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ABSTRACT

To characterize the influence of various constraints on students' composing processes, a study investigated the (1) type of instructions students received prior to their composing and revising sessions, (2) mode of production--whether a computer or paper and pencil was used for composition and revision, and (3) effect of skill level on students' writing processes. The study also examined difficulties that students encountered in regulating the role of editing while composing a first draft, resisting the temptation to edit frequently while using the word processor, planning during either the composing or revision sessions, and making global revisions to first draft compositions. Subjects, eight average and eight talented eighth grade students, completed four tasks, each of which constrained the composing conditions in some way. Tasks included a "no edit" composing session, "free edit" composing session, directed revision task, and spontaneous revision session. Findings indicated that the talented students, without the concomitant distraction of editing while composing on the computer, created valuable content in their preliminary drafts and then significantly improved their texts through global revisions. However, results suggested that the provision of word processors benefited neither the writing processes nor products of the average students. (Methods of protocol analysis are appended.) (JD)

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INTRODUCTION

In this paper, we discuss results of a recent study of the processes and the products of eight average and eight talented grade 8 student writers. The central objective of the research reported here is to characterize the influence of both *production-mode*: (computer versus paper & pencil), as well as *task characteristics*: (unstructured versus procedurally facilitative), on students' text composing processes at two *levels of writing skill*: (average and superior).

The research was intended to address certain claims about difficulties that students encounter in: (a) regulating the role of editing while composing a first draft, (b) resisting the temptation, during first draft composing with word processors, to engage in frequent interruptions for the purpose of on-line editing, (c) engaging in sustained planning during either first draft composing or subsequent revision sessions, and (d) making global, or whole-text-level, revisions to first draft compositions.

QUESTIONS ADDRESSED

Based on the above-listed issues, this study was designed to address these particular questions:

- (1) Since the recursive component of novice writing processes appears to be limited to frequent surface-level editing (Bridwell, 1980), we expected that the relative incidence of constructive, or "high-level" planning episodes might be significantly higher when school-age writers were constrained from editing (referred to throughout as "*No-Edit*") during the production of a first draft, and that after a revision session. the resulting final products would be rated as superior on a number of qualitative dimensions (Joram, 1986);

- (2) In writing tasks designed so as to relieve executive demands (referred to as "procedurally facilitative" by Bereiter & Scardamalia, 1982), immature writers have shown some evidence of high-level composing strategies. We expected, therefore, that providing subjects with a structured revision task (referred to throughout as "*Directed Revision*"), might increase the incidence of planning episodes during revision sessions;

- (3) Since production-mode and writing skill have been shown to influence writing processes, the potentially facilitative influence of both the No-Edit. and the Directed Revision tasks were expected to show differential effects on the composing process as a function of these factors.

- (4). Specifically, it was predicted that the tendency to attend to surface-level text features might increase for Average students when writing with computers, and that the

*This project was funded by the Ontario Minstry of Education under its block Transfer Grant to OISE. The research reported herein was conducted by all four authors jointly. However, the credit for the study reported herein should go primarily to Elana Joram, upon whose thesis work this paper is based, as well as to the principal investigators, P. Lindsay and E. Woodruff. The first author of this paper assumes ownership only of the written report, and not of the research project as a whole.

structured composing and revision tasks would elicit a greater incidence of planning episodes from the talented student writers.

THEORETICAL FRAMEWORK

Revision processes and expert/novice differences

Consistent with current cognitive models (Flower & Hayes, 1981; Scardamalia & Bereiter, 1986), writing is construed as a multi-componential, recursive, cognitive process. Fine-grained descriptions of "expert" writers at work lend empirical support to the problem-solving model of text composing. Investigators using methodological procedures like pause analysis (Matsuhashi, 1982), and verbal reports (Flower & Hayes, 1981), have dispelled the once popular conception of revision as something which writers *do to* their texts (National Assessment of Educational Progress, 1977), or as the last phase in a series of temporally ordered writing stages (e.g. Rohman & Wlecke, 1964).

For the expert writer, revision processes represent an effective, and powerful set of strategies for detecting, and resolving, discrepancies between what has been written, which one might refer to as an *in-process* text, and a set of abstract representations of goals and plans for the finished product, which has been described as an *"intended"* text (Scardamalia & Paris, 1985). Della-Piana (1978) described the revising activities of poets in a similar fashion, and wrote that for these authors, revision involved:

> ...both the *discrimination* or sensing of something in a work that does not match what the poet intends or what the poem itself suggests and the *synthesis* that brings the writing closer to what is intended or suggests the way that this might be done. (p. 106)

Results from cognitive-developmental studies of student-writers (e.g. Scardamalia & Bereiter, 1983), when compared with data from studies of experts' composing processes (e.g. Flower, Hayes, & Swarts, 1980), reveal critical differences in the way in which these two groups of writers approach revision. Specifically, "novice", or immature, writers do not appear to engage in high-level revising activities (focusing on goals, gists, or whole-text-level rhetorical features) during text composing. Rather, it would appear that when novice writers interrupt the production of new material in order to revise, their changes are primarily restricted to making surface-level, or copy-editing changes to existing text (Bridwell, 1980). Novice writers do not seem to approach revision as either: (1) a process of making changes in plans or goals, or (2) a re-viewing of one's text by making global, or discourse-level, changes, which have the potential to affect the contents of one's writing at the "macro" level of gists and main ideas (Bracewell,Bereiter, & Scardamalia, 1979).

In addition to the above-described expert/novice differences in writers' *approach* to revision, it has been reported that experts *regulate* the sub-processes of revision differently. Specifically, experts seem to engage in more frequent phases of sustained and uninterrupted planning during first draft composing. Revision, in this "cycle" of the composing process, takes the form of what Murray (1978) refers to as "internal revision", which is focused on such dimensions as: (a) clarifying the gist of a text, (b) generating and modifying a set of goals and sub-goals, (c) identifying the critical issues, and (d) honing in on a perspective audience. Experts seem to engage in periods of what might be referred to as "epistemic revision" throughout the composing of a text, and to defer frequent interruptions for in-process editing until the substantive content of their writing has been constructed. In the following section, we present evidence from studies which suggest that fluency and reflectivity during first draft composing might be influenced by the writer's ability to delay editing until the final draft stage. This notion was the underlying rationale for our inclusion of the *No-Edit* condition during half of the first draft composing sessions (Joram, 1986).

Allocating attention during first-draft composing: Evidence concerning expert strategies for delaying premature editing

Expert writers' revision processes seems to manifest themselves differentially, according to the writer's focus of attention at any given moment during the composing process, in a series of overlapping cycles. Sommers (1978) compared the revision behaviors of twenty college freshmen and twenty experienced adult writers. She reports that during first draft composing sessions, the expert writers tended to suppress concerns with surface-level editing and local correctness. As one of the expert subjects explained:

> In first and second drafts, I try to cut off as much as I can of my editing generator, and in a third draft, I try to cut off some of my idea generators, so I can make sure that I will actually finish the essay. (p. 387)

In response to the observation that many novice writers, and/or sufferers of writer's block, tend to engage in frequent editing while composing, Elbow (1973) suggested a technique known as "freewriting". This technique, which resembles brainstorming, requires the writer to compose first draft material continuously, as ideas come to mind, without allowing *any* interruptions in order to make corrections. Elbow (1981) proposed that writers might benefit from utilizing two alternating text composing processes during the initial and the final stages of text production. He writes that this "loop process" was devised in response to the many critics of freewriting, who suggested that the use of this

open-ended strategy by student writers might lead to the creation of incoherent or undisciplined final products. The loop process requires that the writer utilize freewriting during first draft composing, and extensive revising in the latter stages of composing.

