Kingdom work on developing programs to aid the thinking processes of writers is being conducted by, among others, Sharples and his colleagues at Sussex University. Sharples, Goodlet and Pemberton (1989) provide the following scenario to illustrate how a writer might use their Writer's Assistant:

"A writer wants to produce a study of 'Pottery in North Eastern Brazil' so, on entering the system, she selects the option for creating a new document. As she is writing for a newspaper color supplement she selects Newspaper Article from a menu of options, getting a structure template and set of constraints appropriate to that type of text. The writer has a fairly firm idea of how the article will fit together, so she starts working in the structure view, sketching an outline for the body of the text by calling up the structure guide to instantiate four main sections headed 'background,' 'development of pottery industry,' 'evaluation' and 'conclusion'. . . With the overall structure established, our writer chooses to brainstorm ideas for the 'development of pottery industry' section. She turns to the notes network view where she sees a note for each of the sections she created in the structural view. She creates notes for subtopics, linking them to the main note with 'aspect' links. To concentrate on one subject—'description of pottery'—she selects a presentation of the notes network in which that note is displayed in the center of the screen and then creates further notes to surround it. . . The author might then switch to a linear view to find that the system has made an attempt to linearize the notes

network into a list of sections and subsections, based on link types. After making some rearrangements she fills out the section headings with text for the article, moving between different perspectives of the linear view to see sections detail or outlined, until the article is finished.”

Other papers describing similarly complex approaches to developing computer aids to individual and cooperative authorship have been described by Barrett (1989a), Duin (1991), Ferraris et al (1990), Forman (1991) and Streitz and Hannemann (1990).

- *Word-processor—tool or prosthesis?*

As mentioned earlier there is some debate whether using a word processor alters the amount of attention we pay to different aspects of the writing process but leaves the skills much the same, or whether using a word processor changes the way people think when they are writing and whether or not this leads to improved documents. Readers will have observed that in my accounts of the experiments described above, I have included, where possible, information concerning the quality of the end product, and the amount of time devoted to various aspects of the writing process.

The accounts above (together with those of other studies) suggest that writers spend less time planning and more time revising with word processors (see Kellogg and Mueller, 1990; Cochran-Smith, 1991; Haas, 1990; and Hawisher, 1989). Haas (1990) notes that this typical finding may depend upon the nature of the writing task, for she found that writers were more likely to resort to pen and paper for more difficult tasks. Teles and Ragsdale (1989) report that academics claim to revise more with word-processors that they do with pen and paper but Hawisher (1989), Underwood and Underwood (1990) and Chandler (1991) report several studies where writers stick to their methods, regardless of the tools they are using. It appears that if writers revise a lot with pencil and paper, then they will revise a lot with a word processor. In their study of productive academic psychologists, Hartley and Branthwaite (1989) observed that many of them commented that the use of word processors had not altered their fundamental method of attack. There was, however, a shift of approach with experience in that novice users of word processors were more likely to use them to edit handwritten drafts, whereas more experienced users were more likely to compose directly with the machine.

Three studies known to the author focus specifically on this question of whether word processors simply alter the amount

of attention paid to sub-components of the writing task, or whether they change an author's writing skills. Kellogg and Mueller (1990) carried out two such studies, one with relative novices (N = 16) and one with more experienced users of word processors (N = 69). In both experiments the participants—college students—were trained to classify their thoughts about their writing processes and, when asked, to press one of four keys to indicate which of four possible subcomponents they were doing: planning, translating, revising, or some other unrelated process. After training and practice for thirty minutes with IBM's Writer's Assistant, the students each composed an essay (within a thirty-minute time limit), half with a word-processor and half in long-hand. They were interrupted approximately every thirty seconds and they responded by pressing appropriately one of the four keys each time.

The results of Experiment 1 showed no significant differences between the written products on marks for content, but that the writers with the word processors devoted more effort to revising and planning, and less to translating that did those using longhand (who spent about an equal amount of effort on each). The results of Experiment 2 were very similar, with the more experienced users showing the effects slightly more clearly than the less experienced ones. Kellogg and Mueller conclude that word-processors restructure the process of writing, but fail to improve writing performance.

