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AUTHOR Fais, Laurie; Wanderman, Richard
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ABSTRACT

The paper describes the application of a computer-assisted writing program in a special high school for learning disabled and dyslexic students and reports on a study of the program's effectiveness. Particular advantages of the Macintosh Computer for such a program are identified including use of the mouse pointing tool, graphic icons to identify available options, menus, windows, the high resolution screen, and standardization of software applications. The study evaluated use of the computer with 27 students who spent one class session a week in the Computer Aided Writing Project. Comparison of pre-testing (September) and post-testing (May) showed mixed results. Further analysis of results indicated a distinction between active/expressive tests or tests couched in the context of a full paragraph, and passive/receptive tests or tests of tasks isolated from context. All the improvements students made were in the active, paragraph-size tasks: organizing specifics into paragraph form, proofreading, writing/grammar, and speaking/grammar. Students' performance on tasks isolated from paragraph context (crossing out unrelated specifics in lists, categorizing/outlining items in lists) and the receptive tests of reading/grammar and listening/grammar showed no improvement and in some cases showed some loss. Teacher observations tended to be positive. (DB)

# A Computer-aided Writing Program for Learning Disabled Adolescents

Laurie Fais
Richard Wanderman
The Forman School
Litchfield, Connecticut

Modern technology has given us an important tool for remediating the problems with written expression exhibited by our learning disabled students: the computer. Like all tools, its value is contingent upon who uses it and how it is used. In what follows, we look at the who's and the how's—and the why's-- of a program using the Macintosh computer as a writing tool for learning disabled students in a private school setting[1].

The Computer-aided Writing Project is a joint venture between the Language Training Department and the Computer Department at the Forman School. Forman is a college-preparatory school for bright, learning disabled adolescents, incorporating a standard high school curriculum for college-bound students and an individualized Language Training Program in which approximately 85% of the students are currently enrolled. In the Project, we are:

using Macintosh computers to give learning disabled students the power to write;

teaching students how to use off-the-shelf computers and software to get real work done;

teaching students to be self-sufficient computer users.

What's so special about this? There are few other schools—public or private, concerned with dyslexia or not—that are using computers in this way. Most schools use computers for electronic drill and practice. We believe that students who have a hard time with writing need to write more, not simply drill the use of parts of speech or sentence construction. Writing is a learning-by-doing process, and the problem with learning disabled writers is that they do not do enough writing to learn from their own experience. Our program changes that by giving our students more experience with writing of all types, from simple lists and outlines to extensive research papers.

What makes writing with a computer different? Simply put, writing with any computer radically changes the writing process in that it separates composing from printing. No longer does a mistake mean a re-write. No longer does a paragraph out of place mean a re-write. No more white out. No more illegible handwriting. No more worry about the most mundane part of the writing process, the physical act of getting the words onto the paper. Now our students can worry about more important things, like what they are trying to say. The computer is a prosthetic writing tool for learning disabled students in that it helps compensate for a great number of their weaknesses. We believe that we can make better writers of our students by showing them how to use computers, which in turn will give them the power to write greater quantities and to learn about writing from their own experience.

In our culture, reading and writing are important parts of the learning process. People who can not actively participate in these activities are lacking an important channel of information exchange. The use of a computer as a writing tool allows learning disabled individuals to participate fully in the world of written, verbal communication. The effect this has on their image of themselves as learners and idea producers is profound. With the aid of a computer, many learning disabled people can now see their ideas, outside of their heads, in legible written form for the first time.

We chose the Macintosh for our Project because it is the easiest computer to use, it has a well designed visual/kinesthetic interface (which includes the use of a pointing device called a mouse) and the programs written for it have a consistent interface which makes learning new programs easy.

But, as important as the type of computer a learning disabled person chooses to use is the spirit in which it is used. Using any computer, including the Macintosh, in an environment of pressure and lack of personal interaction and caring will simply amplify the pre-computer problems the learning disabled person had. At Forman, we do not have prerequisites for computer use. We want to make computers as accessible as possible to everyone. Whether or not a person has typing skills or knows anything about programming is immaterial to his being able to sit down at a computer and get some writing done.

## The Macintosh Computer and Dyslexia

Using personal computers is still relatively complex, and using most types of personal computer involves the precise use of either the English language or a syntactical form determined by the manufacturer. There is a movement in the computer industry, however, toward more visual as well as other non-verbal computer interfaces, making the use of computers less dependent on written language. The Macintosh computer is an example of such an effort.

The Macintosh is different from most other microcomputers in that it uses a visual as opposed to command-line interface of the type used by the Apple II, IBM PC, and virtually all other microcomputers. With a command-line interface, one types a command or series of commands to make the computer do things. This raises problems for many people using these types of computers; the same problems are exaggerated in the case of the learning disabled person.

A few of the problems:

One has to know the commands in order to type them. This involves memorization of letters, words, or phrases.