Elbow suggests that:

> Writing calls on two skills that are so different that they usually conflict with each other: creating and criticizing...Most of the time it helps to separate the creating and the criticizing processes so they don't interfere with each other: first write freely and uncritically so that you can generate as many words and ideas as possible without worrying whether they are good; then turn around and adopt a critical frame of mind and thoroughly revise what you have written- taking what's good and discarding what isn't and shaping what's left into something strong. You'll discover that the two mentalities needed for these two processes- an inventive fecundity and a tough critical-mindedness- flower best when they get a chance to operate separately. (p. 7)

The effects of task structure and level of writing skill on text production

Very little research has been done in order to investigate systematically the pedagogical claims made by advocates of either freewriting (e.g. Kinney, 1978), or the loop process (e.g. Elbow, 1981). A study by Glynn, Britton, Muth, & Dogan (1982), however, sheds some light on the cognitive effects of eliminating the attentional bottleneck which can result from over-emphasizing surface-level concerns in the early stages of the composing process. The results from this study also suggest that individual differences in level of writing skill will play a significant role in determining the likelihood that such task manipulations will produce a beneficial impact on writing.

These investigators asked thirty average and thirty low verbal ability (SAT scores) undergraduates to compose first draft texts in one of 3 conditions: (a) "Polished Sentences"- students asked to focus on mechanics, organization, and content, (b) "Unordered Propositions"- students asked to attend only to content, and (c) "Control"- students asked to use their typical first-draft format. The authors report that only the ıge verbal ability students profited from the opportunity to focus on developing the quality of their ideas by delaying premature concerns with mechanics. In the Control condition (students were free to choose their own task structure), average ability students tended overwhelmingly to create first drafts in the form of notes, or outlines, which contained a high proportion of arguments, whereas the low verbal ability students tended to write their first drafts in full sentences, and generated far fewer arguments.

It would appear that a technique such as freewriting, which might be characterised as an "implicit" heuristic procedure, enables the expert, or quasi-expert, writer to mobilise attentional

resources in such a manner as to facilitate sustained planning in the early phases of the composing process. However, if the range of strategies available to novice, or unskilled, writers is restricted to the use of topical cues and basic genre knowledge, as Scardamalia & Bereiter's (1986) "knowledge-telling" model would suggest, then it is quite probable that such tacit metacognitive strategies would not be powerful enough in order to upgrade the fundamentally additive way in which immature writers regulate text production processes.

Computers as writing tools

A related issue for instructional design in this domain concerns the influence of technological assistance on cognitive skills. The suggestion that we encourage novice writers to generate multiple first drafts can seem intimidating to the uninitiated. The burden of endless re-copying can dissuade student writers from making substantial changes during revision (Shaugnessy, 1977). On the basis of such arguments, the suggestion has been made that the use of word processors in writing classrooms might alleviate the onerous task of re-writing a succession of in-process texts (Daiute, 1983). In this section, therefore, we discuss the extent to which computers might encourage more extensive revision than is normally found in studies of school-age writers.

The word processor is often described as a tool which can enhance the quality of written compositions.

> Not having to re-copy helps writers to compose freely, focusing on what they want to say...the ease of revision encourages writers to experiment and to view their writing as dynamic. (Daiute, 1983, p. 139)

There is little research evidence to support such notions.

> Research concerning the effects of word processors is almost non-existent in spite of the pressing need to explore these effects. (Bridwell, Nancarrow, & Ross, 1983, p. 383)

Text-editors provide the well-intentioned writer with a versatile array of facilitative tools for the mechanical aspects of revision. Indeed, it would appear that writing with computers increases the incidence of surface-level revision (copy-editing) during the composing process (Loheyde, 1984; Bridwell, 1983; Daiute, 1983). However, text editors provide only the means for carrying out a writer's intentions with regards to revision. The author must supply the content, strategies and goal structure within which revision will enhance, rather than depress, the quality of text produced.

Clearly, if word processors are going to *have an effect on* student writing, this technological

influence will only manifest itself if the abilities of the author compliment the potentially facilitative dimensions which are tacitly embedded in this new technology. As Perkins (1985) argued, three conditions must be satisfied before educators can expect that children's learning activities will benefit from the mere *availability* of computers:

- Is the opportunity really there?
- Do the learners recognise the opportunity?
- Are learners sufficiently motivated to take the opportunity? (p. 13)

On the basis of the above-discussed research, we expected that results from our manipulations of task structure during first draft composing sessions (No-Edit/Free-Edit) would be sensitive to differences in students' level of writing skill. It was predicted that only the talented student writers would take advantage of the opportunity to utilize the first draft No-Edit sessions for high-level planning, knowing full well that a revision session would follow, when errors could be corrected. The average writers were not expected to have access to the requisite strategies with which to fill the void created by eliminating their normal editing functions. Likewise, since the provision of word processors does not necessarily result in an improvement in students' writing, we expected that only the high ability writers would benefit from the availability of computers during first draft and revision sessions. The Directed revision procedure, which requires that the student engage in whole-text-level revisions, was expected to result in an increase in high-level planning in both average and talented student writers. Since typical student writers seem to approach revising as a surface-level editing procedure, we expected that the average writers would show more high-level planning during the Directed revision sessions than during the Spontaneous revision sessions. The talented student writers were expected to provide a greater number of high-level responses than the average students to the requests for Justification statements in the Directed revision sessions. Likewise, we expected differences to emerge in our analyses of high-level thinking as a function of Mode of production. Namely, that the students revising with word processors would do better than those revising with paper & pencil. In accordance with these predictions, all of the results will be discussed in terms of the influence of Skill (average versus talented student writers), Mode of Production (paper & pencil versus word processor), Task Instructions (No-Edit versus Free-Edit first draft composing, and Spontaneous versus Directed revision), and interactions amongst these factors on both the *process* and the *product* measures during first draft and revision sessions.

METHOD

Design

Three factors were investigated in this study. One factor was the type of instructions given to subjects prior to their composing and revising sessions. Thus for half of the composing sessions, the subjects were not permitted to do any editing on their texts *(No-Edit Composing)*. During the other half of the composing sessions, subjects were allowed to edit freely as they composed *(Free-Edit Composing)*.

Similarly, in order to evaluate subjects' revision strategies, during half of the revision sessions subjects were required to make explicit changes in their texts prior to carrying out their own revision (*Directed Revision*). Specifically, they were asked to delete a sentence they had already written, to select two different sentences and move them to a new place and finally, to add a new sentence to the text. In making their choices of what sentences to move or delete, subjects were instructed that they should make their selections in a way that would: "...either improve your paper or do the least harm." In each instance, subjects in the Directed Revision sessions were asked to evaluate and justify their particular choice of sentences to delete, move, or add, subsequent to completing the requested operation. During the *Spontaneous Revision* sessions, subjects were simply asked to revise their texts, following a request that they: "...try to make this composition better".

The second factor that was investigated was the *Mode of Production* namely whether a Computer or Paper and Pencil was used for composition and revision.

The final factor was *Skill Level*. Average grade 8 writers were compared to "Enriched" (talented) grade 8 writers. The "enriched" writers were so designated on the basis of being enrolled in a section of the school's English program reserved for those students demonstrating superior writing skills. They scored higher than their peers on the Reading Comprehension subtest of a standardized language test: the Canadian Test of Basic Skills $F(1,15) = 4.27, p < .05$), and on overall Grade Level in English ($F(1,15) = 11.90, p < .002$).

Subjects

The subjects were eight enriched and eight average Grade 8 student-writers. The enriched subjects were so designated as described above. The average grade eight writers were selected randomly from three Grade 8 classes in the same middle-income suburban junior-high school. All

subjects came from the same three classrooms, had the same English teacher and had similar computer experience with the schools' "ICON" computer (equipped with a resident word processor), which was used throughout the study.