However, the word processing system used by Kellogg and Mueller would, in terms of my earlier description of different levels of system, be at level one. The participants used an IBM PC with IBM Writing Assistance Software. This included only basic text editing functions (insert, delete, move, copy and print). More complicated software may be required if one is to alter the nature of writing.

Zellermayer et al (1991) used a specifically designed computing tool, The Writing Partner, for their experiment. This suite of programs was designed mainly on the basis of work done by Bereiter and Scardamalia (1987) discussed earlier. The programs were designed to help high-school pupils (aged thirteen to fifteen) move from knowledge-telling of author-based prose to knowledge-transforming of reader-based prose. They aimed to achieve this by providing three kinds of help during writing: 1) memory supports; 2) guides concerning evaluation, elaboration and coherence; and 3) guides reminding the writer of rhetoric, writing goals, and the writer's audience.

Zellermayer et al studied three groups. Group 1 (the control group) wrote five essays with a conventional word processor. Group 2 wrote five essays with a word processor using The Writing Partner. Group 3 wrote five essays with a second version of The Writing Partner that provided guidance only on request. The resulting essays were assessed 'blind' by two trained writers on a single holistic rating scale and on five analytic scales designed to measure: number of ideas; coherence; idea development; cohesion and connectedness; and ending.

The results showed that the group with The Writing Partner produced significantly better essays overall than both the control group and the group who could solicit the programs when they wished. (The mean overall quality scores were 146.8, 131.5, and 128.6 respectively).

In order to test whether or not the computer aided writing programs had changed writing performance, members of all three groups completed another essay, two weeks later, using pen and paper. The argument here was that if writing performance had changed then this would show itself on such a post-experimental writing task. The results were very similar to those described above. The essays written by Group 2, who had trained with The Writing Partner were significantly better than those written by the control group and those who had been able to solicit The Writing Partner when they wished. (The mean overall quality scores this time were 42.6, 33.3 and 35.4 respectively). Zellermayer et al argue that the pupils who used The Writing Partner first of all internalized the cognitive writing strategies offered and then came subsequently to use them on data collected from a questionnaire about effective writing strategies that the pupils completed just before they wrote their post-test essays.)

These three studies then, those of Kellogg and Mueller, and that of Zellermayer et al, suggest a possible reconciliation between those who feel that word-processing simply restructures writing processes, and those who feel that it changes the nature of writing. It is clear that the nature of the assistance provided by the computer-aid is crucial. In terms of my earlier discussion of levels of support, we might expect that the greater the support, the more likely writing with word-processors will change writing skills, particularly with extended practice.

Such a conclusion may help to resolve some of the differences in the current findings. However, it over simplifies

many issues, notably those posed by different writing tasks, different writing tools, different writing experiences and habits, and different way of assessing the effectiveness of writing. These complexities will be discussed further in the final section of this paper.

### **Evaluating Written Products**

It is not easy to evaluate the quality of a piece of writing, or to decide whether one piece of writing is better than another. Indeed, it is tempting to think that if we have re-written something, then it must be better than it was before. But, if we are to move beyond opinion and value judgment, and to try and assess whether or not, for example, computer technology alters how well people write, then we need to collect and analyze some data.

As noted in the previous section of this review there have been many attempts to evaluate the effects of writing with word processors in our educational systems. And in that section, I pointed out that many of the early studies were limited because of the brevity of the intervention program. Other problems arise from the small sample sizes and the quality of the programs used. However, later studies, which remove some of these deficiencies, still seem to produce equivocal results (see, for example, the review by Hawisher, 1989).

Dunn and Reay (1989), in reviewing some of these later studies, point to the difficulties of making comparison studies. They emphasize, in particular, that investigators need to equate keyboard speed in the experimental groups with handwriting speeds in the control groups before drawing conclusions. In their study, for example, Dunn and Reay found no significant differences between the quality of the writing of their twelve and thirteen year olds using word processors and those using handwritten composition when keyboard skills were ignored. However, when keyboard skills were taken into account, those writers who were adept (i.e., faster on the keyboard than by hand) did better on measures on writing quality, and those writers who were less competent (i.e., slower on the keyboard than by hand) did worse. These results may not seem surprising, but they point to the fact that in carrying out comparison studies (or indeed studies of any kind) one has to collect appropriate data.