One has to spell the commands correctly for the computer to execute them. This also involves memorization. Many of the commands are contractions which are not always phonetic in nature and therefore hard to memorize.

The syntax of the command structure in many operating systems is not intuitive.

Standardization

Another aspect of virtually all personal computers except the Macintosh is that there is no standardization in the way programs work within the various operating environments. This means that to use three or four programs within any of the non-Macintosh operating environments, one has to memorize three or four different commands for each operation. For the learning disabeld person with poor memory skills, especially for language material, this type of memorization is hard if not impossible.

Apple made some important decisions about the way they want people to interact with the Macintosh. One of the most important was that the Macintosh operating environment should be (and is) standardized; all programs, whether written by Apple or third party software houses, look and operate in similar ways. Much of the Macintosh interface is built into the computer as a semi-permanent part of the machine. All software runs within and interacts with this standard visual environment. Unlike other microcomputer software, almost all Macintosh software shares a common operating syntax and a common visual style. The Macintosh operating system itself also looks and feels like every other program that runs on the machine.

Needless to say, this standardization makes using the Macintosh easier than using virtually any other computer on the market. In the case of learning disabled people, this ease of use ("user-friendliness" in computer jargon) is critical to using a computer at all.

The Mouse

Another aspect of the Macintosh which makes it easy to use is the mouse, a pointing tool that replaces the cursor keys on other computers. It makes moving around the screen easier and faster than cursor keys or joysticks, and clicking the button on the mouse or holding the button down while moving the mouse also allows the user to perform functions that would be language mediated in other computer environments.

Icons

Icons are graphic symbols that visually represent objects on the Macintosh screen. To make a selection within the Macintosh environment, one points to an icon with the mouse and clicks the mouse button. The MacWrite program icon is a picture of a hand writing on a piece of paper with the word "MacWrite" written under it. One never has to write out the word "MacWrite" or even recognize the word to select and run the program; one simply points to its icon with the mouse and clicks the mouse button. Correct spelling is not an issue within this environment; the keyboard is not normally used in making selections.

All programs that run on the Macintosh (also referred to as "applications") have their own distinctive icons. The files created by different applications also have their own icons and these in some way relate to the application's icon. Most icons visually represent the function of the program they belong to.

Menus

All Macintosh software uses pull-down menus located in a line on the top of the screen and available at all times. Menus are activated by pointing with the mouse to the menu of choice, then holding the mouse button down to "pull" the menu down revealing specific menu choices. The visual feedback and kinesthesia involved in making a menu selection with the mouse makes learning how to manipulate menus fast; it usually takes about three minutes for people to learn how to use Macintosh menus. Once learned, menu use never has to be re-learned, since all programs that are run on the Macintosh use the same menu system. Most menu selections are only one or two words long. This makes reading, or recognizing, them easier for the learning disabled person.

Windows

A window is a visual/spatial area on the screen showing the contents of something. For example, to see the contents of a particular disk, one opens the disk's window revealing icons representing the disk's contents. One can have many windows opened at one time so that one can compare the contents of different disks. Manipulating windows is visual and kinesthetic. They can be moved around the screen or re-sized using the mouse. Windows appear throughout the Macintosh environment and their functions are standardized. The visual/spatial aspect of windows works well for the learning disabled person who might not be able to remember the verbal contents of command-line directories used in other types of computers to compare them to one another.

The Screen

The Macintosh's high-resolution, black on white screen not only makes its iconic/visual interface possible, it makes reading text easier. For the learning disabled person who has a hard time with reading under ideal conditions, a low resolution computer screen makes reading difficult and sometimes painful. There is enough negative feedback in the reading process *per se* for the learning disabled person without adding more as a result of a poor

screen. The Macintosh screen, being easy to read, causes less eyestrain than most other screens and contributes little or no negative feedback to the reading process. The black on white text also facilitates the reading process in that it is very similar to the black on white text familiar from "hard copy" reading of books, newspapers and magazines.

The kinesthetic feedback that comes from moving the mouse, coupled with the visual feedback of seeing icons, windows and pull-down menus, makes for a powerful multi sensory learning system. This system makes learning to use the Macintosh faster and easier than learning how to use other computers. For the learning disabled person, this system makes complex, autonomous interaction with the Macintosh a possibility.

All these features are embodied in MacWrite, the word processing program used in the Forman Macintosh Laboratory, in a user-friendly way. Even though one can use MacWrite literally immediately to get real writing tasks done, MacWrite has enough power to satisfy almost all of a typical person's writing needs. MacWrite allows for complex formatting, headers and footers, searching and replacing, and a number of other features. Most importantly, MacWrite is a what-you-see-is-what-you-get word processor. This means that what is on the screen in terms of formatting is exactly what the printer will print. This is essential for the learning disabled person who needs concrete visual feedback with little abstraction.