Procedures

Each subject was seen five times individually over a period of two weeks. For all subjects, the first session was devoted to collecting measures on the subject's keyboard skills, to modelling and ensuring that subjects practice both "thinking aloud" and writing without editing, and finally to establishing a collaborative working rapport. During the next four sessions, each subject completed the following 4 tasks:

- A *No-Edit Composing* session in which the subject wrote a first draft of an expository text with explicit instructions NOT to engage in any editing or revision while they were composing. They were, however, given the assurance " that next time we meet, you'll be free to make any changes you want on this paper".
- A *Free-Edit Composing* session in which the subjects wrote another first draft on a different topic.
- A *Directed Revision* task in which the subjects were required to revise their their most recent first draft according to an explicit set of instructions described above. Following their *directed revision*, subjects were allowed to edit their text as they saw fit;
- A *Spontaneous Revision* session, in which the subjects revised their most recent first-draft following only the relatively nondirective instructions to: "Try to improve this paper, so that it would be more interesting for your classmates".

The order in which the subjects received No-Edit or Free-Edit composing and Spontaneous or Directed revision was counterbalanced across subjects and subjects were randomly assigned to a given condition. All sessions were tape-recorded, and subjects were asked to "think-aloud" throughout as they composed or revised.

Measures Obtained

The measures obtained can be grouped into two general categories - Process Measures and Product Measures.

The Process measures were derived from an analysis of the subjects' think-aloud protocols during composing and revising, and from the justifications provided in response to experimenter probes during the *Directed Revision* condition. The think aloud protocols were typed, parsed into thought segments, and categorized into 36 different types of statements (see Appendix A). The coding

scheme was designed in order to capture two dimensions of the subjects' thinking aloud. Firstly, the protocols were analyzed in order to monitor the general types of strategies which were utilized in the different experimental conditions. Hayes and Flower's (1983) model of writing, which describes this cognitive activity as a recursive set of problem-solving processes, was the source of the *"General"* categories in the protocol coding scheme. These include:

- Planning--Draft
- Planning--Revision
- Generating
- Editing
- Environmental concerns
- Evaluation/Justification

Within each of these *General* categories there were a number of *Sub-categories*. These identify the level of text being attended to by the subject in each specific instance of the application of a General strategy (see Appendix A). The sub-categories were drawn from the work of Scardamalia & Bereiter (1986). These authors report that when contrasting the think aloud protocols of novice and expert writers, engaged in activities such as *Planning* or *Evaluation*, significant differences emerge in the amount of attention devoted to generating, and operating upon, abstract representations of the text-such as a potential audience, or its rhetorical characteristics. As Scardamalia & Paris (1985) report:

> Expert writers are distinguished from novices by making use of a variety of abstract mental representations of their actual and intended texts and by carrying out second-order operations with those representations. (p. 7)

Within the General categories of Planning (Draft and Revision) and Evaluation/Justification, sub-categories were collapsed for the preliminary analysis, into high-, and low-level statements, so as to minimize empty cells. Thus, for example, within the Planning category, protocol statements assigned by the coding process to the sub-category of *Single-Topic Content*, such as: "I am going to write about trees...", were counted as reflecting a low level concern, whereas statements indicative of planning strategies which focussed on *Organization*, *Audience*, *Rhetorical Characteristics*, or *Gist*, such as "I am going to write about why I think that, because someone reading this wouldn't understand my rationale...", were rated as reflecting high-level concerns. A similar distinction between high- and

low-level concerns was made in the analysis of protocol statements in the **Evaluation/Justification** category.

Two independent raters judged a random sub-sample of the protocol statements (33%) to make certain that objective scoring using this taxonomic scheme could be done accurately. The inter-rater reliability was .87 for assigning thought units to sub-categories, and .95 for assigning thought units to the General categories. One of these raters subsequently scored the remaining 66% of the protocols. Three additional checks on inter-rater reliability were undertaken during this latter portion of the coding process, and the inter-rater -r- remained at $r > .85$.

A number of Product measures were also obtained. All 64 texts, (16 x 2 drafts, and 16 x 2 revisions) were scored for (1) length, (2) time taken to produce, (3) grammatical exactitude, (4) spelling errors, (5) punctuation errors, (6) holistic quality, (7) creativity, (8) technical quality, and (9) stylistic quality. Two judges rated holistic quality on a scale from 1 (lowest) to 5 (highest) (combined inter-rater reliability =.81), and two other judges rated the texts (same scale) for creativity, technical and stylistic quality (combined $r = .72, .29$ and .40 respectively).

RESULTS and CONCLUSIONS

Multivariate analyses of variance were carried out to determine the effects of Skill Level, Mode of Production, and Instructions (two editing conditions and two revision conditions) on all of the process and product measures. The design allowed for Mode to be analysed as a between subjects factor, and Instructions to be analysed as a within subjects factor. Skill level was always a between subjects factor. The nine different Product measures were subjected to two separate multivariate analyses of variance, one for the first draft composing sessions and one for the revision sessions. In all cases, specific univariate tests were only made after a significant F ratio (at $p < .05$) had been found in the multivariate analysis.

First Draft Composing Sessions-Process Measures:

The influence of Skill: We compared the relative incidence of the various statement-types in the subjects' think aloud protocols (each codeable statement was assigned to a General category and a sub-category- e.g. "Planning/Draft---Gist"). A MANOVA of these data revealed a highly significant Skill x Instructions interaction ($F(1,15) = 14.13$, $p < .01$). Subsequent ANOVAs on the incidence of "High-Level Planning" statements- (the percentage of high-level planning statements as a function of

the total number of planning statements), revealed a main effect of Skill ($F(1,15)=53.9$, $p < .000$) on this measure. The enriched students' planning statements contained a much larger percentage of high-level comments than did those generated by average students (X 68.2% vs. 13.4%). The results are shown In Figure 1.

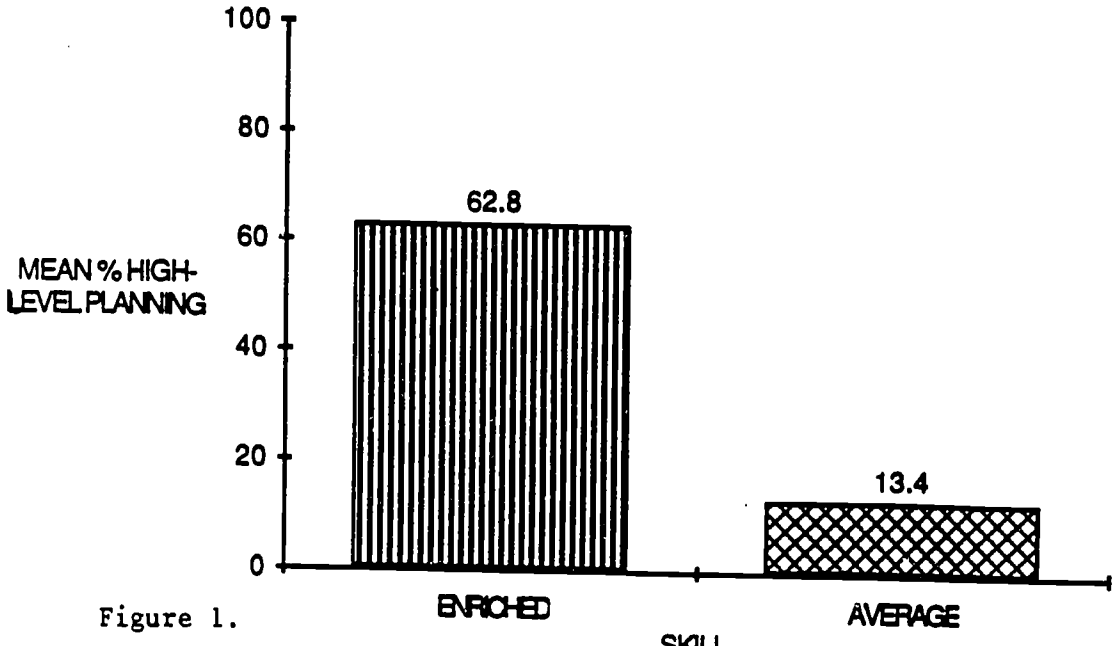

Figure 1.
RELATIVE INCIDENCE OF HIGH-LEVEL PLANNING DURING FIRST DRAFT COMPOSING

The combined influence of Skill and Mode of Production: There was a significant Mode x Skill interaction ($F(1,15)=4.89$, $p< .03$). Enriched students, composing with computers, generated 74.3% high-level planning statements, whereas those students composing with paper & pencil generated 54.1% high-level statements. The same comparison for the average students reveals the opposite pattern. Average students, composing with computers, generated 8.3% high-level planning statements, whereas the average students composing with paper & pencil generated 17.7% high-level statements.