The comparison study seems to be the *sine qua non* when it comes to evaluating new methods and techniques in

education. A great deal of energy has been expended, for example, in assessing the value of educational television programs and computer assisted learning using this approach. Once, however, it has been determined that certain media accomplish some things rather well and some things rather badly (compared with human instruction) then the focus of evaluation usually turns to examining how one can make more effective use of the medium concerned. It may be that we have not yet fully arrived at this stage in assessing the effects of computers on writing—although the current interest in writing processes may mean that we shall arrive at this position rather more quickly than was the case with other media.

Of course, assessing the effects of different processes on writing quality is not a simple matter—and it probably can never be done perfectly. My purpose in this final section of this review is to indicate the variety of tools available to researchers in this respect. The aim is to classify them in some way—to see what is available and to discuss the varieties and constraints that exist.

- *Different types of writing*

There seem to be at least three dimensions along which one can classify an evaluation study. First of all, as we saw in table 1, one can categorize writing in terms of different types. Clearly the tools appropriate for evaluating one kind of writing may not be appropriate for another.

- *Different research methods*

Second, we can also categorise research methods into different types or genres. Jaeger (1988), for instance, distinguishes between experimental (comparison) methods; quasi-experimental methods; survey methods; case-study methods; ethnographic methods; historical methods; and philosophical methods. The authors in Jaeger's textbook discuss the advantages and disadvantages of each in detail. As Shulman (1988) puts it: 'What distinguishes the methods from each other, by virtue of their contrasting disciplinary roots, is not only the procedures that they employ but the very types of questions they try to raise.' So, the kinds of methods used in an evaluation study will depend upon the kinds of questions being asked. If we want to find out how teaching methods have changed, a survey method may be appropriate; if we want to compare the efficacy of different methods of instruction then a quasi-experimental procedure may be best; and, if we want to explore the feelings of participants, and underlying social and political issues, then we might opt for an

ethnographic approach. In many cases, of course, more than one method will be appropriate.

Bereiter and Scardamalia (1987) make a similar point in the context of research on writing when they outline six levels of enquiry. Table 4 shows how research at different levels poses different kinds of questions, and utilizes different methods of approach. Bereiter & Scardamalia conceive of the different levels as each having advantages and disadvantages, but all feeding into each other.

- *Different measures*

Third, we can consider the variety of measures that might be appropriate for one or more of these research levels. Shriver (1989), for example, describes three approaches to evaluating text text-focused, expert-focused, and reader-

**TABLE 4.** Six levels of enquiry in research on writing—as outlined by Bereiter and Scardamalia in *Research on Writing: Principles and Methods*, edited by Peter Mosenthal et al.

Level	Characteristic Questions	Typical Methods
1 Reflective inquiry	What is the nature of this phenomena? What are the problems? What do the data mean?	Informal observation Introspection Literature review Discussion, argument, private reflection
2 Empirical variable testing	Is this assumption correct? What is the relation between $x$ and $y$ ?	Factorial analysis of variance Correction analysis Coding of compositions
3 Text analysis	What makes this text seem the way it does? What rules could the writer be following?	Error analysis Story grammar analysis Thematic analysis
4 Process description	What is the writer thinking? What pattern or system is revealed in the writer's thoughts while composing?	Thinking aloud protocols Clinical-experimental interviews Retrospective reports Videotape recordings
5 Theory-embedded experimentation	What is the nature of the cognitive system responsible for these observations? Which process model is right?	Experimental procedures tailored to questions Chronometry Interference
6 Simulation	How does the cognitive mechanism work? What range of natural variations can the model account for? What remains to be accounted for?	Computer simulation Simulation by intervention

