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Increasing Feedback & Decreasing Errors While Lowering Instructor Workload in ROC EFL Business English Writing Classes

*Customized Expert System Development,
Application and Research Results
(An Empirical Study)*

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ABSTRACT

This paper details the development and application of a computer based expert system that finds errors in students' business letter writing assignments. The project was begun in 1990 and set out to find if such a system could be created by English instructors (no such system existed at the time that was practical and affordable for ROC schools). The major goal was to reduce teacher burden while increasing the amount of feedback given to students.

A software package was created through the use of new easy-to-use software development languages and programming methodologies. The QBL TOOLS expert system was found to be a low cost, medium technological answer to the problem of large class size. A trial study was performed in the 1992-1993 school year, including 200 EFL students, and found that such a system was practical and was able to measure statistically significant reductions in students' writing errors. A full study was undertaken in the 1993-1994 school year.

Over 700 students used the QBL TOOLS expert system while studying business English. A control group and test group were chosen. For five business writing assignments, students' errors were tracked. The result, using t-tests, showed that the test group, which received the expert system's feedback, was able to reduce errors more than the control group, which did not receive the feedback. A survey of

student attitudes showed that the test group perceived a larger improvement of their English writing skills. Conclusions and possible applications are included.

The specific parts of this paper include:

Part I introduces the background of the study and the main hypotheses that were tested.

Part II covers the general development of the expert system and introduces its use.

Part III details the trial study that tested the feasibility of the expert system and the practicality of carrying out detailed research on students' writing errors.

Part IV summarizes the full study of the impact of the computer system on students' errors (included control and test groups).

Part V analyzes the specific types of errors and error trends of participating students.

Part VI reviews the results of a study of how the expert system actually affects students' attitudes about their own English abilities.

Part VII summarizes findings with conclusions and implications for writing classes.

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GLOSSARY OF TERMINOLOGY

AI: Artificial Intelligence

API: Application Program Interface; the part of a program that can be accessed and controlled by other programs

Artificial Intelligence: computer hardware and software combination that performs functions analogous to learning and decision making

Assembly Language: a low-level computer language used in instructing a specific type of computer or operating system

BASIC Language: Beginner's All purpose Symbolic Code; a widely used high-level computer programming language

C Language: a powerful high-level computer programming language widely used because of its speed and ability to create complex programs

CAI: Computer Assisted Instruction

CALL: Computer Assisted Language Learning

CAW: Computer Assisted Writing

Context Sensitive Help: on screen text that assists the user to answer questions related to the action being performed at the time

Customized Software: a computer program that is created or modified for a specific purpose, for which commercial programs are not available

DOS: Disk Operating System; most widely used software for controlling personal computer functions and programs; widely thought of as difficult to use because it is controlled through command line codes

ESP: English for Special Purposes such as business English or academic English

Expert System: a computer program that imitates the actions of a human expert in a specific field

GUI: Graphic User Interface; synonyms with easy-to-use program interfaces that use menus, buttons and mouse movements to control a program rather than command codes

IDE: Integrated Development Environment; used in creating programs

Mouse: a computer input device that controls an on-screen arrow

PC: a Personal Computer, not linked to a network (in this study, PC refers only to IBM compatible machines)

Program Interface: the part of a program that the user sees and responds to in order to accomplish some type of task

QBL Student Version: a program used by students in preparing business letters for input into the QBL TOOLS expert system

QBL TOOLS: a program that finds errors in students' business writing while also allowing detailed analysis of progress

QBL: Quick Business Letters

RAM: Random Access Memory; more of this type of memory is required for more powerful programs

VB: Visual BASIC; the first, and generally accepted as the best, high-level programming language for Windows

VBA: Visual Basic Applications; Microsoft's use of Visual BASIC as a special language to control and modify commercially available Microsoft programs

Visual BASIC: see VB

Windows: a widely used program for controlling a personal computer and other programs; often thought of as easy-to-use because it is based on objects rather than command lines

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I. INTRODUCTION

A. THE PREDICAMENT FACED BY WRITING TEACHERS

EFL classes in the R.O.C. are regularly taught by teachers who have EFL/ESL/TESOL training from U.S. universities. The differences, however, between the U.S. based ESL experience and that of the R.O.C. often frustrate teachers in their attempt to apply ESL/EFL theory. The most striking difference is class size. A class with fewer than forty students is considered small, while the norm ranges from 40 to 60.

Special classes and night school class sizes can approach 70 students. Yet these classes are not intended to be introductory or lecture based, as are their large sized counterparts in the U.S., such as introductory economics or psychology.

Although class size is very large, there is typically no specific arrangement to assist a teacher with such a class. Student assistants are rare and not often assigned to individual teachers. Teaching aids are limited to cassette tape players and language labs (where students listen to pronunciation through headphones and speak into microphones). Some schools offer more advanced versions of such systems, but mostly directed toward speaking and listening skills. Clearly, the support for teachers of English writing is limited.

Writing classes, in the R.O.C., are often one of two types: technical/business writing or creative writing. Creative writing is usually a university based elective class

while business writing is required for international trade majors at the university and college levels. Business writing can also be offered at a university or college as an elective for non-business majors or as a requirement for other business related majors. Elective classes are few in number and tend to have a smaller enrollment than required classes although this is not consistent between schools. Required business writing classes are included in every international trade department. Because business schools, in the R.O.C., often enjoy a high level of enrollment, not unlike their U.S. counterparts, the demand for business writing teachers is substantial.

Teachers of business English (business communication or business writing is commonly named *business English* in the R.O.C.) may lack an understanding of business or may have business experience but lack strong English skills (Liao, 1990). This common mismatch of teacher and subject matter leads to frustration for the teacher of a business English class. Correction of homework assignments adds a further complication. The correction of hundreds of assignments, from teaching only a few classes, can greatly increase a teacher's workload with little or no corresponding increase in remuneration. A typical teacher, in both the U.S. and the R.O.C., begins his/her first year of teaching with enthusiasm only to quickly realize that the correction of hundreds of homework assignments is not a sustainable approach. Numerous suggestions have been made as to how to avoid teacher

burnout, such as time management and selective grading (Goddard, 1990), which can be helpful, but do little to change the underlying causes.

There is little doubt that the most effective way to improve writing is to write with frequency (Martin & Ranson, 1990). Additionally, the use of English business writing is fundamental to success in Taiwan's export driven economy (Tsui, 1992 and Harger et al., 1993) Few teachers, however, are willing to take home hundreds of papers every week. More than any other factor, it is the overwhelming number of errors to be corrected that encourage teachers to avoid assigning and correcting homework, yet it is this very activity that can serve R.O.C. students best.

B. TECHNOLOGICAL APPROACH

Although class size may at first appear to be the source of difficulty in teaching a business writing class, it is actually the teacher's out of class burden that is the real problem. A study by Lewis and Woodward (1988) found that large class size does not hinder student performance in applying principles of business communication in a letter form. That study actually showed that students can perform better in a large class environment than in a small one (under the assumption that the teacher can still input the required amount of work). With no evidence that large class size is a hindrance to learning, combined with the shrinking budgets of educational institutions, even U.S. schools are moving towards making large classes the norm. The obvious result is that for the same amount of in class time, a teacher will have

① more homework, ② quizzes and ③ exams to correct. Of these three, correction of homework, actual business letters, requires the most time.

Beginning in 1990, the author set out to find a way to overcome the problem presented by English written homework in the business English class. After grading hundreds of assignments by hand, it seemed obvious that much of the time was being spent in the mechanical action of writing comments on the students' papers. The author also observed that the majority of errors were repeated among students, thus causing the teacher to mark the same error and write the same comment numerous times. A technological solution seemed perfect for such a situation.

With constraints that included limited budget, little computer programming expertise and a growing awareness of intellectual property rights (thus limiting choices of software), the author undertook customized development of an expert system. This paper documents the application of new technologies that give enormous flexibility to teachers wishing to bring computers into the classroom in some context. It is clearly the case that finding just the right software for a specific class situation is difficult. As instructors in the Republic of China, on Taiwan, teaching EFL students, the opportunity to apply commercially available software becomes even smaller. Additionally, it may be the case that software that works well in one context may be ineffective in another context (Frase et al., 1985), thus forcing customized development or customization of software. The question, answered in this paper, is, "Can customized software be developed and significantly

impact students' language ability under the above mentioned constraints?" More specifically, eight hypotheses were tested in this study:

- 1) Complex educational software, such as an expert system, can be developed with limited funding from the host educational institution (preferably near the amount of zero dollars).*
- 2) Such software can be created in a short amount of time (a six month period, from conception to completion, for a single program).*
- 3) Instructors of English with little programming experience can create the needed coding for such software.*
- 4) Software can be created that matches the unique needs faced in a Taiwan business English class setting.*
- 5) Customized software can have the "look and feel" of new commercially available "user friendly" software (specifically the use of professional appearing graphical user interfaces or GUIs).*
- 6) Feedback generated from such an expert system can have measurable and statistically significant effects on students' writing.*
- 7) An expert system can inform instructors what the most common type of student writing errors are, thus helping to form a more specific curriculum.*

- 8) *Exposure to computer generated feedback will influences students' attitudes about their own abilities as well as their desires and interests in writing English.*

This paper summarizes the four year project, undertaken at The Overseas Chinese College of Commerce, to test the above eight hypotheses.

C. LITERATURE REVIEW

The application of computers in assisting teachers is certainly not new and has become widespread in applications such as computer correction of standardized exams. The specific application of computer technology in a writing class has largely been limited to questions surrounding the use of computers in completing assignments. Numerous studies have investigated the impact on students' attitudes from using computer based editing software when completing their English assignments. Generally, use of computer software has been found to help students concentrate on content (Daiute, 1983). The ease of editing computer documents can encourage more editing and experimentation. Fisher (1983) and Gula (1983) report that students not using computer editing software perceive revision as difficult and therefore avoid it.

The specific application of computers for finding errors in students' writing has been investigated in numerous studies. To date, the efforts to judge such computer systems have been mostly based on the application of network and main frame

based systems. In such cases, students would type their English writing assignments at computer terminals in computer labs. At any stage of the editing process, students could choose to use software that would find their writing errors, such as punctuation and grammar errors. Observed benefits and advantages of such systems include:

- 1) Analysis of writing can help to improve students knowledge of conventions in such areas as spelling, punctuation and grammar (Wresch, 1988).
- 2) Such use of software can encourage students to be more independent of the instructor (Wresch, 1988).
- 3) Students prefer critical feedback that is impartial, such as that produced by a computer, as opposed to feedback from instructors that is often seen as biased or unfair (Frase et al., 1985).
- 4) Students improve their editing and writing skills significantly more than other students not using computer based feedback systems (Reid, 1986).

Research on the impact of computer generated feedback on native English speakers has generally shown positive results (Kiefer and Smith, 1983; Frase et al., 1985; Kiefer, 1987). Pennington (1991), has pointed out the weak construction of these past studies and warns that more research needs to be done before any conclusions can be drawn. Generally, well structured (i.e., internal/external

reliability and validity) and long-term studies of ESL/EFL students' exposure to computer generated feedback is lacking.

1. COMPUTERS & WRITING IN & OUT OF THE R.O.C.

When looking at CAI (Computer Assisted Instruction) and CALL (Computer Assisted Language Learning) in Taiwan (R.O.C.), it is clear that application of these technologies in the classroom is in its embryonic stage. Through a combination of factors, computers have generally not entered the R.O.C. language scene. These factors include, but are not limited to:

- ◆ *General lack of computerization of schools in the R.O.C.*
- ◆ *Lack of access to mainframes and minis, on which many CAI and CALL software was originally developed.*
- ◆ *Needed technology only recently commercialized, i.e., powerful computer packages, i.e., 80486 CPUs, sound cards and CD-ROMs.*
- ◆ *Expenditures of time and money for non-computer based "language labs" that are not perceived as successful teaching tools.*

The factors sighted above are of a structural nature and have not been influenced by language teachers. The last factor I will sight is directly related to teachers and the last "technology solution" for language learners, i.e., the audiolingual methods, from the late and early sixties, as applied in a language lab. Although many of the motivating theories have since been supplanted, the language labs go on. Schools nearly everywhere around the world automatically include labs as part of any English program (Strei, 1979).

It is likely that negative experiences with language labs have led teachers to be skeptical of new technologies in the classroom. Many Taiwan schools have installed language lab equipment. Often, the engineers who installed such equipment did not understand all the features and installation requirements and certainly had little grasp of the pedagogical applications. The result was that at many locations, these language labs simply became glorified, and expensive, tape players. The equipment actually served to separate the students from the teacher and encouraged less motivated students to daydream through the class period. Such experience is not unique to Taiwan, nor is it new, but may be endemic to language labs (Kirpal, 1979). Teachers are often placed in these labs with no training, not even a manual on the lab's features and use, while a class of fifty students wait for the teacher to get the hang of it. With teachers struggling to find use of the technology they already have, it is unrealistic to expect them to quickly swallow another "technology solution" pill (Chen, 1995a).

2. PRESENT

In the past decade, numerous academics have examined the application of CAI in R.O.C. classrooms. From the very start, teachers have believed that computers have enormous potential. Of special interest is the understanding that CAI may be especially useful in the Taiwan situation where students of writing are often at a low level of skill attainment and class size is large (Chen, 1988).

Many teachers, domestic and foreign have observed that students generally have a positive attitude toward technology in the classroom. Studies have consistently shown that students have positive feelings about computer technology being used in the classroom and that such technology does have a positive impact (Nash et al., 1989; Brady, 1990; Herrmann, 1987; Johnson, 1988; Phinney & Mathis, 1990).

The specific applications of computers in writing class (as addressed in this author's study) tend to focus in three areas:

A) EMPHASIS ON TYPING AND WORD PROCESSING SKILLS

Once an English department obtains a computer lab, it is quite clear that the first step in using any software is the fundamental interaction between the users and the machines. This means that many teachers are using labs with no special language software, but instead simply having students write their assignments using English based software. As mentioned above, this has proven to be beneficial to students. Important research continues into areas such as: social interaction implications of CALL (Johnson, 1991; Chen, 1995b), the impact of networking (Esling, 1991), use of the Internet (Wang, 1995) and word processing (Neu & Scarcella, 1991), just to mention a few.