## Effects of Using a Computer on the Writing Skills of Learning Disabled Students

Those who work with learning disabeld students, or, in fact, any students, on computers often make intuitive claims about the advantageous effects this work has on the students' abilities to express themselves in writing. Unfortunately, there is currently a lack of "real" research validating these claims. The work that makes up the Forman School Computer-aided Writing Project has been designed to serve as the basis for educational research that

validates and explains the effects of using the Macintosh on the growth of the writing skills of these students.

The Computer-aided Writing Project encompasses all of the various contexts in which learning disabled students at the Forman School learn to use the Macintosh computer as a writing tool: small group classes, Computer-aided Composition, and the one-to-one language skills remediation course Language Training (LT). In September of 1986, all of the 185 students in the LT program were screened and 48 were selected to go to the Laboratory one day a week during their LT class time, accompanied by their teachers. There they were taught how to use the Macintosh as a writing tool by the Director of the Lab, Richard Wanderman, or his assistant, Emmy Pellico. Of these students, 27 were selected as participants in the Computer-aided Writing Project research program, and were pre- and post-tested in a number of writing and language skills.

The students did informal writing samples and were tested on their abilities to judge the relevance of specifics to a given topic, to categorize specifics and topics into coherent groupings/outlines, to order specifics in a logical paragraph order, and to proofread a paragraph with not only grammatical, punctuation and spelling mistakes, but also mistakes of organization and clarity. In addition, the students also took four sections of the Test of Adolescent Language (TOAL), which tested their grammar abilities in the areas of reading, listening, speaking, and writing.

After the pre-testing, the students spent one day a week with their LT teachers and Richard or Emmy working on a variety of tasks. Most learned to use Acta, an outlining program, and became proficient at the process of generating ideas, formulating an outline, and producing a written piece of work, either in Acta or in MacWrite. Students learned all the basics of word processing and printing. Some engaged in "conversations" from computer to computer with their teachers. Much of the learning was directed toward the

accomplishment of a specific piece of work, often work for another class, such as a senior English critical essay, a History research paper or a Science Fair project write-up. Some exercises were just that—generated by the LT teacher for the sake of teaching a student how to use the Macintosh as a writing tool. The teachers kept notes on their observations of how certain approaches seemed to work, what students' reactions were, and what the more subtle effects of using the Macintosh seemed to be.

Students were post-tested in May, covering the same areas as their pre-testing the previous September. In the course of evaluating the results of each of the tests in the battery, certain trends became apparent.

Unrelated Specifics (see Figure 1.)

Students were asked to eliminate from a list of words and sentences those items that did not fit the general category of the list. Students made no improvement in this area; in fact, there was a downward trend in the post-testing results.

Categorizing/Outlining (see Figure 2.)

Students organized items in a jumbled list, out of the writing context. They showed no change, and in fact may have shown some loss.

Arranging Specifics (see Figure 3.)

Students were asked to arrange lists of sentences into paragraphs. The paragraphs were of differing organizational types: temporal, comparison/contrast, spatial, logical, etc. Markedly more improvement was shown on this test than on the previous two.

Proofreading

Students were asked to proofread for spelling, punctuation, sentence structure, paragraph structure and relatedness of specifics. Over half of the students made noticeable improvements. Fourteen students omitted the unrelated specific on the post-test, while

only three had done so on the pre-test. Fourteen correctly joined fragments on the post-test as compared to three on the pre-test. Of the four who corrected spelling mistakes on the pre-test, two did so correctly. On the post-test, nine out of the 15 making corrections made correct corrections.

TOAL: Listening/Grammar (see Figure 4.)

Students were tested for sensitivity to similar (spoken) grammatical structures, a task involving their receptive grammatical knowledge. About one quarter of the students showed no change, one quarter of the students improved, and half of them got worse.

Reading/Grammar (see Figure 5.)

Students were tested for their ability to recognize syntactically different (written) sentence structures, again, a function of their receptive grammar. The results were similar; approximately one quarter of the students showed no change, one quarter of the students improved somewhat and half of them got worse.

Writing/Grammar (see Figure 6.)

The results were quite different in this test, where students' ability to utilize English syntax in writing was tested. This tapped their active/expressive grammar. About half of the students lost a little ground, but half of the students improved by even wider margins.

Speaking/Grammar (see Figure 7.)

Students' expressive spoken grammar was assessed on this test. Again, over half of the students made impressive gains, while one quarter of the students showed no change and one quarter of them showed minor loss.

The consideration that seems to be the most significant in making sense of the full array of results is the distinction between active/expressive tests or tests that were couched in the context of a full paragraph, and passive/receptive tests or tests that were made up of tasks isolated from that context. All the improvements that students made were made in the active, paragraph-size tasks: organizing specifics into paragraph form, proofreading, Writing/Grammar and Speaking/Grammar. Students' performance on tasks isolated from paragraph context (crossing out unrelated specifics in lists; categorizing/outlining items in lists) and the receptive tests of Reading/Grammar and Listening/Grammar showed no improvement and in some cases showed some loss. Students exhibited greater sentence sense in both the TOAL and proofreading tasks and a much greater tendency to make corrections (and a greater ability to make correct corrections) on the proofing task.