The influence of Task Instructions: The enriched students produced the highest incidence of high-level planning statements when in the No-Edit condition, whereas the average students performed best when in the Free-Edit condition. The results are shown in Figures 2a and 2b.

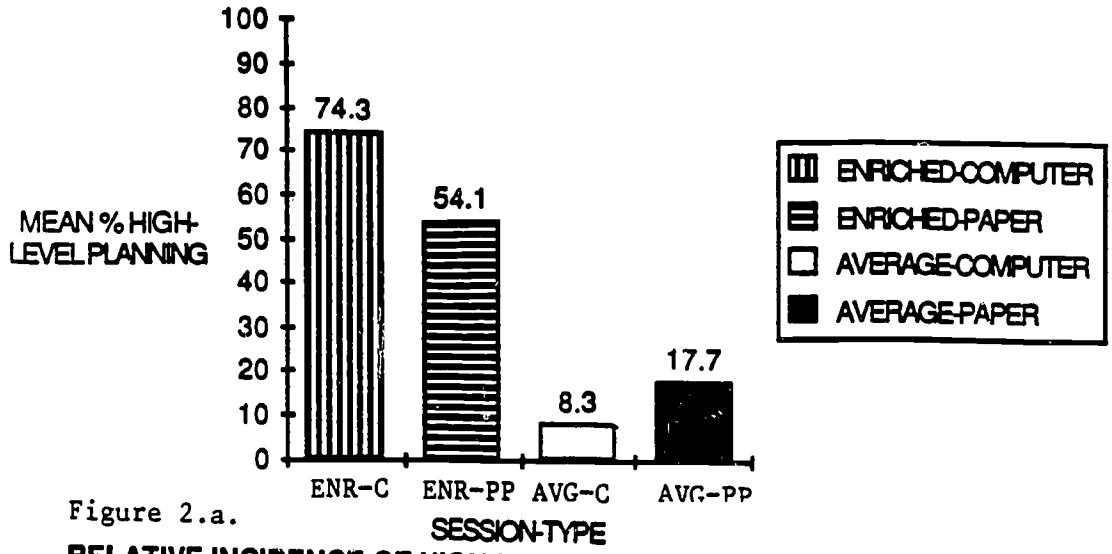

Figure 2.a.
RELATIVE INCIDENCE OF HIGH-LEVEL PLANNING DURING FIRST DRAFT COMPOSING

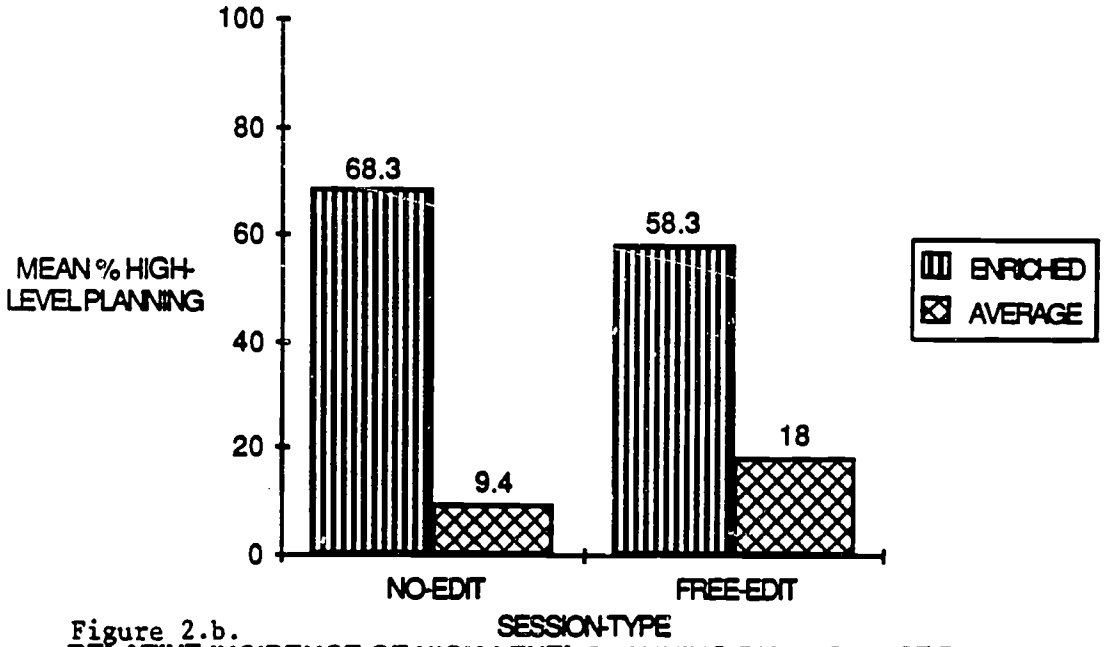

Figure 2.b.
RELATIVE INCIDENCE OF HIGH-LEVEL PLANNING DURING FIRST DRAFT COMPOSING

Mode of Production x Task Instructions x Skill effects: Enriched writers' think aloud protocols from sessions within which subjects wrote with computers, revealed 22% more high-level statements in the No-edit condition, than in the Free-Edit condition. In the paper & pencil sessions,

enriched student writers in the No-edit condition generated 17% more high-level statements than when composing a first draft in the Free-Edit condition. The results are in Figure 3.

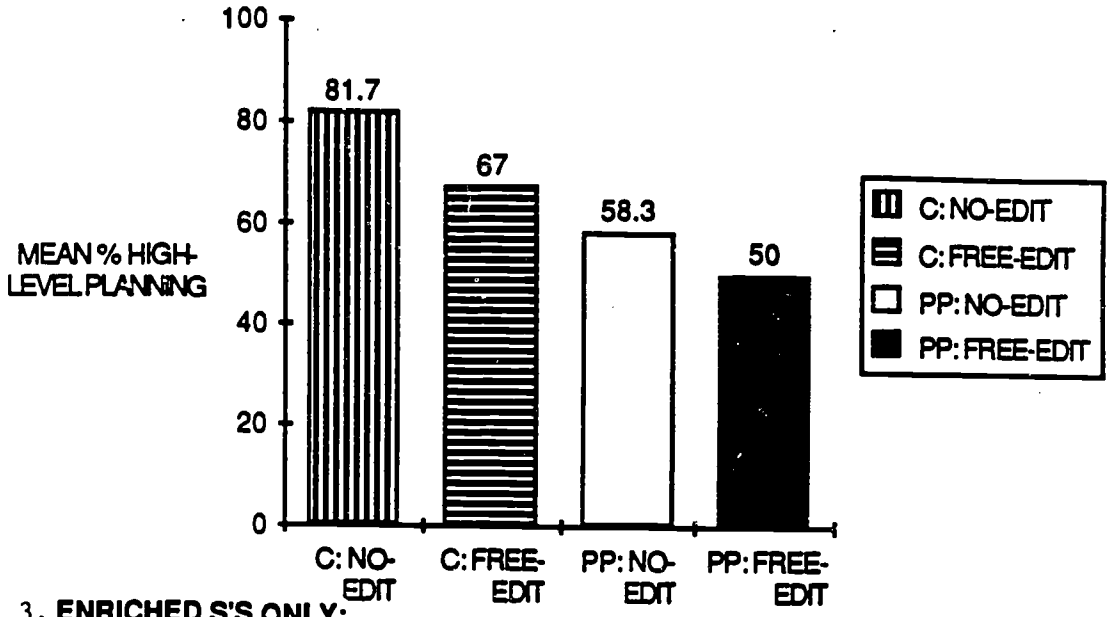

Figure 3. **ENRICHED S'S ONLY:**
RELATIVE INCIDENCE OF HIGH-LEVEL PLANNING DURING FIRST DRAFT COMPOSING

The Average writers composing with computers, by contrast, showed just the opposite pattern. This group showed a 100% decrease in high level concerns if one compares their scores in the No-Edit condition with those in the Free-Edit condition. For average students writing with paper & pencil, there were 17% more high-level statements in the Free-Edit condition, as compared with the No-Edit condition. The results are in Figure 4.