Some researchers have expressed a general frustration with the application of computers in the English classroom. Hoffman (1991) reports on a problem most

researchers in this field face, i.e., lack of support for hardware, software and pedagogy:

When the students filed into the CALL Centre the first day, I had not one scrap of written documentation to offer them about how computers work, how the LAN works, how a word-processor works or how any of my learning activities work. All I had was my own knowledge of these, and the ability to explain things orally.

Other researchers are attempting to solve this problem (King, 1995) by examining the techniques used in the United States, where computers in the class room have a longer history. Of course, that history involves numerous disciplines, while this author is primarily concerned with EFL writing.

B) COMPUTER FEEDBACK ON WRITING PROCESS AND/OR PRODUCT

The next logical step is to have the computer actually take some action on the text that has been input by the student. Spell checking programs represent this step very well and have been found to decrease students spelling errors (Liou, 1993).

Questions remain, however, if such on-line corrections may actually make students dependent on the immediate correction ability of the software.

Style and grammar analysis is the next level up. Numerous software packages have been marketed claiming to be “the easiest way to improve your writing” (quote from the box of the Grammatik software package). Researchers such as Pennington and Brock (1989) have compared the writing of students working with tutors to that of students working with grammar correction software. The result, as

could be expected, was that the group working with software did not produce writing at the same level of quality as that produced by the tutored group.

What most researchers understand is that the question is not so clear cut as, “can software be better than teachers.” Rather, the issue is a complex one that involves trade-offs. Brock (1990) raises specific questions that need to be asked when examining these trade-offs, such as how effective the software can be and in what stage of the writing process should the software be used. Brock’s questions can only be answered by detailed research such as that done by researchers like Liou (1993b; 1993c) who generally show positive results in students’ attitudes and writing when using such software in Taiwan. Levy and Garton (1994) have looked into modification of the program Grammatik, in order to tailor it towards the specific needs of their students. Again, results were generally positive.

Dalgish (1991) has shown that simply using databases of errors can help inform teachers about the common errors of their students. With such information, a teacher could place special emphasis on the English constructs giving students trouble, such as articles (as Dalgish found in the case of native speakers of Swedish).

Others have used computers to create corpora of commonly used vocabulary (Meijs, 1994; Granger et al., 1994; McNeill, 1994; Flowerdew, 1991) that can then be drawn on for teaching and learning more effectively. Application of such corpora

is especially promising for use in the ESP area (Kennedy, 1995), where vocabulary tends to be more specialized.

Questions of reliability and validity plague nearly all the above studies (Chapelle & Jamieson, 1991). Small sample sizes present problems with external reliability. For example, Liou's study, in Taiwan, included only 20 students in a control group.

Controlling variables presents very real problems since the activity being researched is only one small part of an English class. Additionally, some researchers have noted the disproportionate impact a teacher with a negative view of computers can have on students participating in a study. Similarly, a teacher with a positive view of computers can help students even overcome shortfalls in software and hardware (a type of Hawthorne effect).

C) THE BUILDING OF NEW CUSTOMIZED SOFTWARE

The most difficult research road to travel is the development of customized software for use with ESL students. In the specific area this research project deals with, the ability of software to analyze written English has generally been classified as artificial intelligence (AI) or machine intelligence. Although this would appear to lie in the realm of advanced computer programmers, a few brave English instructors have undertaken such projects. In Taiwan, Liou (1991; 1992) has worked on creating software that goes beyond the limitations she found in existing grammar checkers. Such a specially built program could address many of the problems unique to speakers of other languages while studying English. In Liou's case the

target group is Mandarin speakers, French native speakers have been targeted (Brehony, 1994) as well as native speakers of Cantonese (Chen, 1994).

The road to a perfect parsing engine (the software that breaks a sentence into its grammatical parts) is full of obstacles. Not the least of which is that English researchers must always keep in mind that any software developed is to be used by large numbers of students and on hardware that is readily available. Attainment of such goal has proven elusive, yet researchers continue to try novel techniques centering on syntactic (Coniam, 1991), semantic (Webster, 1991) and stylistic (Tribble, 1991) approaches.

3. DIRECTIONS & DIVERSITY

Clearly, the fields of CAI, CALL and CAW are being explored in many diverse ways. Yet, computers in the classroom is still not a reality for the vast majority of English teachers in Taiwan. One of the reasons is that the jury is still out on the effectiveness of such approaches. With many studies still having weak constructs, teachers question the reliability of such studies. Researchers also face the dilemma of having to teach heavy class loads, while being confronted with complex questions and difficult procedures encountered in the research CALL. The label “user friendly” has been widely applied to computers and software, however, the reality falls far short of that label.

Computers in the Taiwan language class will not spread until clear benefits can be seen not only for the students but also for the teacher. This experiment attempted to build on the foundation laid by past researchers and to improve on some of the shortcomings previously encountered.

II. SOFTWARE DEVELOPMENT

A. DEVELOPMENT OF CUSTOMIZED SOFTWARE

For correction of student writing errors, commercially available computer based grammar correction packages were investigated. Grammar-checking programs use algorithms to look for words, phrases, or constructions that violate specific rules of grammar, style or punctuation (Smith, 1992). Previous research (see literature review p. 6) studies centered on the use of English text analysis performed by programs such as Writer's Workbench (developed by AT&T), Critique (IBM), RightWriter (Rightsoft), Sensible Grammar (Sensible Software), Grammatik (Wang), etc. Students were allowed to use the software at any stage in the editing process before their assignments were turned in. The correction software was always accessed through a mainframe computer in a computer lab (with the text editing software also often being used at the same location), thus requiring students to go to specified computer labs on campus at specific times. Some of the potentially negative effects of these previous applications of CAI (Computer Assisted Instruction) can be summarized as (Pennington, 1991):

- 1) **Students may use the correction software early in the editing process and thus only make surface corrections to their writing.**
- 2) **Because of early feedback on specific errors, students may become dependent on the software for finding errors, as opposed to developing editing skills.**
- 3) **The constraints of time and location when using the software, caused by the use of computer labs, may not allow students to follow the process of writing that they have developed or are attempting to develop.**

Rather than simply repeat these possible problems, the author wanted to take a new approach that included the development of customized software as well as the modification of the existing software. The existence of new computer operating systems (Windows 3.1 and OS/2.2) as well as the development of powerful PC platforms and easy-to-use software development tools all allowed a rethinking and redesigning of previous approaches. A program that relieved the instructor of the burdensome task of detailed error correction yet allowed the instructor to continue using whatever teaching methods he/she liked was the goal. What was needed was nothing less than an expert system to take the role of teacher or tutor for one small part of the homework correction task. An expert system uses an expert's knowledge and an inference mechanism to teach or supply information about a specific domain (Parsay and Chingnell, 1988), e.g., the knowledge of an English

teacher about correct grammar and style in correcting writing assignments. The result was the creation of a software package, QBL (Quick Business Letters), made up of two PC based programs:

QBL Student Version, for student use in creation of business letters.

QBL TOOLS, for instructor use in correction, tracking and analysis of errors.

1. INITIAL RESULTS

Early on, it was realized that problems of computer illiteracy, platform incompatibility and computer viruses may negatively impact such a computer based process. To limit such problems, the following steps were taken:

- 1. Creation of a program user's manual written in Chinese that is included with the QBL program (see Appendix B).**
- 2. Each student must be required to obtain an original copy of the QBL program and not copy the program from other students (to avoid viruses and assure disk quality that can last throughout the semester).**
- 3. Designation of a location where disks with problems, such as virus, surface damage, etc., could be taken for reformatting (usually a computer lab assistant with a master copy of QBL was sufficient).**
- 4. Clear explanation to all students that the computer based homework was their own responsibility and that class time was not to be spent learning the software or answering questions about the software (in designing QBL and**

the accompanying manual, user accessibility and simplicity were major objectives (see Appendix B)).

5. Teachers' emphasis on the importance of early assignment completion, so as to leave time for reformatting a disk if a problem, such as a virus, should arise.

B. SYSTEM GOALS

1. FOR STUDENTS

After the first testing of the automated system, an effort was made to develop all parts of the process into a more functional and useful system. Keeping the students' program at a low cost while including some of the features normally found in professional writing packages was a major objective of the QBL design.

Additionally, the opportunity to supply on-line assistance to students could actually expand the classroom experience. To this end, freedom to complete assignments on any PC system, not only networks, was viewed as important.

A) PROGRAM FEATURES

The program used by students would not reveal any part of the actual expert system. From the student's perspective, the program should be easy to use (as far as software can be easy to use for the participating students) while simulating the experience of writing a business letter in a work environment.

The actual program structure could guide students through the creation of a business letter in such a way that it reinforced correct letter formats. All the parts of a business letter had to be included as well as the ability to print a correctly formatted business letter.

The inclusion of some kind of on-line help system was desirable. Advice and examples on what to include in each part of a letter would help to give a student a quick and easy frame of reference when he/she simply did not know what was required, e.g., when to use a capital letter, how to use a comma, etc. In the past, students simply left parts of letters incomplete because they were not sure of correct formatting or what should be included. Some students would copy sample letters when unsure what to write; this was a haphazard approach since the sample letter copied often did not include the relevant parts for the student's situation, or simply itself contained errors. By having QBL supply a letter template, and samples for each entry, students could develop habits that carry over into the work environment after completion of the course.

B) HARDWARE ISSUES

Many previous attempts at applying computer assisted feedback have been based on mainframe computers or networks. In the R.O.C., this presents some problems that may be difficult to overcome. The obvious problem is that access to such equipment is often limited to computer department students. When other departments' students do have access to such systems, they often have a lower

priority. In addition, centrally based computer systems do experience down-time. An English instructor would have little opportunity to know if a student's excuse for not completing an assignment due to down-time was true or not. Avoidance of such complex issues was desirable with the QBL program. The best situation would be that QBL could be used on any computer platform capable of running DOS. In this way, each student would have the freedom to decide when and where writing of an assignment could be completed.

Student ownership of personal computers is widespread in Taiwan. It is the case, however, that there is a wide variation in the types of personal computers students use. The QBL program, used by the students, would have to function on the lowest common denominator of student computer systems while retaining features that still give a professional appearance on more advanced computer systems. The fundamental requirements included:

1. Run on an Intel 80286 CPU, using any brand of DOS.
2. Fit into 640K of RAM memory.
3. Able to run with no hard disk.
4. Good appearance on a monochrome monitor.
5. Keyboard access to all program commands.
6. Usable on a 360K 5.25 inch floppy disk drive.

Program features could surpass the above requirements, but the program had to remain compatible with this most basic student computer configuration. Features that could be activated on more advanced computers included:

1. Run on an Intel 80386, 80486 and Pentium CPU in DOS or a Windows/OS/2 DOS window.
2. Color interface for use on color monitors.
3. Mouse support for menus and editing.

2. FOR INSTRUCTORS

Testing of the preliminary computer correction system also pointed the direction that should be taken by the software used to find errors. In this case, software and hardware considerations did not need to match the lowest common denominator of equipment. The correction software is for instructor use only. With this in mind, it is reasonable to expect that a higher level of computer power can be accessible.

The key advantage to this assumption is that a, such as Windows, can be used in the teacher's software. GUI interfaces require more powerful computers, yet are a key ingredient to user-friendly programs.

A) PROGRAM FEATURES

The most important feature for the expert system was ease of use. English instructors have no standard level of computer expertise. The implementation of a GUI interface was the first priority. By supplying a graphic based program, training

time could be cut as well as reducing the frustration factor often encountered when non-computer experts attempt to use new software.

Also important, was the ability to do more than simply provide feedback to students. Some instructors expressed interest in being able to view more details and even perform research into students' errors (as is the case with the author's studies). To this end, the instructor's program would need to list and print totals of a class' writing errors, compare multiple homework assignment results, preferably in graph form, and perform some basic statistical measurements and testing.

C. STUDENT PROGRAM (QBL STUDENT VERSION)

1. PROGRAMMING TOOLS

The student program, QBL Student Version, was developed using Microsoft QuickBASIC 4.5. This version, the last DOS based version produced by Microsoft, offered numerous advantages over other programming languages and other software vendors' implementation of the BASIC programming language.

A) BASIC ADVANTAGES

Although BASIC has a reputation of being used mostly as a teaching tool, its English-like syntax has made it the most popular programming language in the world. First developed by two professors at Dartmouth University, John Kemeny and Thomas Kurtz, in the 1960s, BASIC was first used as a teaching tool (Canter, 1993). While not widely publicized, BASIC underwent major changes as developers in businesses around the world turned to the easy-to-use language. Microsoft

released its QuickBASIC 4 in 1987, soon followed by version 4.5. This new BASIC supports many advanced features that makes coding easier and more powerful than ever before.

QuickBASIC supports structured programming with modules and sub procedures and is no longer a line-oriented dialect. Commands such as SUB, FUNCTION and PROCEDURE, have replaced the reliance on GOTO and GOSUB commands.

Additionally, many QuickBASIC routines have been adapted from other powerful languages, such as C. All of this has not diminished the core concept of easy to understand, English based syntax (see Table 1).

Table 1. QuickBASIC and English Equivalents

QuickBASIC Code	Meaning
ERR	Error
LTRIM	Left Trim
SPACES\$	Empty Spaces
UCASE\$	Upper Case

QuickBASIC also offers an integrated development environment (IDE), from which program code can be run without the need for compiling. When test running code, variables can be changed and the execution continued from the point of pausing the execution. These features make QuickBASIC easy to debug and cut development time. Most importantly, the student's program would rely heavily on string manipulation, since the basic purpose of the program would be to write letters. QuickBASIC's string handling features are extensive and easy to understand.

2. PROGRAM DESIGN

A) DIVISION OF LETTER PARTS

A business letter is made of four main parts: heading, opening, body, and closing (Warden and Chen, 1993). The DOS screen, however, is only 80 characters wide by 25 characters high. Some method was needed to display the different parts of the letter on the screen while also reinforcing the structure of a business letter. The approach used for the student program was to use four different windows. The first window is where the user spends most of his/her time. When the program opens, it is this main screen that is displayed (see Figure 1).

This main screen is where the body of the letter is written. Commands are accessed in the menu, at the top of the screen. All common commands are in the menu; also included are commands that access the other three parts of a business letter. The three commands, See Heading:F2, Opening:F3 and Closing:F4 all open the windows to their respective letter parts (see Figure 2, Figure 3 and Figure 4).