The improvements in active, expressive writing tasks seem to point to a positive experience in the interaction with the Macintosh. Writing with a non-judgmental interactor like the Macintosh which facilitates the writing process by eliminating the high cost of correction and experimentation seemed to give students the self-assurance to "take charge" of their writing, to make corrections, to write enough to learn more about how to go about the process of writing, and to function confidently within the context of the writing experience. The fact that students' performance on the passive and task-specific tests went down is not alarming; it simply indicates that, since students' writing abilities per se improved, knowledge of these isolated skills are not necessary to the writing process. The implications for teaching are obvious. Briefly put, interaction with the Macintosh computer in the writing process and the use of the Macintosh as a writing tool are effective, positive, and beneficial components in a writing program for learning disabled adolescents. In addition, breaking down the teaching of the writing process into specific tasks is non-productive; those tasks do not seem to contribute to improvement in writing.

In round table discussions after the post-testing was done, teachers who had charted the progress of the students involved through the year of work in the Lab compared their impressions and observations. Some observations were unanimous: students working on the Macintosh were using much more sophisticated vocabulary and sentence structure than they had been in the fall. They were generating much greater quantities of written material. They were even using the Macintosh to make an outline before they sat down to write paragraphs.

It seems clear that students produced more sophisticated writing and greater quantities of it for two reasons: first, because the computer is such a non-judgmental facilitator, and second, because it separates writing from hard copy, making a distinction between the process of creation and the tangible result. What is difficult for these students is the physical production of the piece of output. Since the writing process itself is divorced from that physical production, students did not have to limit themselves to the "easy" words, the "little" sentences that they had a tendency to use in order to avoid making mistakes and therefore corrections when writing by hand.

The outlining program Acta was a great enabler for some of them as well; freed from having to create the mechanics of an outline, they could concentrate on how to code the relationships between their ideas and, again, with the physical mechanics out of the way, they could realize the benefits of pre-planning. On the other hand, not all students found Acta to be helpful conceptually. Acta gives structure to thoughts, potentially both a help and a hindrance. For the students who were willing/able to think and write in parts and still in need of external structuring, the program was extremely useful. But for those students who thought holistically or who were not able to break down the conception of their ideas into component parts, the program was frustrating. They were not capable of working with their ideas in a piecemeal fashion, i.e., they could not break their thoughts into units from which they could use Acta to construct an outline. The flip side of that were the

students who were capable of breaking down ideas and structuring them For them, the program was an unnecessary complication in their approach to the writing process.

Teachers also observed that students did not make as many reversals, transpositions or spelling errors in the first place, and definitely caught many more of them when proofreading in their computer-aided writing than they had in their handwriting. It is not quite as easy to explain why this should be so. Certainly one major factor to increased accuracy in proofreading is the fact that, having typed their ideas onto a screen, the students were able, some of them for the very first time, to read their own writing. For dysgraphic students, the revelation of actually being able to decode easily something they had just written was a primary factor enabling them to improve their writing; for the first time, these students were able to benefit from self-generated feedback. Even students who still had problems with decoding the printed word had less trouble with the Macintosh representation of their work than they did with their own handwriting; the high resolution screen makes for a clear image and the black on white printing recalls the standard text representations they are used to. The greater ease of reading coupled with the confidence they gained as a function of working with the Macintosh enabled these students to read more of their errors physically and to recognize them cognitively, so that they could correct more of them. Further, these students were not only more able to revise their work, they were also more willing. Proofreading and revising on the Macintosh, divorced from the scratching out and messy erasures of editing hard copy, are no longer the overwhelming tasks they once were.

But the question of why spelling should be better and why reversals and transpositions should be made less often is not clear at this point. Is there something in the nature of the student/computer interaction that circumvents the processing problems that result in spelling errors for these students? Or is it something as simple as the fact that the effort of keyboarding forces the students to be more conscious of their work and thus to use the knowledge that they have been taught in their LT classes? And how can we explain the

further observation that the dysgraphic handwriting of certain students seemed to improve with experience on the computer?

These are questions still requiring investigation. It may be that some of the illegibility of students' writing is due to their reluctance to have people read what they have written and to their masking of mistakes with orthographic vagueness (haven't most of us at one time or another, when not sure if it was ei or ie, made what could be construed by a sympathetic reader as a loop in each letter and positioned the dot squarely in between the two?). In this regard, it will also be useful to look at a personality index for each student before and after his/her year of work on the Macintosh to determine what sorts of gains in self-image and self-esteem have been made.