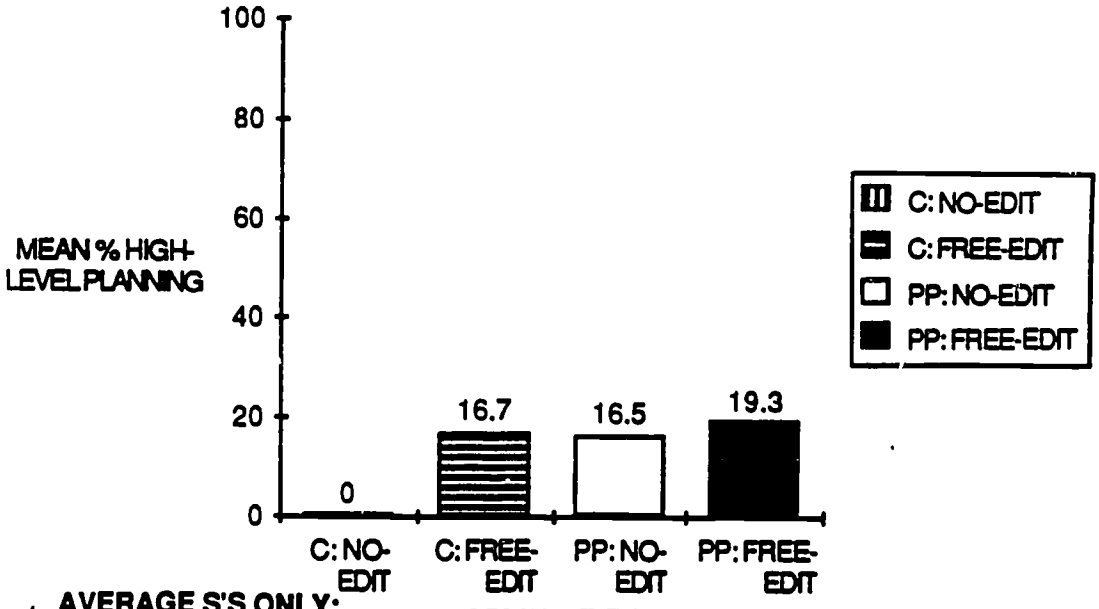

Figure 4. **AVERAGE S'S ONLY:**
RELATIVE INCIDENCE OF HIGH-LEVEL PLANNING DURING FIRST DRAFT COMPOSING

Results from First Draft Composing sessions- Product measures:

The influence of Mode of Production, Skill, and Task Instructions: MANOVAS on the ratings of students' first drafts revealed that the effects of restricting editing on the rated quality of subjects' texts were remarkably consistent with the impact of this manipulation on the process measures. The **Style** measures for the average writing group's compositions were reduced when editing was prohibited relative to when editing was unrestricted during composition (X 2.92 vs. 3.35). This reduction in rated quality was greater for those subjects writing with computers.

The influence of Task Instructions: There was a marginally significant main effect for the Instructions factor on the Technical measure ($F(1,15) = 4.43$, $p < .059$), which showed that inhibiting editing during composing produced lower ratings of technical quality for both enriched and average subjects, regardless of their mode of production.

The influence of Skill: Skill differences in the Holistic scores were not significant, but were in the predicted direction. The effect of Skill on holistic scores ($F(1,15) = 3.64$, $p = .097$) indicated that enriched subjects' scores were higher than those received by average subjects (X 3.1 versus 2.62). The results are shown in Figure 7.

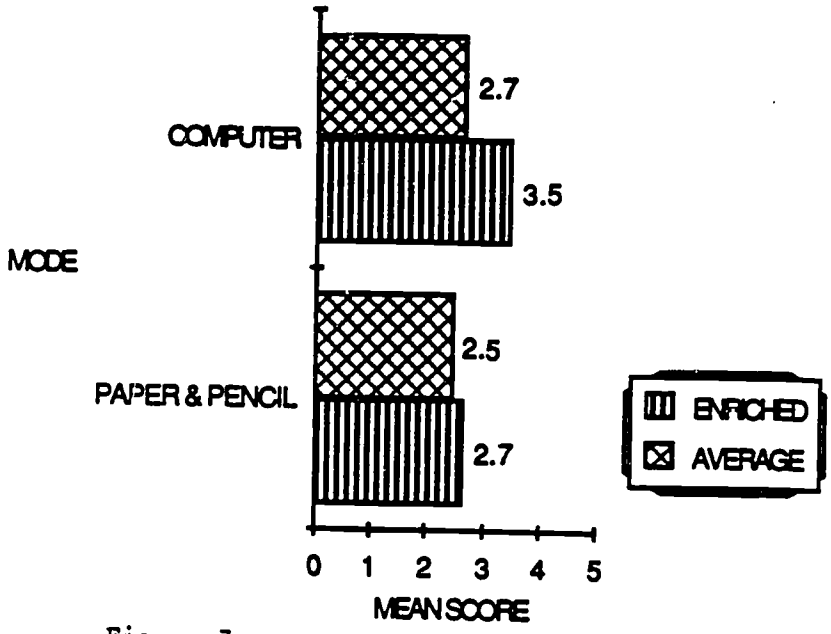

Figure 7.
HOLISTIC RATINGS ON COMBINED SCORES: FIRST DRAFT TEXTS

Results from combining students' Creativity scores from first and final drafts:

Also consistent with the protocol data for the enriched writers, was the fact that their Creativity scores (combined first and second draft scores), increased with the introduction of edit restrictions. We averaged students' Creativity ratings from their first and their final draft composing sessions, in order to measure the full impact of providing students with a Freewriting first draft composing session which was followed by a Revision session. Due to the inclusion in our design of Directed revision sessions, we only analyzed Creativity scores from those first draft texts which were followed by a Spontaneous revision session (8/16 texts).

Skill x Mode of production effects: Univariate F tests on the average product ratings of the first and second drafts showed a significant Skill by Mode interaction on the Creativity scale ($F(1,7)=6.02$, $p < .05$). As demonstrated by other measures, the enriched group performed best on the computer, while the average students received their highest scores when they had written in the paper & pencil condition. These results, (which were adapted from Joram, 1986), are shown in Figure 5.