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Figure 1. Main Editing Screen

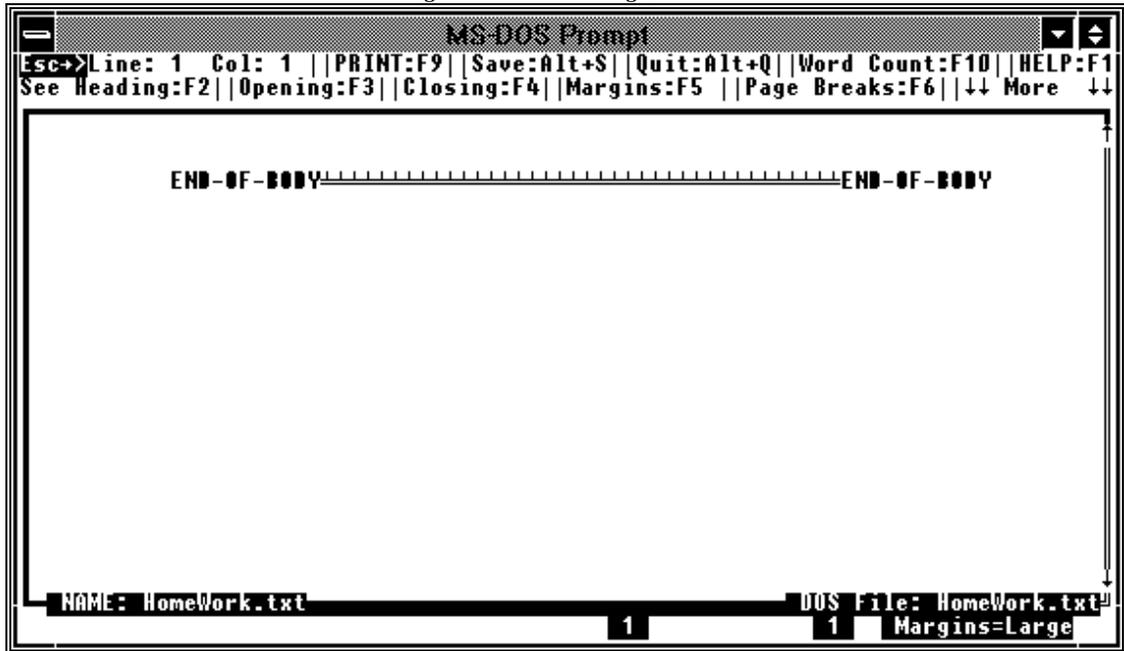


Figure 2. Heading Screen

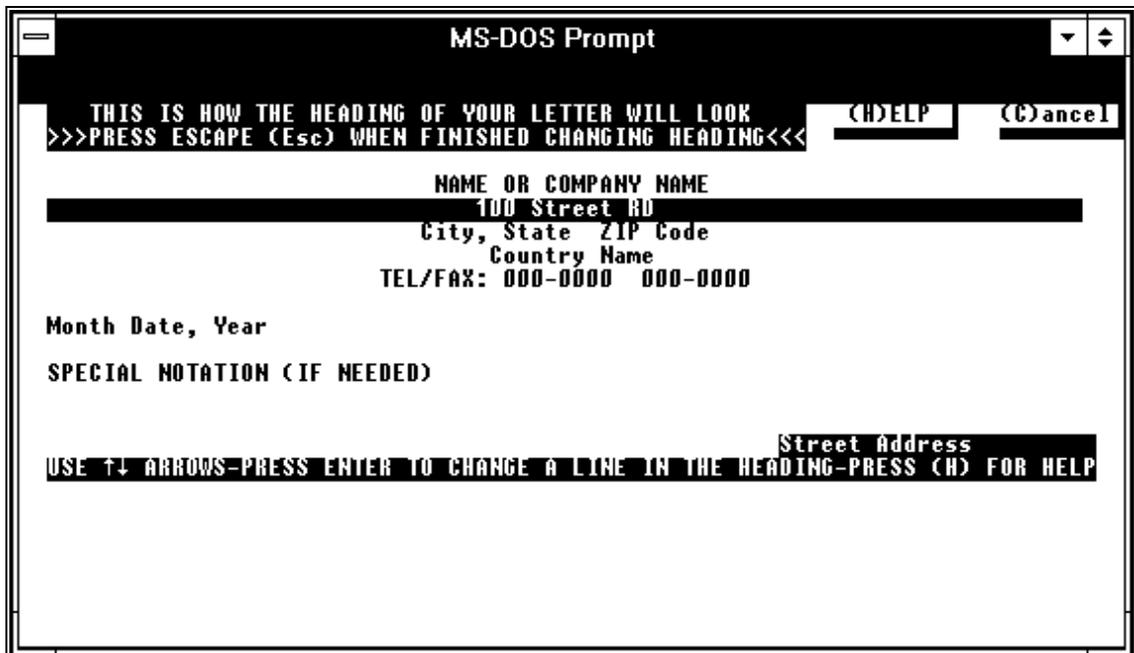


Figure 3. Opening Screen

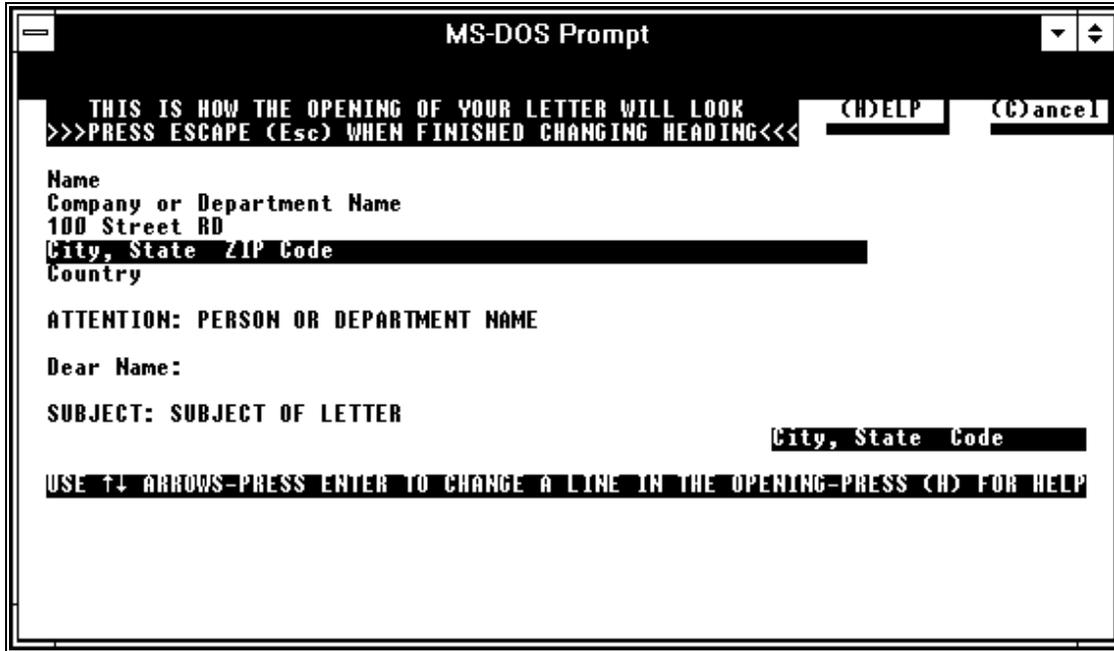
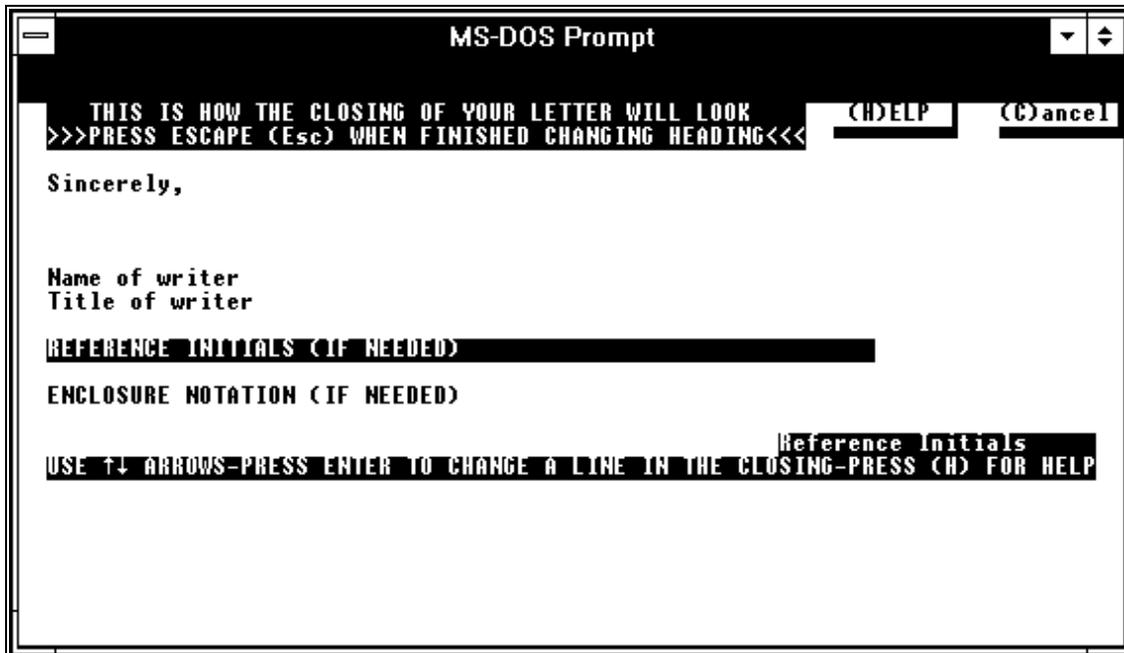


Figure 4. Closing Screen



3. SPECIAL FEATURES

A) CONTEXT SENSITIVE HELP

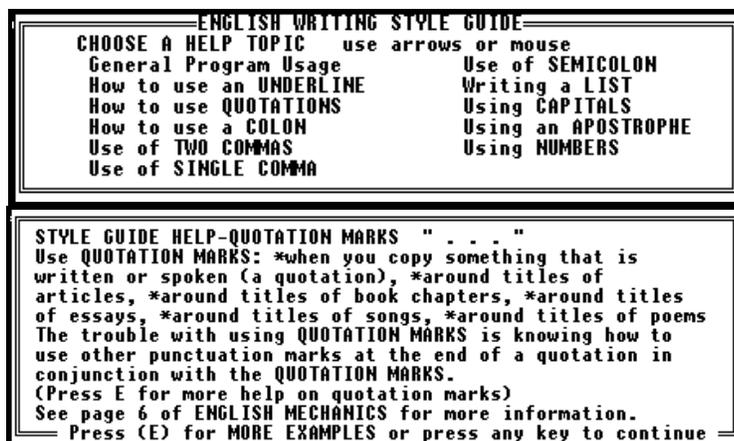
When the user enters the heading, opening or closing windows, he/she may press the “H” key to view a pop-up help window. The help that is displayed depends on what action the user is taking at the time (context sensitive). For example, if the user has opened the heading window, but not yet chosen a specific line of the heading, the help window will describe how changes can be made to the heading.

After a line has been chosen for changing, by pressing Enter when a specific line is highlighted, the help displayed is more specific. Help for the COMPANY NAME line of the heading, for example, will describe exactly how the line should be formatted as well as supplying examples.

B) ON-LINE ENGLISH USAGE HELP

To support the feature of on-line English help, QBL Student Version responds to the F1 key, or menu/mouse accessing of the Help command, by displaying a window with choices of basic English mechanical and grammar advice (see Figure 5).

Figure 5. On-line English Help Choices and Help Window on Using Quotation Marks



Choosing one of the subjects, by moving a highlight with the arrows, then pressing Enter, or directly clicking with a mouse, will display a non scrollable window with the relevant information. While in the specific help window, pressing E, or clicking a displayed E at the bottom of the help window, will display examples of correct usage for the specific subject.

4. USER'S MANUAL

A student user's manual was created using a Macintosh computer (see Appendix B). All explanation is in Chinese characters. The manual is fourteen pages long with each page devoted to one aspect of the program. Every page contains a screen shot of the relevant program situation and an explanation. Also included is an explanation of the division of business letters into the four main parts (heading, opening, body and closing) as well as a summary of all program commands (located on the back of the manual).

D. INSTRUCTOR PROGRAM (QBL TOOLS)

1. ARTIFICIAL INTELLIGENCE (AI) SOFTWARE

The level of AI required to accurately parse English sentences (in commercially available software) has only been achieved in recent years. Different programs take radically differing approaches to achieve their levels of AI. It was obvious, that for this project, the resources did not exist to custom develop such software.

The ability to make existing grammar-checking programs easier to use, and more applicable to the R.O.C. classroom experience was seen as achievable and necessary. After examining several programs, Grammatik was chosen as the AI engine for this project. Grammatik would only act as the actual searching engine while all interface, input and output features would be redesigned to better fit academic goals. One of the most important reasons for choosing Grammatik was its ability to be programmed. Although the detailed functioning of Grammatik has not been widely circulated by WordPerfect (the current owners of the software), it appears that Grammatik functions in two main stages.

Grammatik's *mor-proof*TM parsing engine first parses a sentence into its grammatical parts. This part of the program cannot be modified by the user. Part of this first stage is the determination of fundamental violations of grammar structures, i.e., missing verbs, incorrect forms, etc. After the first stage of checking, Grammatik compares the contents of the sentence to its database or knowledge-base of rules using simple forward chaining (see Hu, 1987, for a good

discussion of chaining in expert systems). These rules can be viewed by the user through the use of Grammatik's Rule Editor program, included with Grammatik as a separate execute file. This database contains rules that are at a higher level than those checked during parsing. The rules in this database can be turned on and off through normal adjustment of Grammatik's options, more importantly, these rules can be changed directly through the Rule Editor program.

For the development of the QBL system, the author included over 200 new rules (see Appendix D) into the Grammatik database (see Figure 6). Any new rules must only contain words that are also contained in Grammatik's dictionary, so the author also made extensive additions to the Grammatik dictionary. In addition to adding rules, the author also changed the category settings for numerous rules as well as modifying the advice that is given by the program when a writing error is found.