Some further observations have clear implications for the mode and content of student/teacher interaction with the Macintosh in the writing process. Whether keyboarding skills are an essential prerequisite to using the computer as a writing tool is sometimes considered controversial. In our Lab, students who did not have handwriting problems and who tended to be impulsive, holistic thinkers, were frustrated by the fact that their slow keyboarding kept their fingers from keeping up with their thoughts. This frustration prevented them from writing enough to learn better keyboarding skills solely as a by-product of their writing experience. For them, keyboarding instruction *per se* was necessary. For the great majority of our students, however, we found keyboarding to be a non-issue. As long as they didn't have to do the writing by hand, dysgraphic students weren't at all bothered by how long it took them to peck out their thoughts. The benefits of not having to write and, again, of seeing their thoughts in legible form far outweighed any initial frustration, or perhaps more accurately put, dispelled it altogether. The motivation level for these students was high enough that they continued to write, and wrote often enough so that keyboarding, albeit their own brand of it, came easier and easier.

Another issue of less concern to general computer-aided writing circles, but of great concern where learning disabled adolescents are involved is the use of a spelling checker program. Like Acta, a spelling checker has features that make it an advantage for some students and a disadvantage for others. It would seem obvious that, for students for whom spelling is difficult at best, a spelling checker program would be an essential tool. However, in the course of using such programs with our students (primarily WriteNow and Spellswell), several things became apparent. First of all, the program had to be fairly good at coming up with "guesses" for alternatives to misspelled words. Learning disabled students far more often than non-learning disabled poor spellers make mistakes on the first letter(s) of words; if a spelling checker "guesses" on the basis of first letters alone, the student will be frustrated by the inability of the program to give him/her any alternatives to the word it has flagged as wrong. Thus, a fairly sophisticated program is required in order for it to be useful at all. Second, for very poor spellers, having a spelling checker flag as misspelled a large number of words in a piece of writing can generate a sense of failure as debilitating as the learning disability itself, especially coming on the heels of the excitement and hope created by working on the computer. Third, spelling checkers are not omniscient. Even where the program is capable of coming up with alternatives for the misspelled word, it is still the student who must determine which, if any, of the alternatives is correct. Thus, spelling checkers cannot be a simple replacement for the remediation of basic spelling skills; the student needs to have those skills in place in at least a receptive sense to be able to utilize the power of a spelling checker.

For all these reasons, then, it is important that care be taken with how a spelling checker program is presented by the teacher and what guidelines are set up for its use by the student.

The preliminary findings of the Computer-aided Writing Project research and observations will be used to generate a curriculum and teaching guide that documents what has been found thus far to be the most effective sequence and content for a computer-aided writing program for these students. The guide will be refined and expanded as our experience teaches us more and more about how to help unlock the writing potential of these students using the Macintosh as a writing tool.

## A Real-life Scenario

It doesn't require research, however, for a teacher to know that working with a computer has a profound effect on the ability of his or her students to express their thoughts. The excitement of watching a mind unfold as it encounters a medium conducive to the expression of all the complexities it has stored for so long is an experience that teachers recognize immediately as validating the work that they do with learning disabled students on the computer.

. . . . . .

*John sat across from me at the table in front of a Macintosh computer. As Head of the Department, I was lucky enough to have one in my office, though I didn't know very much about using it. John is very dysgraphic so I figured using a computer might make it easier for him to write what he wanted to write.*

*We were working on possessives that day. "Give me a sentence using 'boy' in the possessive." "The boy's bat broke" was his reply. Typical. Even orally, John was in the habit of giving the bare minimum verbal response. "OK, now type it with the computer." John slouched back, one hand in his pocket and began to peck. With the patience born of working with learning disabled adolescents, this one in particular, I waited. And waited. Finally, my curiosity piqued, I stood up and strolled around behind John to see what was taking so long. He had typed "The boy's bat broke when he hit the ninety mile an hour fast ball."*

*Intrigued but afraid to be hopeful, I gave him another word: "witch." "The witch's brew boiled." "OK, now type that." Another wait. Then on the screen appeared "The witch's brew boiled over and drowned the black cat sitting next to the fire."*

. . . . . .

*It is a year and a half after the possessives episode. By now John and I are quite spoiled by having a Macintosh at our daily disposal. And I am spoiled by constant exposure to the tremendously positive effects it has on John's ability to express himself. But even at that I am taken aback one day. We are both settling into the beginning of the class, me with my usual banter about homework and seniors, but John strangely silent. I look up to see him bent over the keyboard, now with two hands in the semblance of touch typing that he has taught himself. I start to chide him (his favorite way to waste time in class is to rearrange his disks or change the pattern on my computer desktop) but get no response. I find myself strolling over to his side of the table again. This time what I see written begins "You are going to be mad at me I started to do the homework last night but there was a play that all the seniors had to see and after that..." John, a "typical" dyslexic, for whom written expression has been an anathema for his entire school career, is choosing to communicate with me in written form.*

# Footnotes

1. Throughout this paper we use the term "learning disabled" rather than "dyslexic." "Learning disabled" implies a broader spectrum of students and more accurately represents the population of students at the Forman School. We also do not wish to imply that the computer has benefits only for the more specifically language disabled, or dyslexic, student.