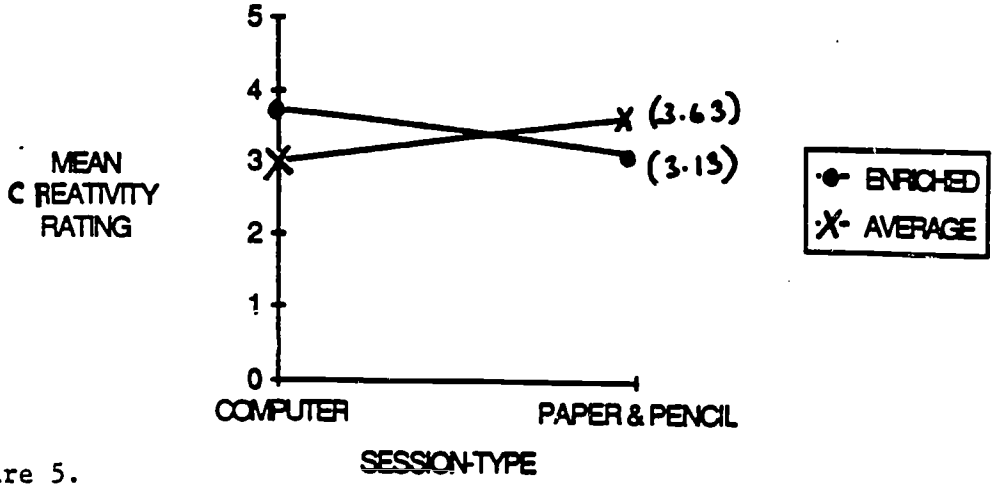

Figure 5. **CREATIVITY RATINGS AS A FUNCTION OF FIRST DRAFT SESSION-TYPE: MODE BY SKILL INTERACTIONS**

The influence of Mode of production and Task Instructions: There was also a significant Mode by Instructions effect on the Creativity scale ($F(1,7) = 11.47$, $p < .01$), with the highest ratings in the No-Edit condition occurring in the computer sessions, while in the Free-Edit condition, the highest scores were obtained when subjects wrote with paper & pencil. These results are shown in Figure 6 (adapted from Joram, 1986).

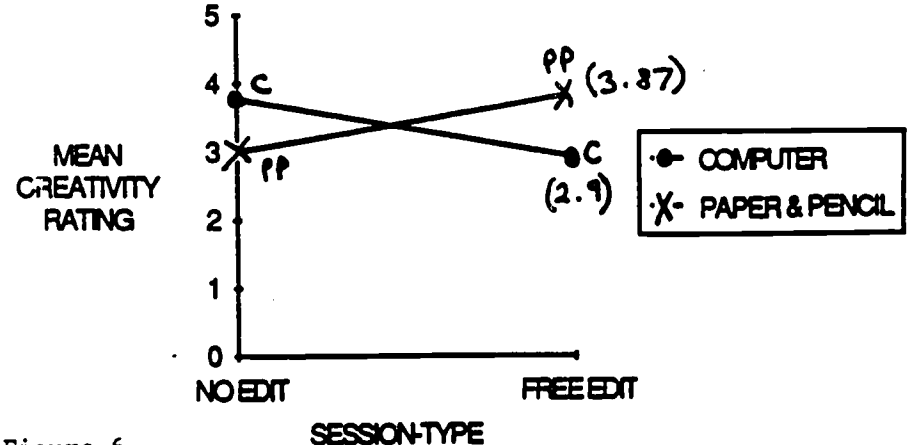

Figure 6. **CREATIVITY RATINGS AS A FUNCTION OF FIRST DRAFT SESSION-TYPE: MODE BY TASK INTERACTIONS**

Conclusions

Thus it is appears that the effects of prohibiting editing during the composing process only become significant when the subjects were using the computer to do their composition, and that the nature of the effect was critically dependent on the skill level of the student. Enriched student writers appear to have been able to take advantage of the opportunity provided to freely generate "writer-based" prose (Flower & Hayes, 1979). However, the average writers seemed totally unable to take similar advantage of the constrained composing conditions. It would appear from the process measures, that the average writers did not have sufficiently well-developed strategies in order to replace the void created by the elimination of editing behaviors. Note that this pattern of results occurred despite the fact that all of the subjects were explicitly told that a revision session would follow in which mistakes could be corrected.

Results from Final Draft Revision Sessions- Process measures:

The influence of Mode of Production, Skill, and Task Instructions: The pattern of results found with the think-aloud data from the 2 revision sessions further support the Skill and the Skill x Instructions effects reported for the composing conditions:

- A MANOVA on the percentage of high-level planning statements in the subjects' protocol data, revealed a significant Instructions main effect ($F(1,15) = 11.95$, $p < .01$), and a significant Skill effect ($F(1,15) = 8.44$, $p < .05$).

- **Skill x Task x Mode:** A comparison of the protocol data from the two revision sessions, revealed that the highest overall percentage of high-level statements was made by Enriched students, writing with computers, during Directed revision.

- **Task:** All writers made more high-level statements during Directed revision sessions regardless of skill, or mode of production.

- **Skill:** The enriched writers made more high-level planning statements than the average students across both mode of production, and session-type.

The results are shown in Figure 8.

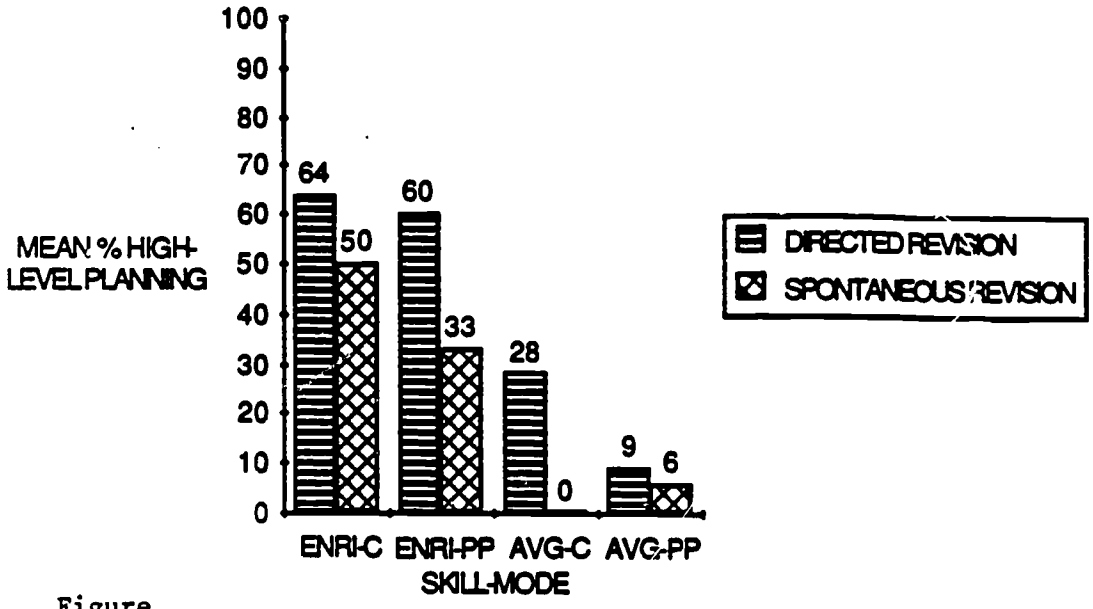

Figure 8. **RELATIVE INCIDENCE OF HIGH-LEVEL PLANNING AS A FUNCTION OF REVISION SESSION-TYPE**

High- versus Low-Level Justification Responses during Directed Revision sessions:

A two-way Analysis of Variance on the "Justification" statements provided by the subjects in the *Directed Revision* task revealed an effect for Skill which approached significance ($F(1,15) = 3.7$, p .08), and a Skill x Mode interaction ($F(1,15) = 4.26$, $p = .06$).

The greatest percentage of "high-level" responses was found in the think aloud protocols generated by enriched writers' composing with computers. Amongst the average students, the greatest incidence of high-level responses occurred when these subjects wrote with paper & pencil. These results are shown in Figures 9.a./ b.