**TABLE 5** Methods of Evaluating Text Quality: The Continuum from Text- to Reader-Focused.

<b>Text-Focused</b>	<b>Expert-Judgment-Focused</b>	<b>Reader-Focused</b>
<b>Readability Formulas</b> <ul style="list-style-type: none"> <li>✓ Flesch Reading Ease Score</li> <li>✓ Fog and Gunning Index</li> <li>✓ SMOG Formula</li> <li>✓ Dale and Chall Formula</li> <li>✓ Fry Formula</li> <li>✓ Kincaid Formula               <ul style="list-style-type: none"> <li>• word frequency/length</li> <li>• length of sentences</li> </ul> </li> </ul>	<b>Peer Review</b> <ul style="list-style-type: none"> <li>• style (local &amp; global issues)</li> <li>• audience analysis</li> <li>• graphics &amp; typography</li> <li>• organization &amp; access features</li> <li>• adherence to conventions</li> <li>• consistency &amp; completeness</li> </ul>	<b>Concurrent testing</b> <ul style="list-style-type: none"> <li>✓ Cloze Testing               <ul style="list-style-type: none"> <li>• lexical predictability</li> </ul> </li> <li>✓ Keystroke Protocols               <ul style="list-style-type: none"> <li>• number of keystrokes</li> <li>• time on task</li> <li>• number &amp; type of errors/assists</li> <li>• error recovery behaviors</li> <li>• number of failures to recover</li> </ul> </li> <li>✓ Eye Movement Protocols               <ul style="list-style-type: none"> <li>• number &amp; location of fixations, saccades and regressions</li> <li>• total gaze duration</li> </ul> </li> <li>✓ User Edits &amp; performance Testing               <ul style="list-style-type: none"> <li>• reading time</li> <li>• time on task</li> <li>• number &amp; type of errors/assists</li> <li>• error recovery behaviors</li> <li>• number of failures to recover</li> <li>• cognitive load</li> <li>• access &amp; retrieval behaviors</li> <li>• memorability/recall/retention</li> </ul> </li> </ul>
<b>Computer-based Stylistic Analysis Programs</b> <ul style="list-style-type: none"> <li>✓ Writer's Workbench (UNIX™)</li> <li>✓ Epistle-1 (IBM)</li> <li>✓ Critique, formerly Epistle-2 (IBM)</li> <li>✓ Star (GM)</li> <li>✓ Grammatik III (Reference Software)</li> <li>✓ MacProof 3.2 (Lexpertise Linguistic Software)               <ul style="list-style-type: none"> <li>• proofreading</li> <li>• readability/grade level</li> <li>• grammar &amp; style (sentence-level)</li> <li>• sentence complexity</li> <li>• personalized dictionary</li> </ul> </li> </ul>	<b>Technical and/or Subject-Matter Expert Review</b> <ul style="list-style-type: none"> <li>✓ Content Evaluation               <ul style="list-style-type: none"> <li>• accuracy (visual &amp; verbal text)</li> <li>• completeness and depth</li> <li>• match with functionality of a machine, product, etc.</li> <li>• match to stated goals for text</li> </ul> </li> <li>✓ Presentation &amp; Delivery Critique               <ul style="list-style-type: none"> <li>• market/audience analysis</li> <li>• competitive analysis</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• number &amp; type of errors/assists</li> <li>• error recovery behaviors</li> <li>• number of failures to recover</li> <li>• cognitive load</li> <li>• access &amp; retrieval behaviors</li> <li>• memorability/recall/retention</li> <li>✓ Protocol-Aided Revision (think-aloud verbal reports during reading and/or using text)               <ul style="list-style-type: none"> <li>• problem solving strategies</li> <li>• comprehension</li> <li>• miscues &amp; error recovery</li> <li>• access &amp; retrieval behaviors</li> <li>• inference &amp; predictions</li> <li>• satisfaction/preference</li> </ul> </li> </ul>