# Figures

Figure 1. Unrelated Specifics

Figure 2. Categorizing/Outlining

Figure 3. Arranging Specifics

Figure 4. Listening/Grammar

Figure 5. Reading/Grammar

Figure 6. Writing/Grammar

Figure 7. Speaking/Grammar

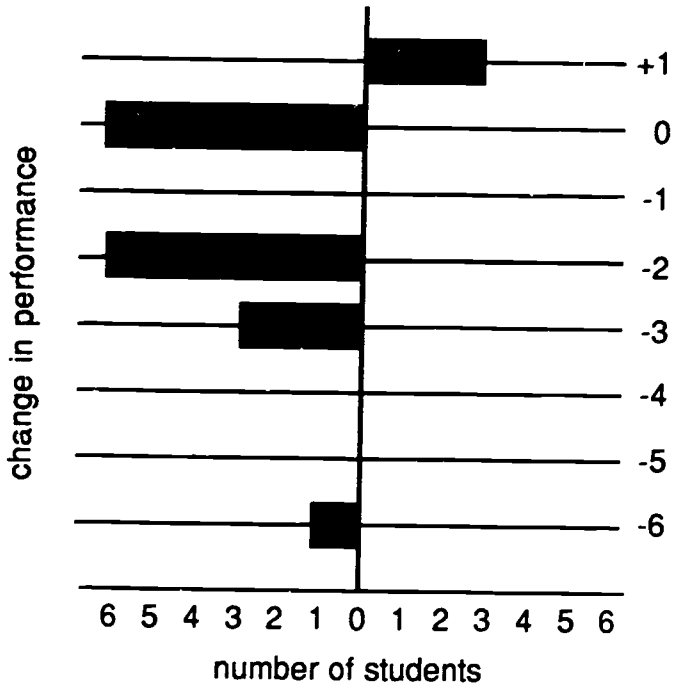


**Figure 1.**
**Fais/Wanderman**
**Computer-aided Writing**

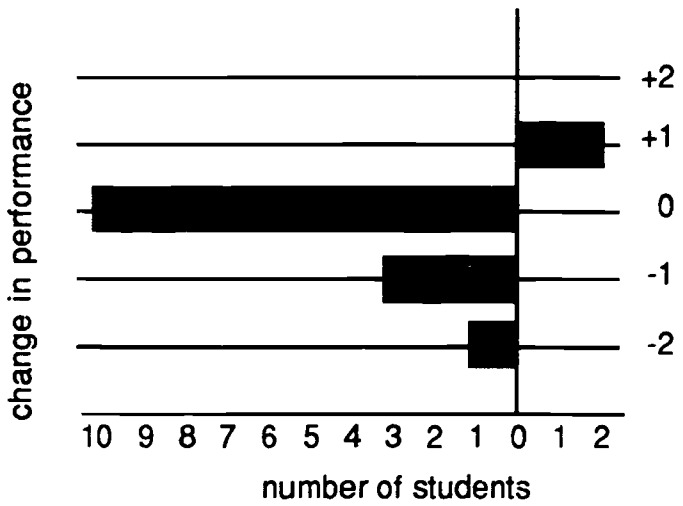