Lastly, after extensive testing, a few problems were found in the first stage of checking by Grammatik, the actual parsing, could flag false errors. Such flagging of a false error could easily be changed if the rule for the error existed in the database, but rules that were used in the actual parsing are not available for modification. In most cases, rules could be programmed into the second stage of checking, the rule database, that countered the false flagging of an error in the parsing stage (in Figure 6; the third and fourth custom rules are countering false flags of errors by Grammatik).

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Figure 6. Customized Rules Used by Grammatik5

<p>@!#/ economics @<"~Cap" @!"department"C==+isf\The name of a general course is not capitalized. Change trade to trade.</p> <p>@!#/ marketing @<"~Cap" @!"department"C==+isf\The name of a department should not be capitalized if the 'd' in department is not capitalized.</p> <p>@"386" computer_\0==+isf\GMKW wants to say this is wrong, but I think not, so ignore it.</p> <p>@"486" computer_\0==+isf\GMKW wants to say this is wrong, but I think not, so ignore it.</p> <p>@#/ so\>==+isf\Do not begin a sentence with the word 'So,' which is usually used to introduce a clause or phrase.</p> <p>all @5 us @5 not\>==+isf\replace 'all . . . us' with 'none of us'</p> <p>before @#\>==+isf\change 'before' to 'ago' or else explain before what? for example: before I left, before 1990, before November 2, etc.</p>
--

2. WINDOWS DEVELOPMENT

The Windows 3.1 environment, just released at the time the author began development of the QBL system, offered many advantages over DOS. The tools available to develop Windows software were limited however. The use of C and the Microsoft SDK (Software Development Kit) was the only way to proceed. The release of Microsoft Visual BASIC 2, in 1992, provided a way to program in Windows, without learning a new language and even the opportunity to port some already developed code into the Windows' environment.

3. PROGRAMMING TOOLS

A) MICROSOFT VISUAL BASIC

The advantages of using QuickBASIC also apply to Visual BASIC, namely, easy-to-use syntax. Additionally, Visual BASIC allows the construction of interfaces without requiring any coding. Since its release in 1992, Visual BASIC has been seen as the easiest method for programming Windows, yet it retains all of the powerful features that are common to the Windows 3.1 interface. More than any environment, Microsoft Visual BASIC is a truly visual development environment (Petzold, 1992).

The most important differences between DOS based BASIC and Visual BASIC are (Sarna and Febish, 1993):

- 1) Visual BASIC is not a procedural language but a visual language
- 2) Visual BASIC is event driven

In Visual BASIC, code is placed inside objects and is activated when the object is acted upon. The process of developing a Visual BASIC program is quite different from DOS based BASIC. Visual BASIC's steps towards application creation include (Sarna and Febish, 1993):

- 1) Creating and manipulating objects visually
- 2) Setting properties visually or through BASIC code
- 3) Writing BASIC code for desired event handlers
- 4) Calling pre-written methods supplied by third party vendors (Dynamic Link Libraries, DLLs)

By avoiding the coding of every window, menu and mouse functions, Visual BASIC allowed the author to avoid reinventing the proverbial wheel. Combined with calls to the Windows' API (Application Program Interface), the author was able to create a completely professional software package with minimal expenditure of time and money. Windows itself has hundreds of functions available that can be accessed by other applications through the Windows API (Appleman, 1993). Once programming

is completed, a standalone .EXE file is compiled that does not require a runtime module. This fact, combined with small .EXE file size, makes programs developed under Visual BASIC appear more professional than applications requiring extra files and large disk space.

4. INTERFACE DESIGN

A) OVERVIEW

When designing the actual interface, a priority was placed on following the standard Microsoft interface designs. Although not even all Microsoft programs follow the standards for Windows GUI programs, most do, including Windows 3.1. Working from the assumption that instructors using QBL TOOLS would be mostly computer novices, the importance of following the conventions of the Windows interface was apparent. Since Windows use is the common experience users would have, to one extent or another, the interface goals were to match the Microsoft standard set out in the book The Windows Interface An Application Design Guide (Microsoft, 1992). When interface parts could not fit exactly to Microsoft recommendations, the next priority was to match the original IBM Common User Access (CUA) guidelines (IBM, 1989). The general advantages of a GUI environment are summarized by Cox and Walker (1993):

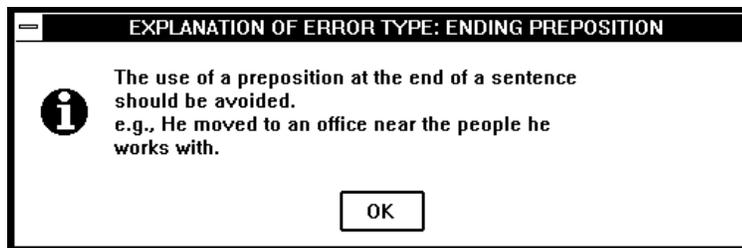
There are a number of major advantages of the object/action model: it lends itself easily to visual representations of the system, which are conceptually attractive, easy to learn and easy to manipulate; and it leads to relatively simple models of complex systems. . . User control means that it is up to the user, not the computer system, to decide how a particular task is to be performed. Techniques for ensuring user

control include: use of windows, modeless dialogues and flexible display facilities (including provision of overviews).

(1) SYSTEM FEATURES (see Appendix C)

- 1) QBL TOOLS' helpful on screen yellow help memo notes guide the user through each action so that the user does not get lost.
- 2) Advanced on-line context sensitive help (accessed by just pressing F1 at any time) that includes complete index and search capabilities--so the user can quickly find the answer to a question--as well as hypertext (by pressing on green words, the user can jump to specific definitions and instructions).
- 3) Clicking with the right mouse button on any object opens an explanation box that lets the user see what it does or what its meaning is (see Figure 7).

Figure 7. A Pop-up Explanation Box Resulting from Clicking the Right Mouse Button

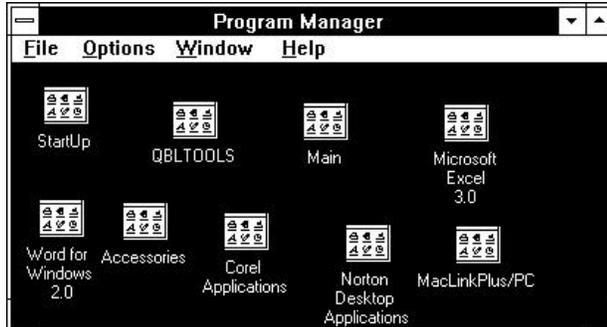


B) GETTING STARTED WITH QBL TOOLS

(1) OPENING THE PROGRAM

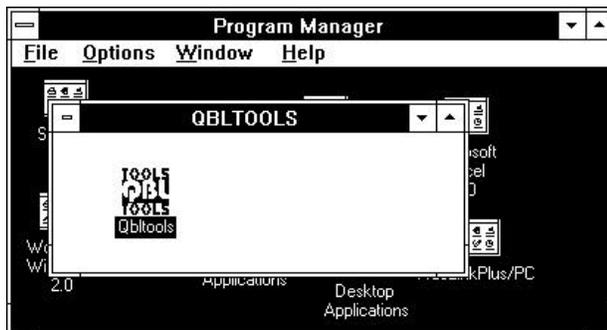
After QBL TOOLS is installed, the QBL TOOLS program group will be automatically placed in the Program Manager window by the QBL install program (see Figure 8).

Figure 8. The QBL TOOLS Group Inside Program Manager



Clicking twice on the QBL TOOLS group will open it (see Figure 9). Clicking twice on the QBL TOOLS icon will start the program.

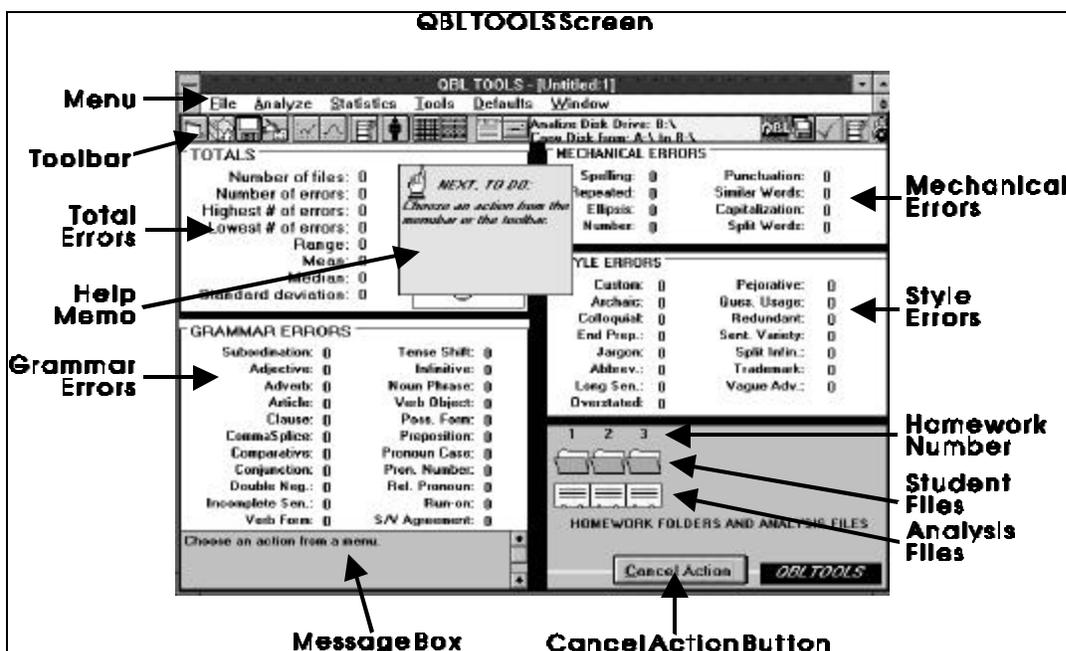
Figure 9. QBL TOOLS Program Group Opened



(2) QBL TOOLS SCREEN

The main screen for QBL TOOLS opens with an empty analysis file displayed. The different parts of the screen are shown in Figure 10.

Figure 10. The Main QBL TOOLS Screen



Every action can be begun by clicking buttons on the toolbar or choosing a menu selection in this screen. Clicking with the right mouse button on any error type displays an explanation of what the error type is. The same action on any button in the toolbar also displays an explanation of the button's use.

(3) HELP MEMO NOTES

When the user opens the main QBL TOOLS screen, he/she can see a yellow square with the words **WHAT TO DO**. This note is to help guide the less experienced user through the steps of using QBL TOOLS.

5. DDE AND OLE

Microsoft has created two important standards, DDE (Dynamic Data Exchange) and OLE (Object Linking and Embedding), which allow multiple programs to communicate with each other and even to contact with files and programs that have

not been opened by the user. This means that data can be retrieved from files that do not belong to the native file structure of the program performing the retrieving.

OLE allows objects created in one program to be placed in another program.

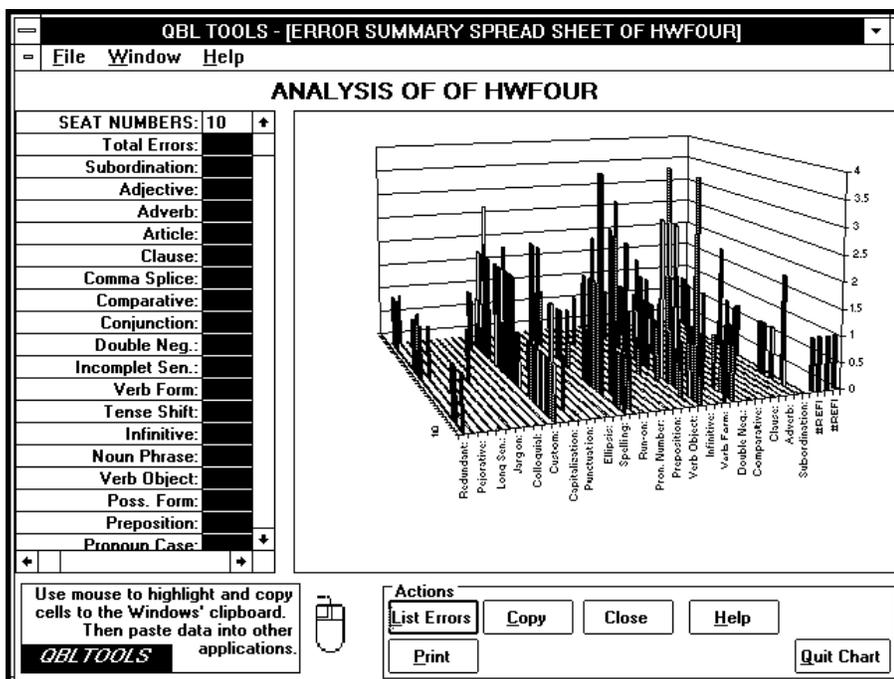
Clicking on an OLE object opens the application that created it (Miller, 1993).

These features, more than any other, accelerated the development time of the QBL system. Multitasking allows QBL TOOLS to control Grammatik5 and monitor its progress as it searches for the errors in up to one hundred student files located on a single class disk. Grammatik5 on its own does not have the ability to check multiple files.

A) ACCESSING MS EXCEL

If the user has Microsoft Excel (version 4 or higher) for Windows on his/her hard disk, he/she can create a three dimensional bar graph of students' errors (see Figure 11). The data for the graph is taken from the spreadsheet created in QBL TOOLS through the Create Spreadsheet command. Such a graph is very useful in spotting individual students with unusually high error rates (outliers). This graph is also helpful in quickly spotting which error types are most frequently occurring.