(the % figures in this graph are actual numbers, and so do not add up to 100%- this kind of graph was chosen to indicate relative proportions of high-level responses)

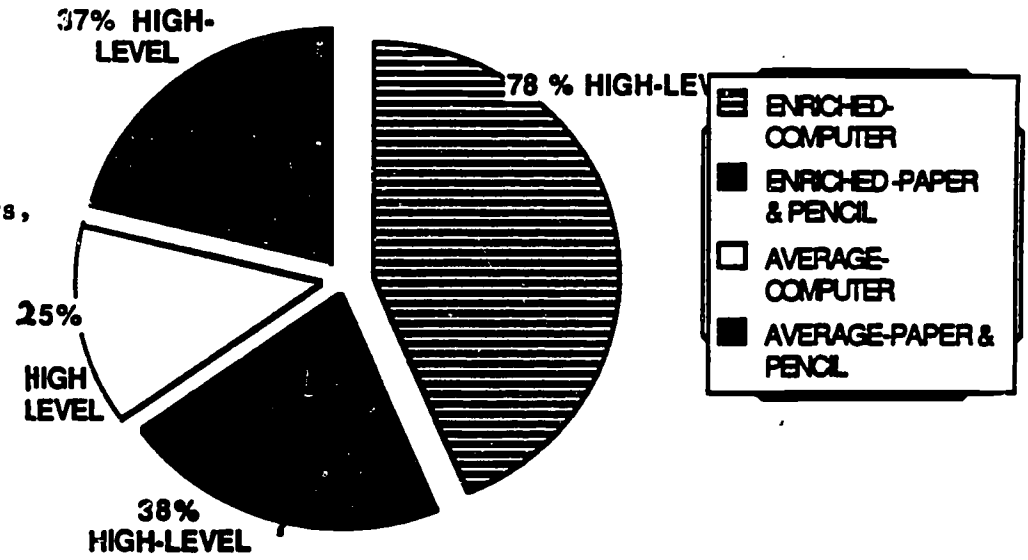

Figure 9. a. **RELATIVE INCIDENCE OF HIGH-LEVEL JUSTIFICATION STATEMENTS DURING EXTENDED REVISION**

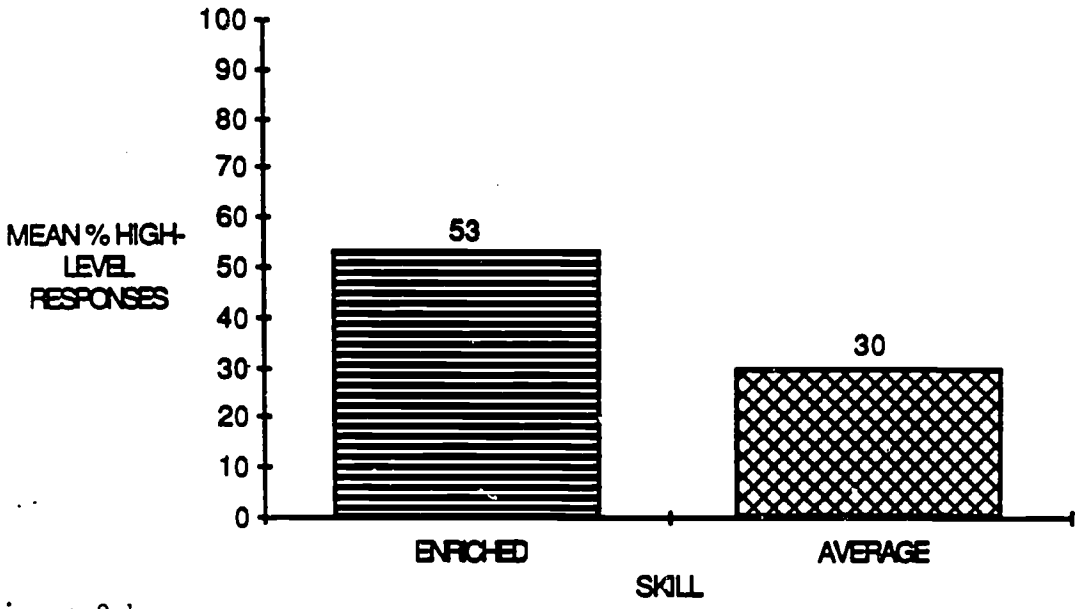

Figure 9.b. **RELATIVE INCIDENCE OF HIGH-LEVEL RESPONSES DURING DIRECTED REVISION**

Results from Final Draft Revision Sessions- Product Measures:

A MANOVA on the ratings of revised compositions revealed a main effect that approached significance for Mode ($F(1,15) = 3.6$, $p = .07$), as well as a marginally significant two-way interaction for Skill x Instructions ($F(1,15) = 4.0$, $p = .061$).

The influence of Task Instructions: Results from subsequent Univariate F-Tests revealed that the specific influence of *Spontaneous Revision* was to increase scores on the dimensions of Style ($F(1,15) = 9.35$, $p < .01$), and Technical Correctness ($F(1,15) = 4.59$, $p < .06$).

The specific influence of Directed Revision was to increase scores only on the Holistic and Creativity dimensions. For the enriched writer, revising on the computer resulted in an increase in the rated quality of texts on these last 2 dimensions. These results are shown in Figure 10.

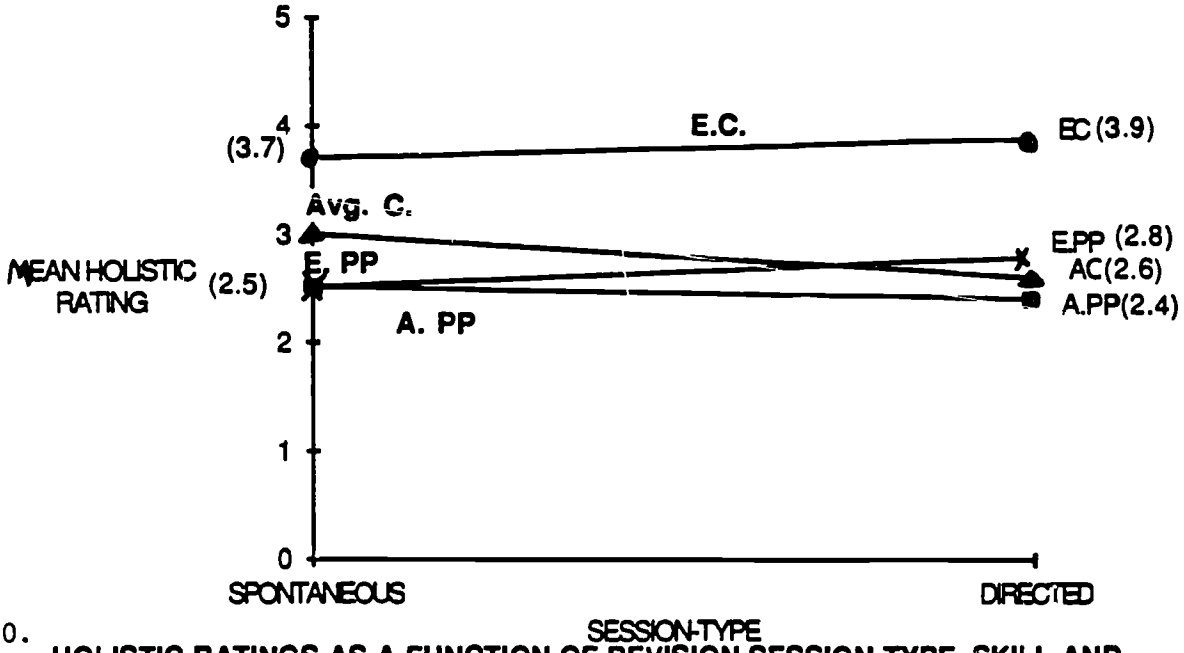

Figure 10. HOLISTIC RATINGS AS A FUNCTION OF REVISION SESSION-TYPE, SKILL AND MODE

Conclusions:

In sum, it would seem appropriate to conclude that the *Directed Revision* task, like the *No-Edit* task, selectively influenced the students' writing. The nature of the influence depended on: (1) the ability of the student to respond with appropriate strategies and goals, and (2) the facilitative contribution of the mode of production. In this study, the mere availability of a word processor did not appear to have a beneficial impact on the writing process of the average grade eight writer, as reflected in their think aloud data or global quality measures of produced text. However, the interaction of a talented, though still very inexperienced writer, plus a structured writing task and the availability of a word processor, combined so as to significantly increase the relative incidence of high-level text-composing strategies.