**Figure 2.**
**Fais/Wanderman**
**Computer-aided Writing**

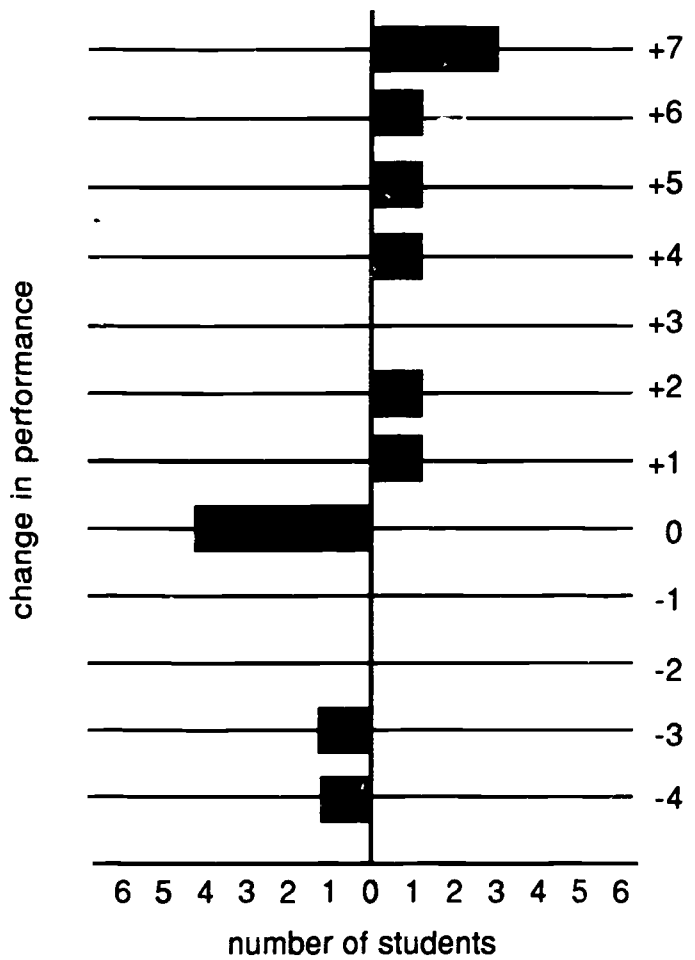


**Figure 3.**
**Fais/Wanderman**
**Computer-aided Writing**

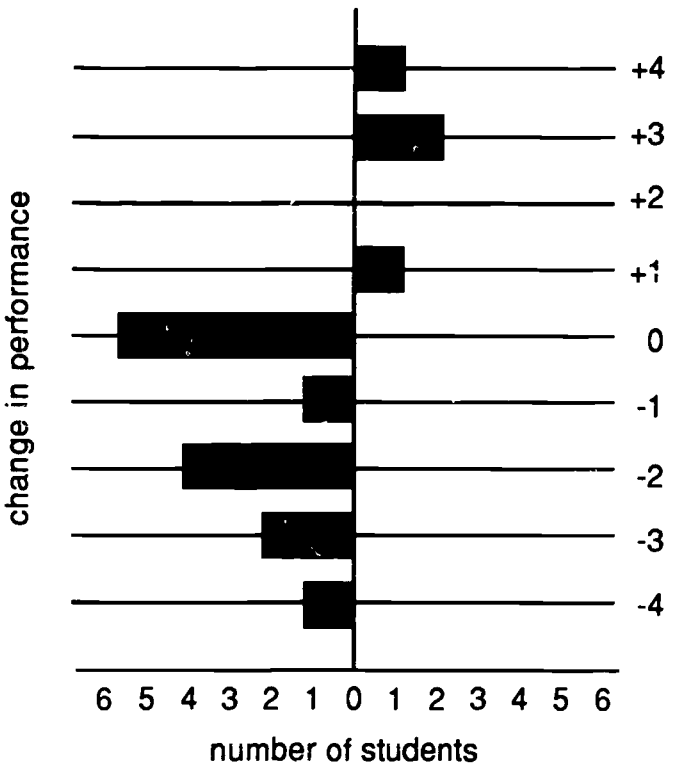


**Figure 4.**
**Fais/Wanderman**
**Computer-aided Writing**

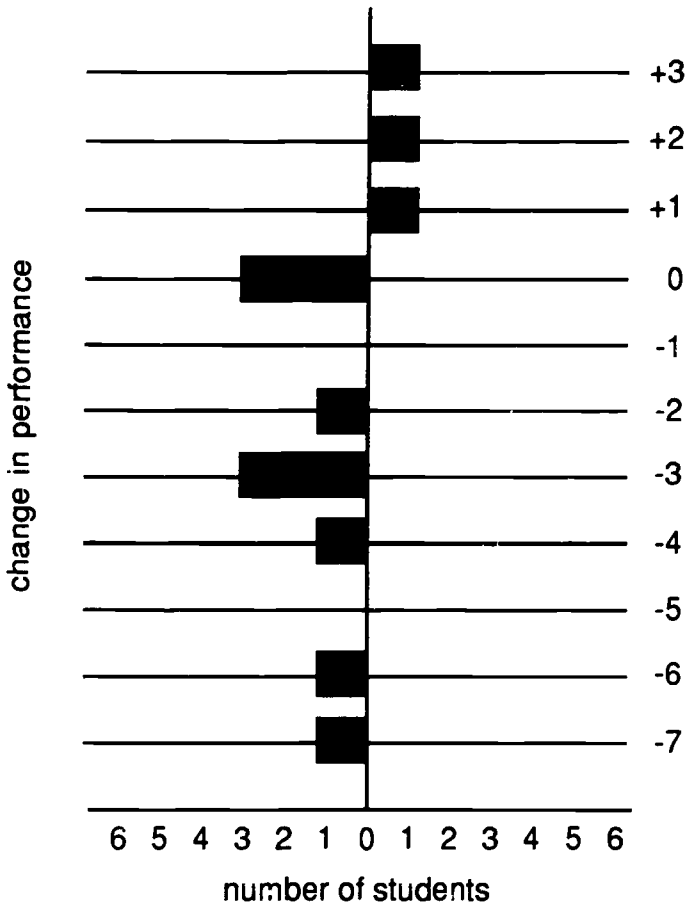