Figure 11. An Imported Excel Chart



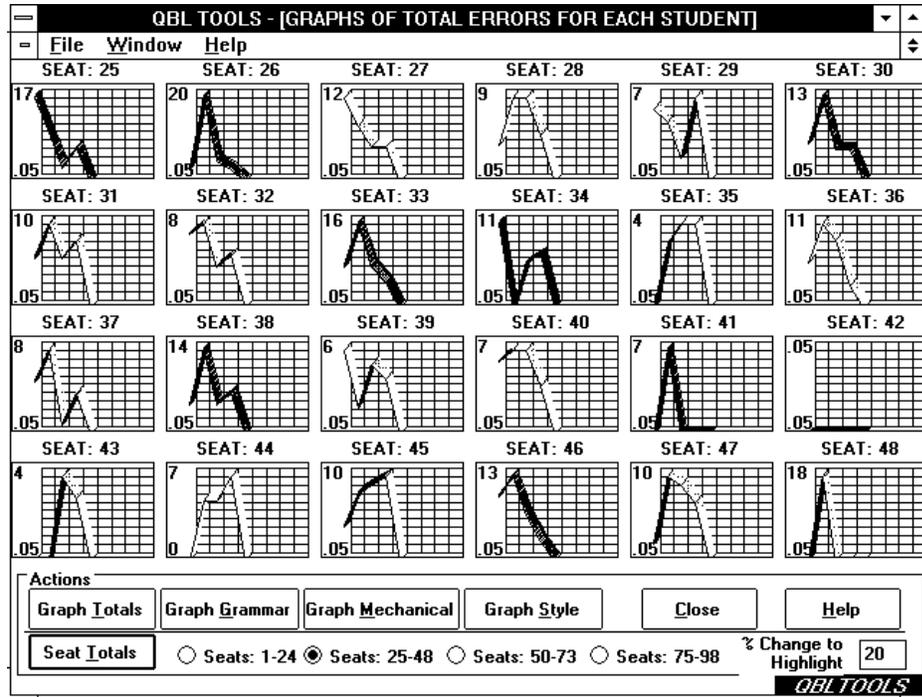
B) CHARTING PROGRESS FOR GROUPS

Graphs can be created for the four groups of errors, i.e., Totals, Grammar Errors,

Mechanical Errors and Style Errors. Each individual student's total errors can also

be graphed (see Figure 12).

Figure 12. Graphs Showing Individual Students' Progress



6. STATISTICAL TESTING

The general statistical measurements, i.e., total errors, highest, lowest, range, mean, median and standard deviation are made whenever a new summary of errors is created and saved. These same routines are accessed for obtaining the relevant numbers in statistical tests. The specific tests performed are an ANOVA and a *t*-test. Although the BASIC coding for the statistical tests is not complex in any single procedure, the overall structure of the statistical testing is fairly complex because of the number of calls to specific procedures used in gathering the numbers to be used in a specific test. No fewer than eleven procedures and functions are accessed to produce the result for a single statistical test (see Appendix I).

A) T-TEST

A t-test can be used to find if the errors (any error type as well as total errors) of one homework are of the same population as a second group. The null hypotheses is that the means of the two groups are equal (see Equation 1). Equation 2 shows the specific t-test used in the program. Of course, the equation must be represented in equivalent BASIC code and requires a number of sub procedures in order to complete the calculations..

Equation 1. The Null Hypotheses of the t-Test

$$H_0: u_x = u_y$$

Equation 2. The Specific t-Test Used in QBL TOOLS

$$t_0 = \frac{\bar{y}_1 - \bar{y}_2}{S_p \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

In this formula, \bar{y}_1 and \bar{y}_2 are the sample means, while n_1 and n_2 are the sample sizes and S_p^2 is an estimate of the common variance.

$$S_p^2 = \frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}$$

The two individual sample variances are represented by S_1^2 and S_2^2 .

The result is compared with a t distribution at $n_1 + n_2 - 2$ degrees of freedom.

The final step in obtaining the t-Test Statistic Value from the BASIC Code (Student A and B represent the two groups to be tested)

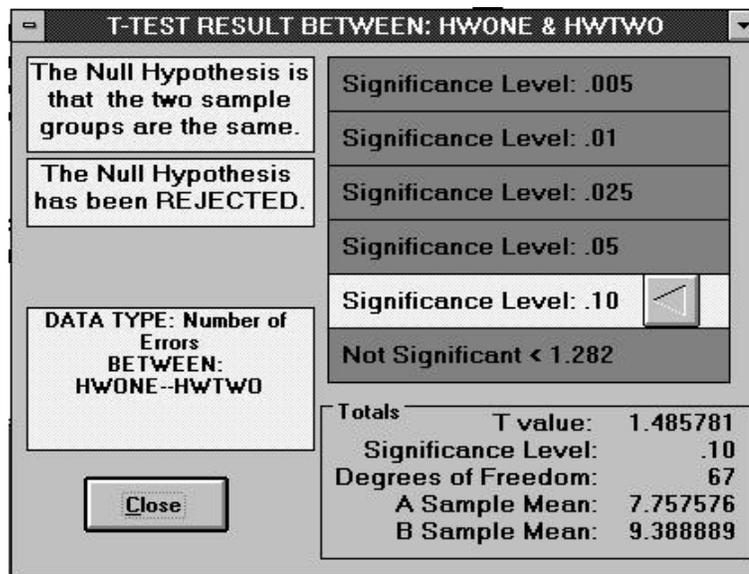
Listing 1 t-Test Represented in BASIC Code

```
Ttest! = ((MeanA! - MeanB!) / Sqr((((StudentsA! - 1) * (VarA!)) + ((StudentsB! - 1) * (VarB!))) / (StudentsA! +  
StudentsB! - 2) *  
((1 / StudentsA!) + (1 / StudentsB!))))))
```

B) T-TEST RESULTS

The test results will appear in a window (see Figure 13). If the t-test is below 1.282, the null hypothesis will be accepted. If the t-test is above 1.282, the null hypothesis will be rejected (based on an assumption of 50 or more students in the test). The level of significance is displayed along with the degrees of freedom, sample means and exact t value.

Figure 13. Display of t-Test Results



C) ANOVA TEST

An ANOVA test can be used to find if the errors (any error type as well as total errors) of numerous homework assignments are of the same population. The null hypothesis is that the means of the groups are equal (see Equation 3 and Equation 4).

Equation 3. The Null Hypothesis for the ANOVA Test

$$H_0: u_1 = u_2 = \dots = u_a.$$

Using the restricted model: $Y_{ij} = \mu + e_{ijR}$ where the dependent variable Y_{ij} (for any individual i within a group j) is equal to the unknown value of the independent variable plus the error of the actual observation (R denotes the restricted model).

Equation 4. The Specific ANOVA Test Used in QBL TOOLS

The actual F test is:

$$F_0 = \frac{(SS_{Treatments}) / (a-1)}{SS_E / (N-a)} = \frac{MS_{Treatments}}{MS_E}$$

Broken out as:

$$MS_{Treatments} = \frac{SS_{Treatments}}{a-1} = \frac{\sum_{i=1}^a \frac{y_{i.}^2}{n} - \frac{y_{..}^2}{N}}{a-1}$$

$$MS_E = \frac{SS_E}{N-a} = \frac{SS_T - SS_{Treatments}}{N-a} = \frac{\sum_{i=1}^a \sum_{j=1}^n y_{ij}^2 - \frac{y_{..}^2}{N} - \sum_{i=1}^a \frac{y_{i.}^2}{n} - \frac{y_{..}^2}{N}}{N-a}$$

Where $y_{i.}$ represents the total of the observations in the i th group and \bar{y}_i represents the average of the observations under the i th treatment. $y_{..}$ represents the grand total of all observations and $\bar{y}_{..}$ represents the grand average of all observation. N

represents the total number of observations and n is the number of observations in each treatment.

The result is distributed as F with $a-1$ and $N-a$ degrees of freedom.

The Final Step in Obtaining the F Test Value for the ANOVA Statistic from the BASIC Code.

Listing 2 F-Test Represented in Visual BASIC Code

```
ADATA.SSTotal = ADATA.MistakesSquGrand - ((ADATA.MistakesGrand * ADATA.MistakesGrand) /  
ADATA.StudentsGrand)  
ADATA.SSTreatments = (ADATA.MistakesSqu / 30) - ((ADATA.MistakesGrand * ADATA.MistakesGrand) /  
ADATA.StudentsGrand)  
ADATA.SSError = (ADATA.SSTotal - ADATA.SSTreatments)  
ADATA.MSTreatments = ADATA.SSTreatments / (ADATA.A - 1)  
ADATA.MSError = ADATA.SSError / (ADATA.StudentsGrand - ADATA.A)  
ADATA.Ftest = ADATA.MSTreatments / ADATA.MSError
```

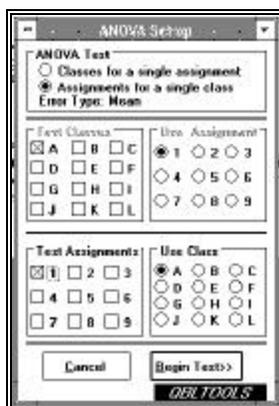
D) SETTING-UP ANOVA TEST

The user decides whether he/she wants to compare multiple classes performing a single assignment or a single class performing multiple assignments (see Figure 14).

Depending on the choice, the check boxes and circles available for Test

Assignments and Use Classes will change. When testing, QBL TOOLS will request the user to insert the appropriate class disks. The ANOVA results are then displayed in a window similar to that of the t-test (see Figure 13).

Figure 14. Setting-up an ANOVA Test



7. WINDOWS HELP FILE AND USER'S MANUAL

Although the QBL system overcomes many of the problems encountered in other automated correction systems, teachers who tested the program often had questions. These questions rarely required deep understanding of computer hardware or software. Rather, the questions were more a reflection of inexperience in the Windows environment generally and lack of exposure to the QBL TOOLS program specifically. Such problems could easily be solved by making available an easy-to-use manual and on-line context sensitive help. Such systems were later created in 1994 (see Appendix C).

E. COMPLETED PROCESS

Figure 15 shows the process used by the completed QBL TOOLS expert system. This process was used as the basis for the research on student error reduction summarized in this paper. Figure 16 shows what specific feedback looks like. Included in Figure 16 is a sample student letter followed by the list generated by QBL TOOLS.

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Figure 15. The Completed QBL TOOLS System

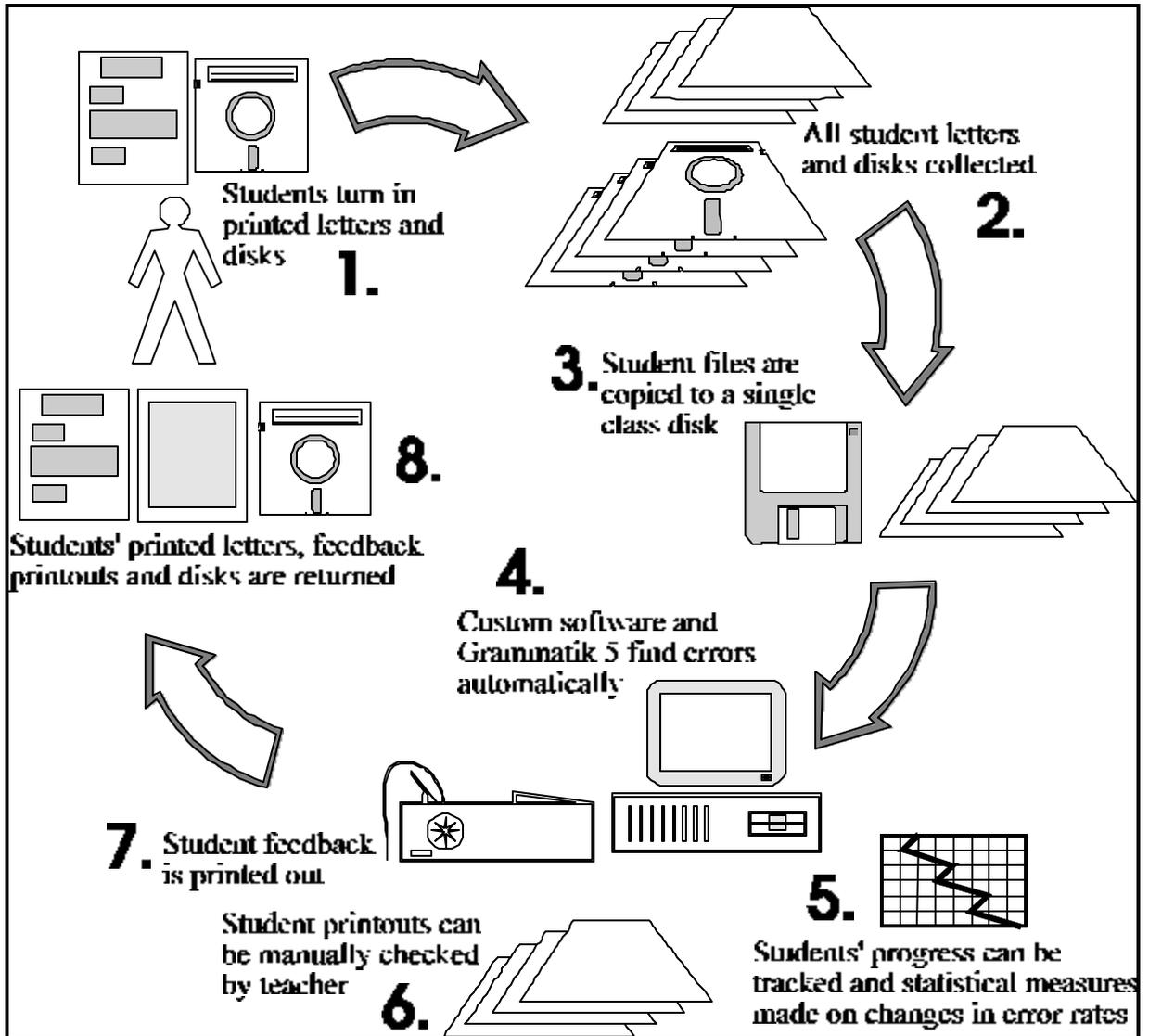


Figure 16. Example of Student Writing and Corresponding Feedback

Sample of Student Writing (from body of an application letter)

I know that a position in Assistant Manager. I am very interested in this position and feel that I am well-qualified. Please Please consider me as an applicant for this position.

Now, I study at The Overseas Chinese College of Commerce. Where I am a student, it has been my pleasure to be vice-president of math club . I have had join many of club in my school, like Economics club, speaker club. In that time, join thsoe club, I was got more knowledge about speak, Economics, business. I learn some about social skills.

At college, see my resume, I always have high grade in about international trade. I also had ever learn English in success language school. I feel that my English skills are well suited for this position.

Thank you for taking the time to look over my application. Please let me know when would be a good time for speaking with you about this position. If you need to contact me, you can call me between six to ten P.M. My home number is (04)5663475.