<b>Guidelines &amp; Maxims</b> <ul style="list-style-type: none"> <li>✓ Felker et al.</li> <li>✓ Harcourt, Brace &amp; Jovanovich</li> <li>✓ Hartley</li> <li>✓ Strunk &amp; White</li> <li>✓ Williams               <ul style="list-style-type: none"> <li>• principles of style for visual or verbal text</li> <li>• visual or verbal text features to avoid or use sparingly</li> <li>• audience analysis</li> </ul> </li> </ul>	<b>Editorial Review (in-house)</b> <ul style="list-style-type: none"> <li>• style &amp; copyediting</li> <li>• adherence to conventions, specifications, boilerplate or guidelines (visual &amp; verbal text)</li> <li>• consistency &amp; completeness</li> </ul>	<b>Retrospective Testing</b> <ul style="list-style-type: none"> <li>✓ Comprehension (true/false, etc.)               <ul style="list-style-type: none"> <li>• paraphrase</li> <li>• recall/summary/gist</li> <li>• recognition</li> <li>• inference</li> </ul> </li> <li>✓ Surveys, Interviews &amp; Focus Groups               <ul style="list-style-type: none"> <li>• rank/rate visual &amp; verbal test</li> <li>• comprehension</li> <li>• persuasiveness &amp; believability</li> <li>• satisfaction/preference</li> <li>• attitudes &amp; beliefs</li> <li>• inference</li> </ul> </li> <li>✓ Critical Incidents/Storytelling               <ul style="list-style-type: none"> <li>• key events &amp; incidents</li> <li>• relevance/severity judgments</li> </ul> </li> <li>✓ Reader Feedback Cards               <ul style="list-style-type: none"> <li>• comprehension</li> <li>• satisfaction/preference</li> <li>• attitudes &amp; beliefs</li> </ul> </li> </ul>
<b>Checklists</b> <ul style="list-style-type: none"> <li>• recommended or required visual or verbal text features</li> <li>• visual or verbal text features to avoid or use sparingly</li> <li>• audience analysis</li> <li>• consistency &amp; completeness</li> <li>• probable translatability</li> <li>• adherence to conventions</li> </ul>	<b>External Review</b> <ul style="list-style-type: none"> <li>✓ Text Features Evaluation</li> <li>✓ Holistic Rating (primary trait scoring or general impression marking)               <ul style="list-style-type: none"> <li>• style (local &amp; global issues)</li> <li>• audience analysis</li> <li>• graphics &amp; typography</li> <li>• organization &amp; access features</li> <li>• persuasiveness &amp; believability</li> <li>• competitive analysis</li> <li>• personal &amp; corporate identity</li> </ul> </li> <li>✓ Consumer Advocate Review               <ul style="list-style-type: none"> <li>• competitive analysis</li> <li>• truth &amp; ethics</li> <li>• legal, health &amp; safety implications</li> </ul> </li> <li>✓ Gatekeeper Review               <ul style="list-style-type: none"> <li>• appropriateness of content</li> <li>• context(s) for use/dissemination</li> </ul> </li> <li>✓ Document Design Process Critique               <ul style="list-style-type: none"> <li>• document development cycle</li> <li>• audience &amp; task analysis</li> <li>• style guides/standards/tools</li> <li>• project management</li> <li>• communication channels</li> <li>• education &amp; training methods</li> </ul> </li> </ul>	
<ul style="list-style-type: none"> <li>✓ an example of a particular method or individuals who developed or elaborated a method.</li> <li>• a typical focus or dependent measure during evaluation.</li> </ul>		

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focused and discusses a variety of measures under each heading. Table 5 summarizes her account.

- *Concluding comments on evaluation*  
My aim in writing this section of this review has been to show how one might classify approaches to evaluating the quality of writing in terms of a three-dimensional matrix: different text types x different research methods x different evaluation measures. It is perhaps not too surprising, then, to find that we cannot reach an overall simple conclusion concerning such questions as: Does using computers improve writing? Different investigators have used different cells in this matrix to tackle the question, and there is very little agreement as to what constitutes the best approach. Not only do so many different components interact in so many different ways, but we also need to remember that for each cell in the matrix, as pointed out by Dunn and Reay (1989), there is the question of whether a choice of any particular text type, method or measure can ever be entirely appropriate.

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