IMPLICATIONS: Theoretical and Educational

Both the No-Edit and the Directed Revision sessions reported in this paper represent what might best be called "implicitly facilitative task structures". The talented student writers in our study, who already possessed the prerequisite strategies for planning during first draft text production, seem to have been able to take advantage of the opportunity to focus on creating valuable content in their preliminary drafts, without the concomittant distraction contributed by frequent surface-level editing. Since editing is more frequent on word processors, it is not surprising that this condition was especially beneficial to those talented writers composing with computers. Likewise, when given the opportunity to make large-scale revisions (Directed Revision), the talented writers were able to improve their texts significantly. The influence of task structure was strongest when talented students composed with word processors. The results suggest that the provision of a word processor did not benefit either the writing processes (as reflected in the think aloud protocols), or the product ratings of the average grade eight student writers in our study.

The notion that writing with computers is always beneficial, for all students, continues to thrive in many educational settings. A review of our results suggests that such a notion fails to serve the varying needs of students. Likewise, we have presented some tentative and exploratory results concerning the potential impact of separating the writing process into discrete stages, such as "Free-Writing", and "Re-Writing". These findings suggest that in instructional implementations of such approaches, the influence of learner characteristics, and mode of production, on text production processes must always be considered. The combined influence of writing skill, task structure, and mode of production, which characterized this study's significant findings, suggests that it is the use of computers, rather than their availability alone, which presents an investigator with the most promising point of departure in such investigations. In sum, it is clear that currently, in the field of computer-assisted writing instruction, "knowledge engineering" (Norman, 1980) must evolve in tandem with cognitive-developmental models of performance, if we expect to be successful in helping children become "mindful" users of the "technologies of the intellect" (Clark & Salomon, 1986).

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APPENDIX A

Analyzing the Think Aloud Data‡

Preparing codeable transcripts

1. During each session, all utterances were recorded, whether they were generated by the subject or the experimenter.

2. These tapes were then transcribed, without omitting any material, by trained project personnel. The tapes were entered directly into a mainframe VAX computer, which is equipped with the Oxford Concordance Program (a linguistic analysis program).

3. All identifying information, other than a code number, was left off of the printed transcripts.

4. The initial analysis of the transcripts was carried out by one of the investigators, and involved subdividing each protocol into the following distinct categories:

- Text content = all material from the actual written composition;
- Experimenters' computer instructions;
- Experimenter instructions = Extended revision tasks;
- Codeable statements = Everything said by the subjects, irrespective of whether the utterance was related to the task at-hand.

Coding: The conceptual analysis of think aloud data

1. All codeable statements were divided into "thought-units" (T-units) in the manner suggested by Flower and Hayes (1983). Thought-units should not to be confused with T-units as they are more commonly used in writing research. In traditional textual analyses, a T-unit is the smallest possible distinct statement, minimally consisting in a single unpunctuated sentence, for example, "My car is a blue Ford." A T-unit was defined operationally as the expression of one complete thought, for example, "trees, I think I'll write about trees. . . ." The T-units were numbered sequentially within each protocol.

2. A set of protocols was assigned to two of the investigators, who scored each

‡The methods of protocol analysis presented in this appendix were developed by Mary Bryson for the following report: (1985) Lindsay, P.H., Woodruff, E., Joram, E., & Bryson, M. Final Report to the Ministry of Education.

codeable statement with two codes: The first code refers to a general category, the second code refers to a sub-category. For example, the following statement:

"I think I'll write about why we should save the forests in Canada by wasting less paper"

- (1) occurred in a "first draft" session, and, was rated as a "planning" statement, (so "general" code = P);
- (2) was rated as a "gist" sub-type, within the planning category, (so "sub-type" code = G).

This latter codeable statement was therefore coded as: "P.G."

3. All codeable statements were assigned to a general category, as well as a sub-type within that general category.

The following is a list of the general categories:

- Planning--Draft
- Planning--Revision
- Generating
- Editing
- Environmental Concerns
- Evaluation

The following is a list of the sub-categories, which are presented under the heading of the general category to which they are assigned:

GENERAL CATEGORY: PLANNING

Sub-Categories:

- **Content**. Student sets sub-goal concerning a single category topic, without specifying any relational connectors, either to existing text, or to an overall gist. Example: "I can write about cars."
- **Rhetorical**. Student sets sub-goal which specifies a particular stylistic quality which the text ought to characterize, without directly referring to an audience. Example: "I need to make this more interesting."
- **Audience**. Student sets sub-goal which contains a relationship (either implied or explicitly stated) between an audience and a section (large or small) of the text. Example: "I have to change this word 'cos they won't understand it."
- **Organization**. Student sets sub-goal which specifies a structural component of the text, either at a local or a global level. Example: "This part tells what my composition is about, so it's gotta go in the introduction."

- **Gist**. Student sets a sub-goal which specifies a relational topic, or macro-proposition, which will form the basic ideational structure of that text. Example: "I think I'll write about why we should all help to avoid the chance of having a nuclear war."

General Category: Generating

Sub-Categories:

- **Content search**. Student repeats material out loud, either re-reading from the text or rehearsing prior to transcription, without explicitly formulating a sub-goal. Example: "Trees, um . . . what else about trees. . . ."

- **Difficulty/Block**. Student states that he/she is unable, at that particular moment, to continue. Example. "I can't think of anything to change."

General Category: Editing

Sub-Categories

- **General Scan**. Student states that he/she is perusing a portion of text. Example: "I'm just looking to see what I already wrote."

- **Surface Change**. Student specifies an alteration to existing text which is either orthographic or is a change which is totally restricted (i.e., no semantic variation would result), in its potential impact at a textual level--local or global. Such changes include altering spelling, upper-case to lower case etc. Example: "Oops, I need a capital 'p' here."

General Category: Environmental Concerns

Sub-categories:

- **Task**. Student asks a question concerning one, or more, aspects of the assigned task. Example: "Should I write my name at the top?"

- **Mode**. Student asks a question which specifies one or more aspect/s of the transcription mode, whether the latter is pencil & paper, or computer. Example: "How do I add a sentence . . . should I draw an arrow?"

- **Think Aloud**. Student says something which explicitly specifies one or more aspect/s of the think aloud procedure. Example: "Should I also say everything I write?"

- **Physical Setting**. Student says something which specifies one or more aspect/s of the physical environment. Example: "Who is in the other testing area?"

General Category: EVALUATION

Sub-Categories:

- **General Effect**. Student evaluates a portion of text without specifying any precise

criterion for that particular judgement, other than, for example, referring to how it "sounds," or how it "seems good." Example: "I don't like the way this sentence sounds."

- **Language**. Student evaluates a portion of text on the basis of one or more explicitly stated features of the language. Example: "I shouldn't use ain't, that's bad grammar, I need to say are not."

- **Single Topic**. Student's evaluation of a section of the text refers to a single-category topic/idea, which is not connected in a relational sense with the rest of the text. Example: "'Cos this is about computers, so it goes here."

- **Rhetorical**. Student's evaluation of a portion of text explicitly refers to a particular stylistic quality which that segment ought to characterize, without directly referring to an audience. Example: "This part is really boring."

- **Audience**. Student's evaluation of a section of the text contains an explicit reference to an audience/reader. Example: "Someone reading this wouldn't know my friend is crazy, so. . . ."

- **Organization**. Student evaluates a portion of text on the basis of its structural properties. Example: "So this paragraph really doesn't make a good introduction."

- **Topic Elaboration**. Student explictly states that a particular segment of text extends ideas which occur in another portion of that text. Example: "It explains more about the war, like why it happened."

- **Gist**. Student's evaluation of a portion of text refers to a relational ideational structure which could be characterized as the "gist" of that text. Example: "Because this is about my main point, that people need to think more about nuclear war."