Sample of Some of the Errors Reported by Grammatik 5

=====
 Check: Please Please
 Rule Class: Doubled Word or Punctuation
 Advice: Delete doubled `Please`.
 =====

Check: club .
 Rule Class: Punctuation
 Advice: Delete extra space before the `.`.
 =====

Check: math club
 Rule Class: Noun Phrase
 Advice: An `article_` or other `modifier_` usually precedes the word `club`. Check also for missing hyphenation.
 =====

Check: Economics
 Rule Class: Spelling
 Advice: Spelling error.

=====
 Check: join
 Rule Class: Noun Phrase
 Advice: An `article_` or other `modifier_` usually precedes the word `join`.
 =====

Check: club
 Rule Class: Noun Phrase
 Advice: An `article_` or other `modifier_` usually precedes the word `club`.
 =====

Check: speaker club
 Rule Class: Noun Phrase
 Advice: An `article_` or other `modifier_` usually precedes the word `club`. Check also for missing hyphenation.
 =====

Check: thsoe
 Rule Class: Spelling
 Advice: Spelling error.
 =====

Check: Economics
 Rule Class: Spelling
 Advice: Spelling error.
 =====

Check: I
 Rule Class: Sentence Variety
 Advice: You have used `I` to begin 4 of the last 10 sentences. Consider more variety with your sentence openers.
 =====

Check: always
 Rule Class: Custom Rule Class 1
 Advice: `always` means `at all times` when you may really mean: every day, often, frequently, when every you want, etc.
 =====

Check: had ever learn
 Rule Class: Incorrect Verb Form
 Advice: The `auxiliary verb_` `have` is usually followed by a `past participle_`, not `learn`.
 =====

Check: to
 Rule Class: Conjunction
 Advice: The correct expression is `between` X `and` Y.

III. TRIAL STUDY

A. AN EXPERIMENTAL STUDY

A preliminary study of a computer based correction system, performed during the 1992 fall semester, proved the concept viable. Through the use of the automated approach, time spent correcting assignments was decreased 90 percent, the number of letter writing assignments was increased and students received detailed feedback on their writing errors. During that time, the software to analyze correction results, QBL TOOLS, was completed. For the 1993 Spring semester, a more detailed study of the QBL approach was initiated. This experiment was intended to answer the question: *Can statistical measurements be generated that reveal the impact of the QBL system on students' English writing errors?* If answered in the positive, then this experiment would also be the starting point for a more thorough research project in the 1993-94 school year.

1. CLASSES

The project studied eight classes of business English, approximately four hundred students, from one college and one university. The class was a one year required business writing course. The data collected was then analyzed using the new QBL TOOLS software. Some special considerations led the author to concentrate the review on four of the classes in the group, referred to here as classes: A, B, C and D.

These first three classes were all business English classes in the international trade department of a college located in central Taiwan (The Overseas Chinese College of Commerce), while the D class was a required business English class in the international trade department at a university in the same area of Taiwan (Feng-Chia University). The motivation for studying these classes was that they were all taught by the same instructor. The homework assignments were consistent as well as the activities in class and the class hours. The only exception was the D class which met only two hours a week, as opposed to the normal four hours a week for A, B and C classes. The D class also completed only three assignments instead of five, due to less class hours and the meeting time of the class coinciding with numerous national holidays.

2. LETTER WRITING ASSIGNMENTS

The writing assignments were complete letters, such as an application letter or sales letter, requiring a minimum of 150 words in the body. Table 2 shows the assignments and the dates they were turned in for correction. The last two assignments, credit acceptance and credit refusal, were completed and turned in at the same time.

Table 2. Assignments and Corresponding Dates

	Class A	Class B	Class C	Class D
1. Application Letter	3/19/ 93	3/19/ 93	3/19/ 93	3/19/ 93
2. Sales Letter	4/10/93	4/10/93	4/10/93	4/10/93
3. Credit Inquiry	5/4/93	5/4/93	5/4/93	5/4/93
4. Credit Acceptance	5/10/93	5/10/93	5/10/93	*
5. Credit Refusal	5/10/93	5/10/93	5/10/93	*

***No assignment due to less class hours and national holidays**

B. RESULTS

1. CHANGE IN DEMAND ON TEACHERS' TIME

As in the preliminary study, time spent on actual correction of errors was reduced by 90 percent. This saving of time was then translated into increased time spent in other areas, depending on the individual teacher's emphasis. The author used the time saved to review, on a one-to-one basis with his students, the details of their writing weaknesses. Other uses of the time saved included: increased emphasis on searching for conceptual errors, increased attention given to layout errors, increased number of overall assignments.

In addition to reduced time demands on the teacher, this system allowed feedback to be returned in less than a week's time after submission (often sooner, depending on the frequency of class meeting). This short time is important when considering the tradeoff between teacher and computer. Although the computer system cannot match the skill of a teacher, a teacher cannot match the speed of a computer. In addressing this trade-off, Noel & Wysocki (1990) point out: "The amount of time between when an assignment is submitted for a grade and when a student receives feedback on the assignment is crucial to the learning process."

2. STUDENT REACTION

Previous studies of the use of CAI (computer assisted instruction) in writing, have shown that students generally have a positive feeling toward it. Most studies have

focused on the attitudes of students rather than actual changes in skill related to CAI. Important factors in student attitude include ease of use and downtime of the computer system (Wedell & Allerheiligen, 1991). The author avoided many of the negative factors by allowing students to complete their assignments at their convenience (the student program is on a floppy disk). All correction of homework is done by the teacher.

No serious questions, about the use of the QBL system, were raised by participating students. In fact, the consistent nature of the system made it easier for students to concentrate on decreasing their errors. This consistency is an important point if we believe the goal of correcting assignments is to actually modify behavior. A student whose grade was lowered by repeated spelling errors, could count on the same result in the next assignment, unless action was taken to prevent spelling errors. Although Grammatik's explanation of errors is often terse, students had few questions about the errors. With many errors occurring in such clearly objective areas as spelling and subject-verb agreement, students understood what was needed for improvement with little need for intervention by the teacher.

3. TYPES OF ERRORS FOUND

The most common error detected was spelling errors, accounting for 25 percent of all errors found, see Figure 17 and Figure 18. This error type could also include typing errors made by students, although there is no way to separate the two for closer examination. The custom rule data base was also a large source of errors (14

Increasing Feedback & Decreasing Errors While Lowering Instructor Workload in ROC EFL Business English Writing Classes

percent). Other common errors included noun phrase, sentence variety (beginning numerous sentences with the same word or phrase), incomplete sentence, verb form and subject verb agreement. (See Appendix E for a full breakdown of errors found)

Figure 17. Total Errors of Each Error Type

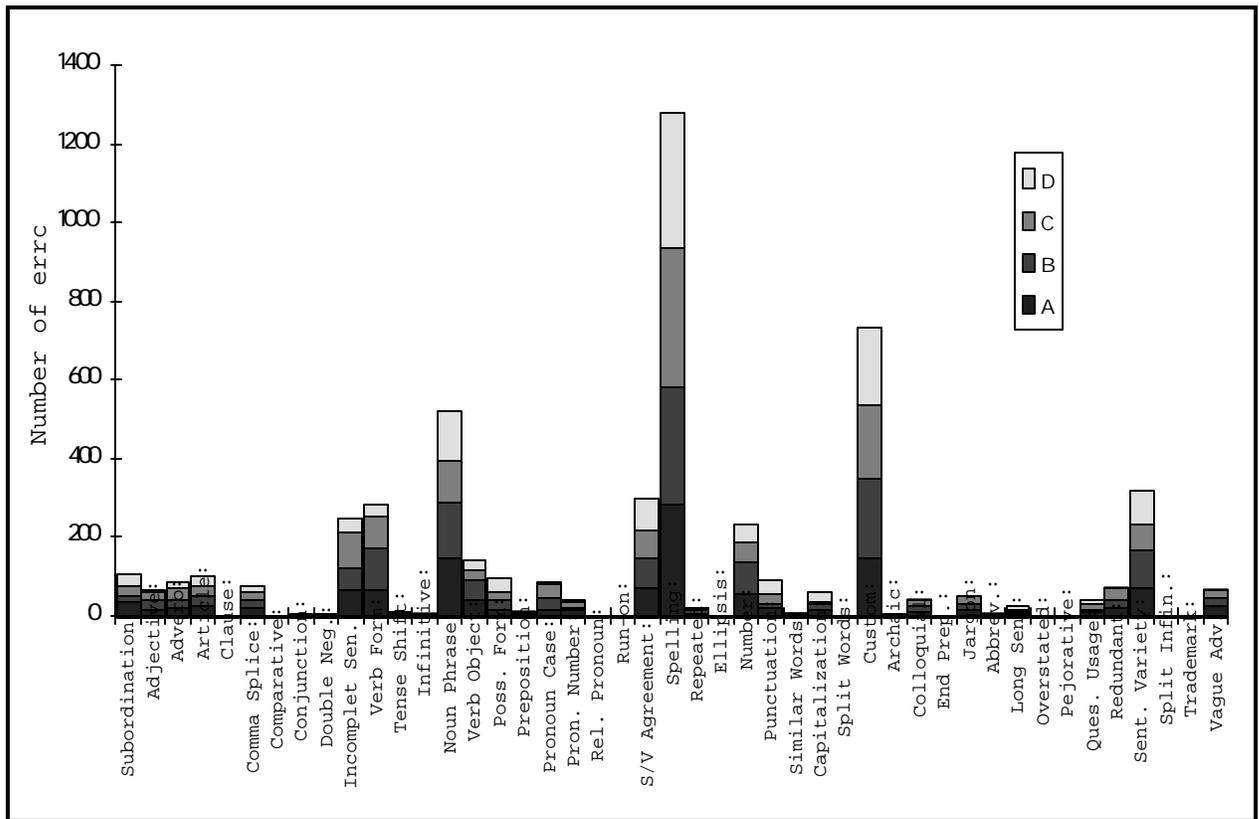
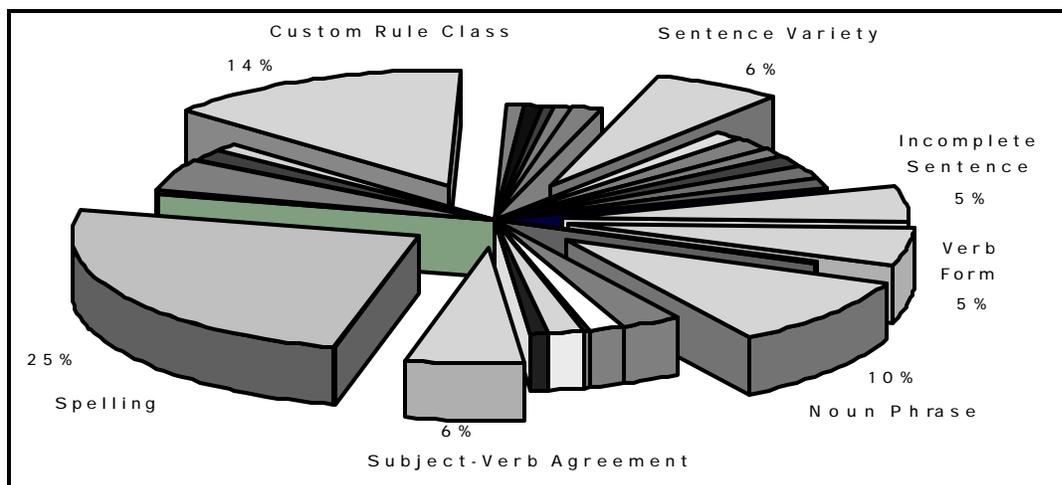


Figure 18. Error Type Percentage of Total Errors



4. DECREASE IN ERRORS

Each class using the QBL system showed a decrease in total errors over the semester, see Figure 19. The mean errors of each class followed a similar decline as shown in Figure 20. The individual error types also paralleled the overall decline in errors with few individual error types standing out from the trend. Figure 21 shows how spelling errors generally followed the downward trend in total errors. Custom errors (see Figure 22) showed an increase in assignment two that may reveal the particular demands made on the student by the assignment. We would expect to find that different assignments emphasize different error types, however over the five assignments no single error type attracted special attention.

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Figure 19. Change in Total Errors

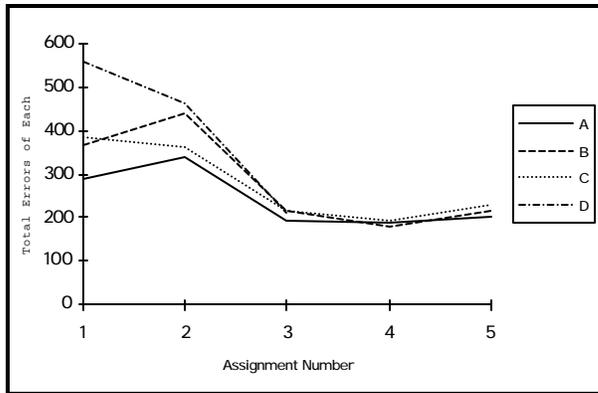


Figure 21. Change in Spelling Error Type

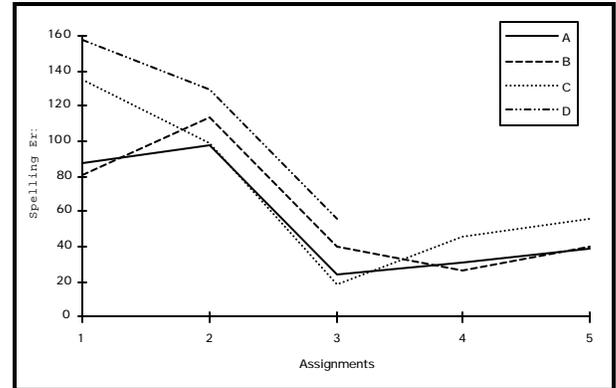


Figure 20. Change in Mean Errors

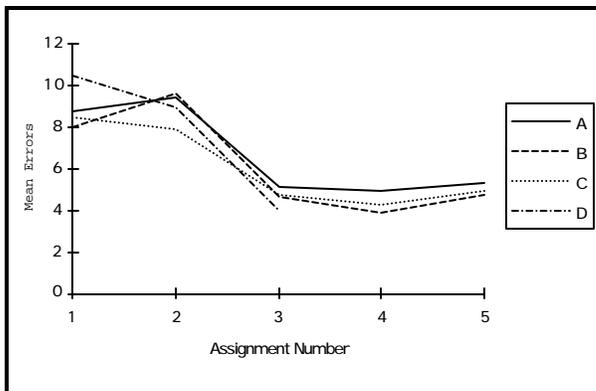
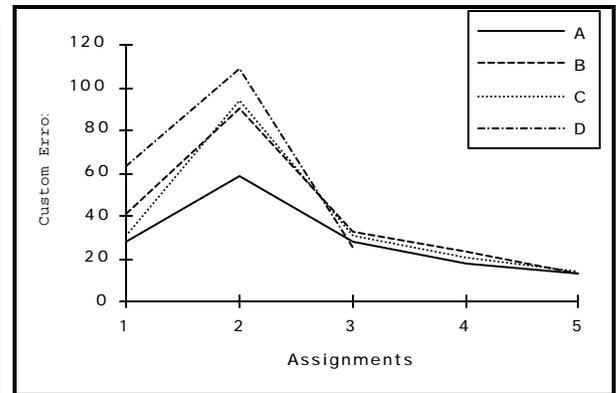


Figure 22. Change in Custom Error Type



5. TRENDS

Trend analysis revealed more details of the nature of the decline in errors. Using the least squares method to calculate a straight line that best fit the data, a downward line with slope of -1.1 was found to be significant (examining total errors per student). The coefficient of determination (r^2 ranging from 0 to 1) reflected the observation that the changes in errors were not strongly linear. However, classes A and C did show a higher significance in the F statistic, see Table 3. Figure 24 shows the trends extended to before and after the present experiment.