**Figure 5.**
**Fais/Wanderman**
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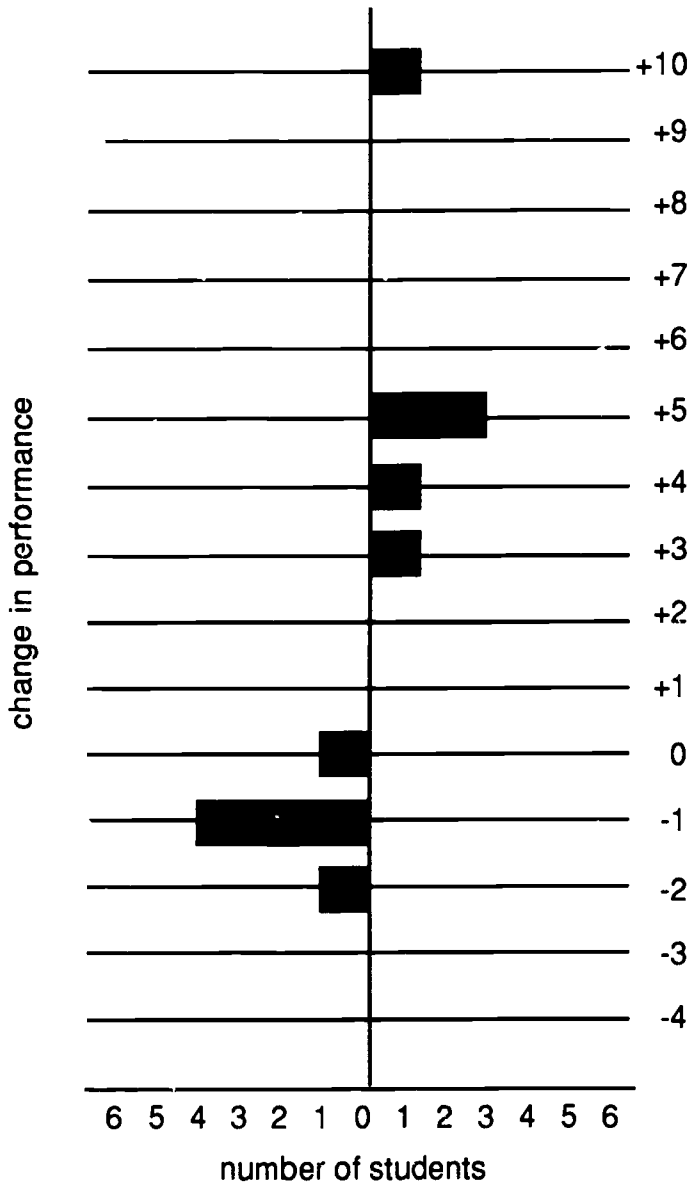


**Figure 6.**
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**Computer-aided Writing**

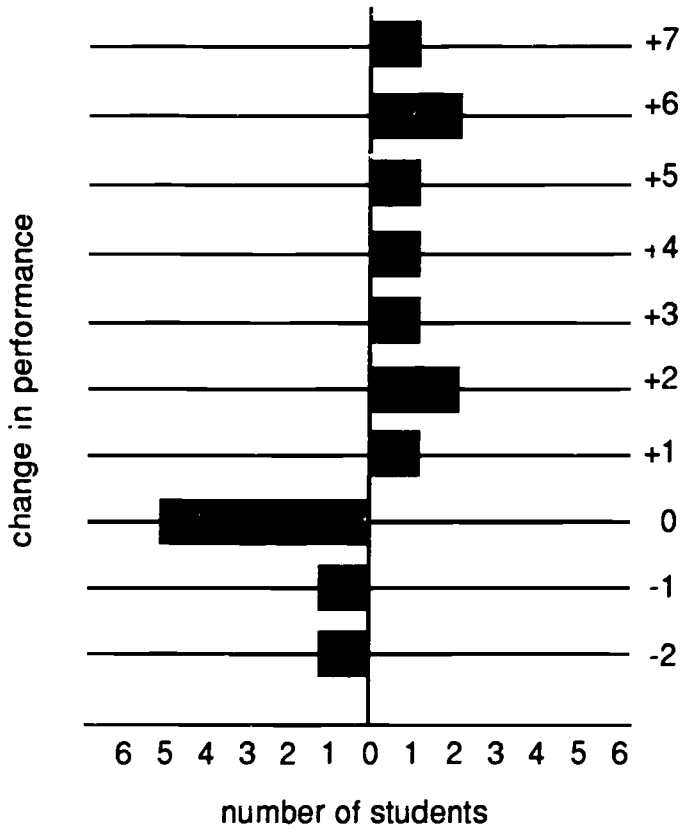


**Figure 7.**
**Fais/Wanderman**
**Computer-aided Writing**