A similar treatment, using an exponential curve, is shown in Table 4. The fit for an exponential curve is similar to the linear curve, with the F statistics and the r^2 statistics not differing greatly. Figure 23 shows the exponential curves extended with the exception of Class D (the curve for Class D quickly falls outside the chart range). For more accurate trend analysis, more data points are needed. However, it is clear that some decline is at work. Whether this is a linear or exponential relationship can only be found from data that is begun from the first semester of assignments and studied throughout the whole school year.

Table 3. Linear Trends of Errors

	Class A	Class B	Class C	Class D
Slope	-1.1	-1.2	-1.1	-3.3
F	6.53	4.55	8.76	11.6
Significance	.10	.25	.10	.25
r^2	.69	.6	.74	.92

Table 4. Exponential Trends of Errors

	Class A	Class B	Class C	Class D
Slope	.848	.823	.843	.616
F	6.7	4.99	7.80	6.90
Significance	.10	.25	.10	.25
r^2	.69	.62	.72	.87

Figure 23. Extended Exponential Trends

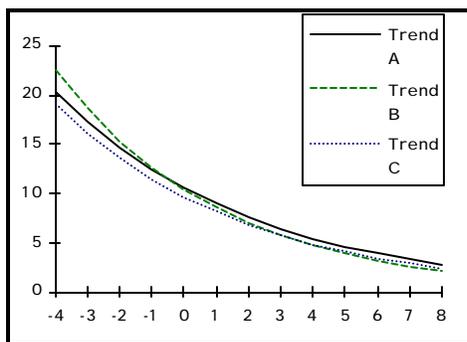
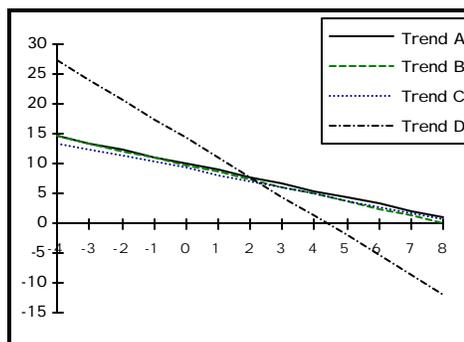


Figure 24. Extended Linear Trends



6. RELATIONSHIP BETWEEN ASSIGNMENTS

The assumption that no change in errors occurred was rejected; results confirmed that there was a significant change in number of errors for each class over the five assignments. ANOVA analysis revealed strong significance for each class between assignments, see Table 5.

Table 5. ANOVA For Errors/Student Over a Semester

Class	A	B	C	D
Assignment	1-2-3-4-5	1-2-3-4-5	1-2-3-4-5	1-2-3
F test	10.76	24.61	8.94	15.21
Significance	.001	.001	.001	.001

A closer examination of each class’ progress through the semester reveals that the change is mostly downward, i.e., an overall decrease in errors. Testing the change in errors between each assignment, see Table 6, reveals that the most significant change occurred with the third assignment. Each class shows a significant improvement between the second and third assignments. This decrease between the second and third assignments occurs in all five classes, including the university class.

Table 6. Mean of Total Errors/Student for Each Assignment

Assignment	1		2		3		4		5
Class A	8.76	NS	9.39	*	5.16	NS	4.97	NS	5.29
Class B	7.97	*	9.61	*	4.65	NS	3.89	NS	4.74
Class C	8.41	NS	7.91	*	4.76	NS	4.22	NS	4.91
Class D	10.5	NS	8.9	*	3.98				

***** *The two means were statistically significantly different (p<.05) using an LSD test*

A major source of fluctuation in errors could be the difficulty of the assignments. Such difficulty could come from many sources, including the way the assignments were presented, the number of examples in the textbook, etc. If this explanation is used for the changes between the second and third assignments, we should see, in assignments four and five, a return to the previous error levels (or at least some significant change). The results, however, clearly do not reveal any rebounding effect.

7. RELATIONSHIP BETWEEN CLASSES

The assumption that all classes were part of the same population was found to be true in all tested cases but one, see Table 7. When tested class by class, the C class was found to be a source of this difference although some factors have caused class D to stand out also, as shown in Table 8. These differences may be contributed to by such factors as assignment difficulty.

Table 7. ANOVA Among All Classes for Each Assignment (Total Errors/Student)

Assignment	1	2	3	4	5
Groups	A-B-C-D	A-B-C-D	A-B-C-D	A-B-C	A-B-C
F value	1.62	2.87	1.45	.789	.711
Significance	NS	.05	NS	NS	NS
SSTreatment	85.56	137.49	24.49	18.47	7.02
SSError	2043.43	1852.83	655.1	1017.93	429.87
SSTotal	2128.99	1990.33	679.59	1036.4	436.89
MSTreatment	28.52	45.83	8.16	9.23	3.51
MSError	17.62	15.97	5.65	11.70	4.94

Table 8. ANOVA Between Classes for Assignment Two

Class	A	B	C	D
A	F=0	F=.51	F=3.396	F=1.40

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	NS	NS	.10	NS
B		F=0 NS	F=8.08 .01	F=4.31 .05
C			F=0 NS	F=.45 NS
D				F=0 NS

8. CLASSES NOT INCLUDED

Although the data presented here centers on four classes, A, B, C and D, the study also revealed that other classes showed a similar drop in errors. Classes taught by other teachers and from departments other than international trade, did not violate the assumption of belonging to the same population over numerous assignments.

These other classes also revealed sudden drops in errors after one or two feedback treatments. The number of assignments as well as the nature of the assignments was not consistent however, and prevented detailed analysis.

IV. FULL STUDY OF ERROR REDUCTION

A. RESEARCH DESIGN

The full study of error reductions was conducted along similar lines as the trial study. The objectives of the full study, however, were somewhat different from those of the trial study. For the full study, two groups were defined: a test group and a control group. With a control group, the hypothesis that the computer generated feedback caused errors to decrease significantly could be tested. All factors for both the test and control groups were kept the same with the only difference being the actual receiving of computer generated feedback.

1. PARTICIPATING CLASSES

For the 1993 Fall semester, sixteen classes of business English were chosen to participate in the expanded study. Four classes were not included in the analysis of errors, but used the expert system. These four classes were three night classes (at The Overseas Chinese College of Commerce) and one university day elective class (at Feng-Chia University).

Night classes and electives were excluded from this analysis due to the difference in student standards, time in class and assignments. The university elective class contained sophomore, junior and senior students from different departments. This diversity, existing in only one class, would not contribute to the depth of the research, it was therefore eliminated from the analysis. An insurance/banking class

was removed from the study when the instructor was replaced by an instructor not participating in the study. Finally, the management class was also removed from the study when one of the assignments was given incorrectly, i.e., in a different sequence than the other classes.

The remaining eight classes were classes from two schools in the central region of Taiwan. Six classes were fifth year classes (the graduating class) at The Overseas Chinese College of Commerce. Two classes were university sophomore classes from the international trade department of Feng-Chia University. The college classes were distributed among different departments (see Table 9). Classes that were not included in the actual statistical study continued using the QBL TOOLS expert system and gave the instructors ample opportunity to make more subjective and detailed observations.

Table 9. Classes Using the QBL TOOLS Expert System

Class	department	Students	Used in Analysis of Data
A	international trade (5 year)	43	43
B	international trade (5 year)	37	37
C	international trade (5 year)	49	49
D	international trade (2 year)	49	0
E	international trade (University)	65	65
F	international trade (University)	56	56
G	accounting/statistics	35	35
H	management	41	0
I	accounting/statistics	44	44
J	insurance and banking	40	0
K	accounting/statistics	52	52
L	international trade (2 year)	50	0
M	international trade (Night School)	55	0
N	international trade (Night School)	60	0
O	international trade (Night School)	58	0

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P	Business Writing Elective (University)	25	0
	Total Students	759	381

Although the participating classes had comparable English skills, it is the case that differences did exist and generalizations can be made. It is generally agreed, among college level instructors, that fifth year international trade department students have the best English skills. This is to some extent because international trade students have more English class hours over their five years than other departments' students.

Even within the international trade department, differences in skill level do exist. The two year students attend college for only the final two years of the junior college program, the first three years being completed in a high school setting as opposed to in the junior college. For this reason, most analysis will be done by examining the classes in groups that appear to reasonably fit together according to skill.

2. CONTROL GROUPS

In the trial study, the need to have control groups was found to be important. Two classes were chosen for the main study's control group. Care was taken to design the experiment so that as many factors as possible would be consistent across all classes, including the control groups. In this way, any differences that did occur, would be easier to attribute to a specific causal factor. The first control group was

class C, a fifth year international trade department class, and the second was class G, a fifth year accounting/statistics department class.

3. LETTER WRITING ASSIGNMENTS

As in the trial study, assignments consisted of writing complete business letters, using the QBL Student Version program. Each student purchased the 5.25 inch floppy disk and user's manual. When assignments were given, the instructor told the students what type of letter was to be written and the specific situation of the letter.

Some inconsistency was unavoidable, as different classes met for different number of hours per week (see Table 10). As was later revealed, one of the classes in the control group, class C was actually highly motivated towards studying English. Randomization of the students, when assigning to groups, would have been the preferable method of the author for this study, but proved impossible since students attend all their classes, throughout their college years, with the same group of students.

Table 10. Class Hours and Number of Assignments

Classes	Class Hours/Week	Number of Assignments
international trade (5 years)	4	5
international trade (University)	2	4
accounting	3	5

The total number of assignments, used with the QBL expert system (not all of which were included in this study) was over 1500. In addition to the computer based

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assignments, each class also completed other assignments, which could not be used with the expert system. Business letters such as résumés and promotions could not be used effectively with the expert system. The specific assignments are listed in **Table 11.**

Table 11. The Assignments and Corresponding Dates (Late 1993-Early 94)

	Class A	Class B	Class C	Class E	Class F	Class G	Class I	Class K
1. Application Letter	10/13	10/13	10/13	10/21	10/22	10/28	10/28	10/29
2. Letter of Inquiry	10/22	10/22	10/22	12/11	12/13	12/1	12/3	12/3
3. Response Letter	12/7	12/8	12/7	12/14	12/15	12/20	12/14	12/16
4. Sales Letter	12/20	12/20	12/16	12/29	12/30	12/29	12/26	12/26
5. Offer	1/5	1/5	1/5	*	*	1/4	1/2	1/5

***No assignment due to less class hours and national holidays**

4. INSTRUCTORS

For this study, all classes were taught by two instructors. Both instructors were full time teachers at The Overseas Chinese College of Commerce, where the study was held. The two instructors chosen agreed to work closely together in order to limit variations between classes. The same textbook was used and a unified curriculum was agreed upon. Specific homework assignments and the times for the assignments were also unified. Participating instructors were from different departments and, for the most part, taught classes from different departments (see **Table 12).**

Table 12. Classes and Corresponding Instructors

Class	departments	Instructor
A	international trade (5 year)	A
B	international trade (5 year)	A

C	international trade (5 year)	A
E	international trade (University)	A
F	international trade (University)	A
G	accounting/statistics	B
I	accounting/statistics	B
K	accounting/statistics	B

5. TYPE OF FEEDBACK

The QBL TOOLS expert system was implemented in the same manner as the trial study. Both the test and control groups received corrections, made by the instructors, to the heading, opening and closing of their letters, as well as the overall correctness of the letter layout. Each error in these areas was clearly marked with a red pen and the student's score reduced. Additionally, if the instructor found any major problems in the body, such as wrong subject matter or incorrect formatting, this too was clearly marked and the grade reduced (see Appendix A).

English errors in the body of all the letters, were found using the QBL TOOLS expert system. Every error found reduced the student's score by two points. The control group would have the appropriate reduction written next to the body of their letters. This reduction would then be added to any reductions made by the instructor, resulting in a total written at the top of the paper and circled. The control group was told that each two point reduction, in the body, represented a single error. A general explanation of the computer system was given to the control group. The explanation included information about the types of errors the system finds as well as the importance of proofreading for spelling and grammar errors. Finally, explanation of the research study was given to the control group.

Most importantly, from the perspective of some students, it was made clear that any final class grades would not be impacted by any differences between classes receiving the feedback or not receiving the feedback. The control group's grades, it was explained, would be based on a normal distribution within the control group only. The homeroom teachers of the control groups were consulted and an attempt was made to assure that any questions arising, out of not receiving feedback, would be quickly referred to the author and could be dealt with satisfactorily.

The test group received the exact same treatment, including the writing of sub totals and a total of score reduction on the original assignment. The only difference was that the test group could view the specific errors in their letters because they were given the actual error feedback printouts (see Appendix A).

6. VARIATIONS FROM TRIAL STUDY

Because an attempt was made to keep all factors the same between the two groups, some activities had to be changed that were included in the trial study. The most important factor was the instructors' interaction with students concerning the computer generated feedback. In the trial study, when the computer generated feedback was returned, the instructor would use class time to meet with each student and make sure he/she understood all the specific points of the feedback. This often meant that the students would quickly verify if their attempts at rewriting were correct or not.

During the full study, there was no attempt to specifically address or follow up on the computer generated feedback. Although the compiled statistical findings were used generally in teaching. For example, if a specific assignment was found to have numerous capitalization errors, the instructor would use class time to review the correct use of capitalization. Such special emphasis of subject matter would be across both groups so as to avoid any special instruction to only the control or test group.

Additional differences between the full and trial studies includes the use of a new textbook as well as different assignments. The full study was held in the fall semester of 1993-94 school year, where as the trial study was in the spring of 1992-93 school year.

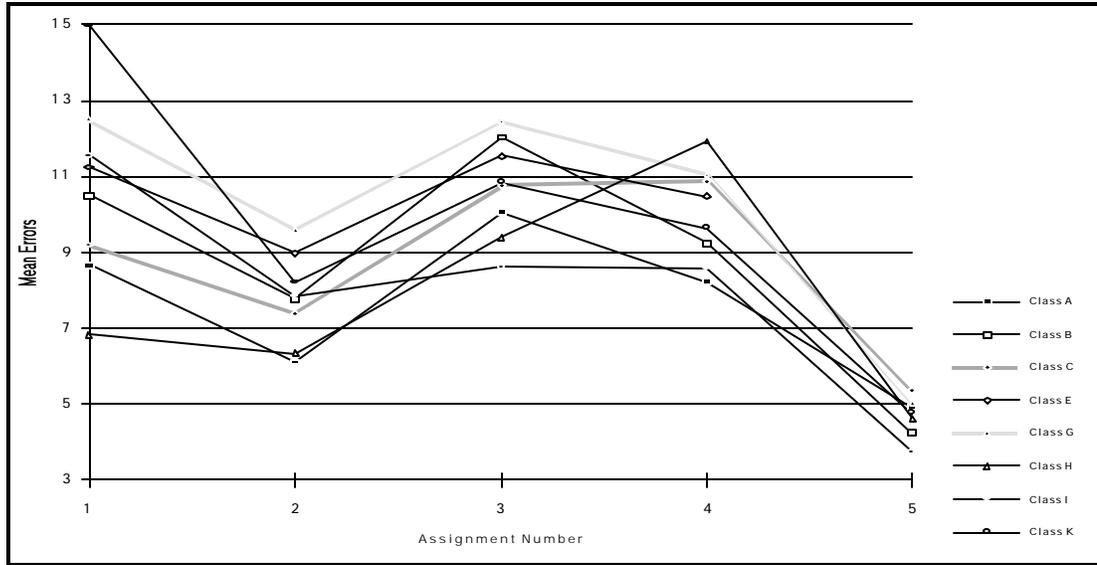
B. RESULTS

1. CHANGE IN ERRORS

As in the pre-study, errors were tracked and statistically analyzed. All classes showed changes in their error rates throughout the semester. Figure 25 shows the changes in average errors for each class over the whole semester. The amount of fluctuation is larger than that observed in the trial study, however, it is clear all classes tend to change in the same manner. (See Appendix F for a full breakdown of errors found)

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Figure 25. Mean Error Rate of All Classes for All Assignments



A further breakout of the different classes clearly shows the tendency of the control classes (C and G) to move towards the high range of error rates. Figure 26, Figure 27 and Figure 28 show the control classes (C and G) compared with the different classes and schools.

Figure 26. Mean Errors of University Classes (and Control Classes C & G)

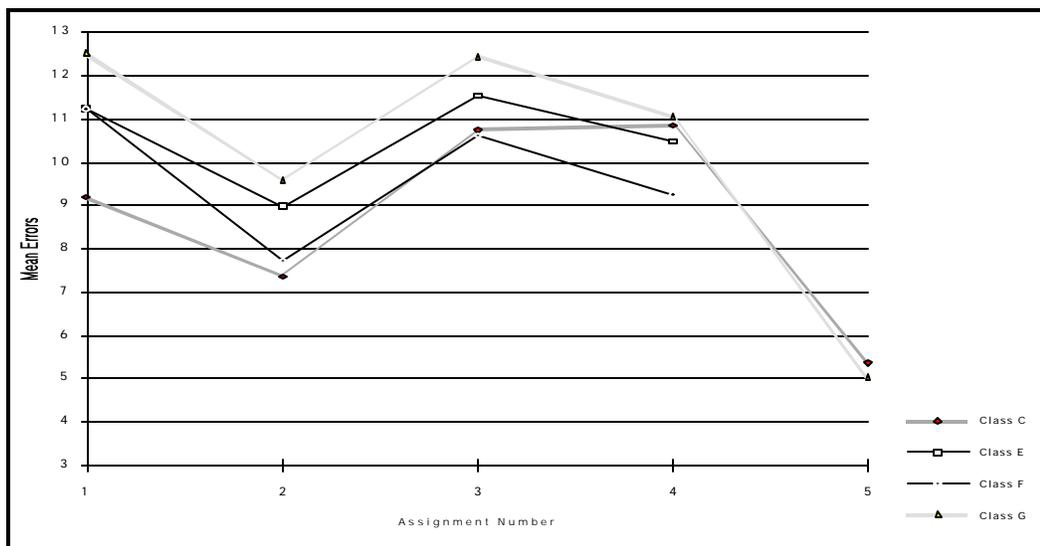


Figure 27. Mean Errors of College Trade Classes (and Control Classes C & G)

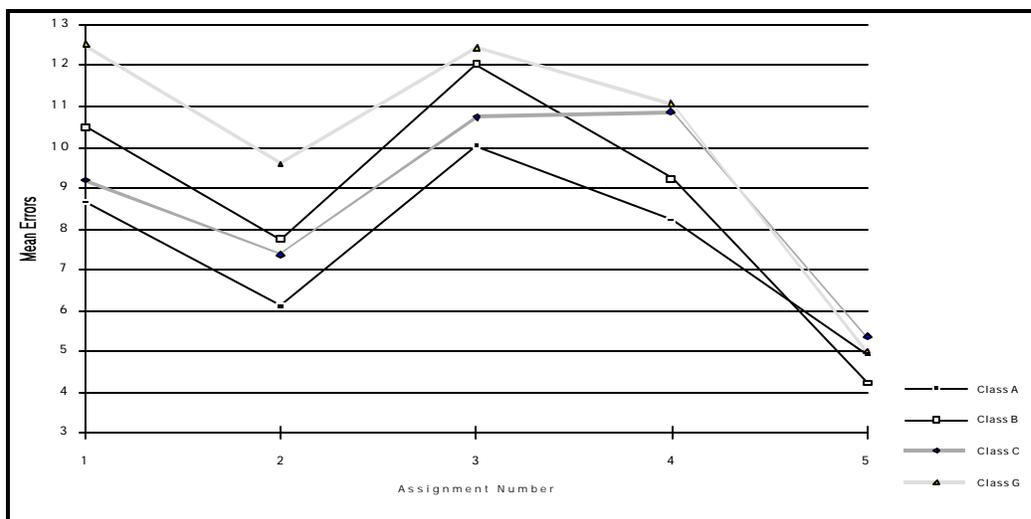
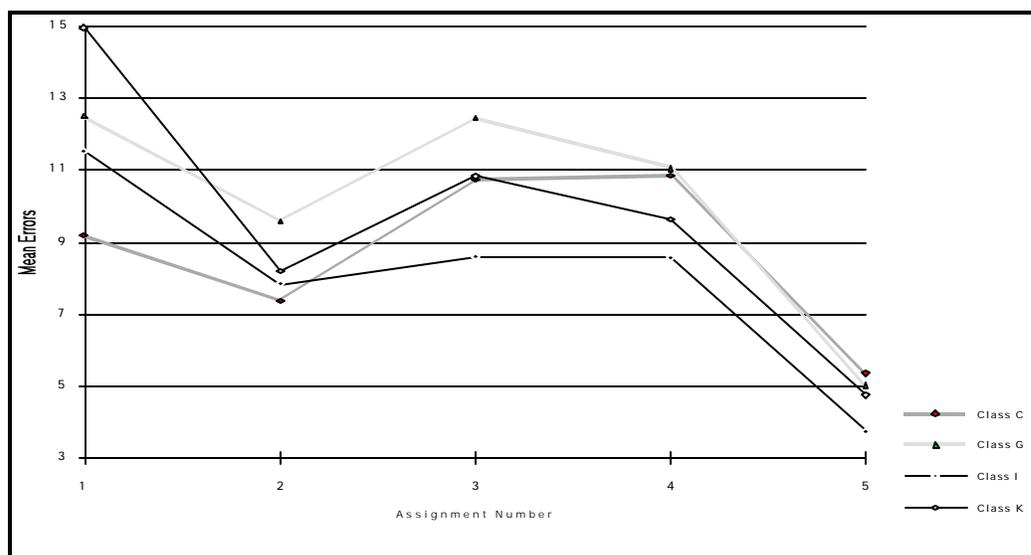


Figure 28. Mean Errors of Accounting Classes (and Control Classes C & G)



2. TRENDS

Trend analysis was performed on the changes in errors to determine the slope and test if the changes were linear or exponential. The least squares method was used to calculate a straight line that best fit the data for both control and test groups. Of the two groups, the test group showed more decline in errors as well as more tendency towards a straight line, although still not highly linear (see Table 13). The

downward slope of the test group was -1.26 while the control group was -0.81. The test group's slope is in line with the slopes generated by the error decline in the trial study. Also in line with the trial study is that the test group's trend analysis generated an F statistic that was significant at the .25 level and an r^2 (coefficient of determination) of .52. The linear trends of both groups are extended in Figure 29.

Table 14 shows the results from fitting an exponential curve to the data. Again, the test group shows a better fit while the control group has a higher r^2 for this test than the linear test. The test group's slope of .841 is right in line with the trial study's finding of .848. Clearly, even with slightly different constructs, the overall change in error rate is the same between the full study and the trial study.

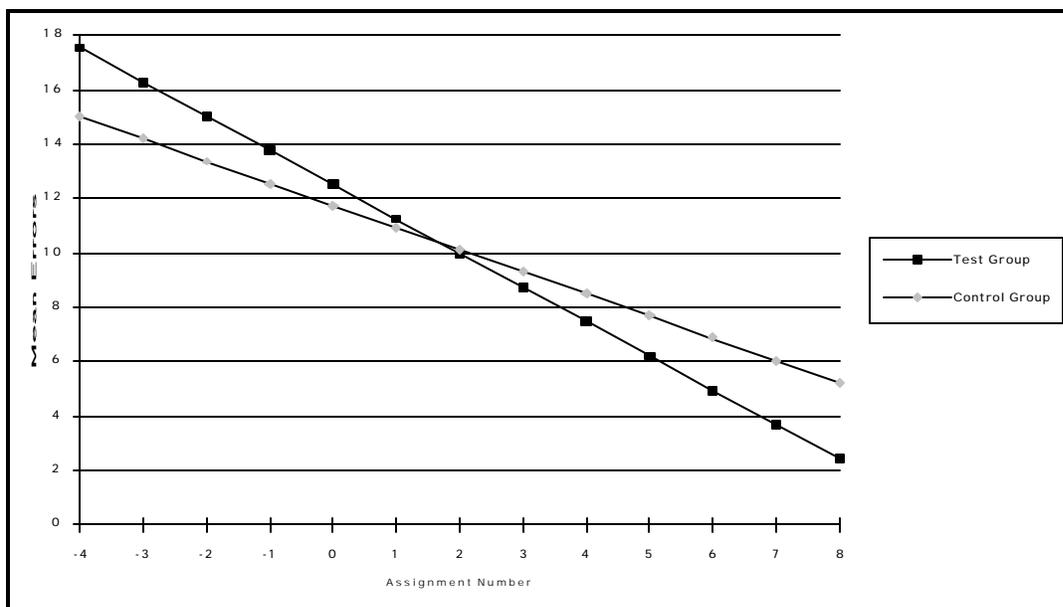
Table 13. Linear Trends of Errors (Full Study)

	Test Group	Control Group
Slope	-1.26	-0.81
F	3.23	0.99
Significance	.25	NS
r^2	.52	.25

Table 14. Exponential Trends of Errors (Full Study)

	Test Group	Control Group
Slope	.841	.89
F	3.25	1.32
Significance	.25	NS
r^2	.52	.31

Figure 29. Extended Linear Trends of Test and Control Group (Full Study)



3. RELATIONSHIP BETWEEN ASSIGNMENTS

The assumption that there was no significant change in errors was rejected for all classes. ANOVA analysis shows that each class showed statistically significant changes over the five assignments. Table 15 details the results of the ANOVA analysis.

Table 15. ANOVA for Errors Over a Semester (Full Study)

Class	A	B	C	E	F	G	I	K
Assignment	1-2-3-4-5	1-2-3-4-5	1-2-3-4-5	1-2-3-4	1-2-3-4	1-2-3-4-5	1-2-3-4-5	1-2-3-4-5
F test	9.36	7.60	10.18	2.68	5.10	9.34	6.17	15.17
Significance	.001	.001	.001	.05	.01	.001	.001	.001

Progress through the semester is shown in Table 16 using a Least Significant Difference test to measure statistically significant changes. Clearly this data shows a much higher level of fluctuation than that observed in the trial study. Nearly every assignment’s rate of errors differs significantly from the previous rate.

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Table 16. Mean of Total Errors/Student for Each Assignment (Full Study)

Assignment	1		2		3		4		5
Test	11.45	*	6.12	*	10.05	*	8.23	*	4.93
Control	10.63	*	7.77	*	12.04	NS	9.24	*	4.24

* *The two means were statistically significantly different ($p < .05$) using an LSD test*

4. RELATIONSHIP BETWEEN NON-CONTROL GROUPS

The assumption that all the classes in the test group were part of a single population was confirmed through an ANOVA analysis. Table 17 shows that the control sections' error rates, for each assignment, are not significantly different, using an F test. Although the classes started the semester with a large spread between each other that was slowly narrowed until the final assignment when all the control sections' error rates were very close. In any case, the selection of the control classes appears to have had no impact in the control group as a population. Of special note is the fact that the two classes, E and F, from a different school fit within the population also. This confirms a similar observation made in the trial study. Such a finding would suggest that results of this research project could be applied over a wider educational area, including different types of schools.

Table 17. ANOVA Among Control Classes for Each Assignment (Full Study)

Assignments	1	2	3	4	5
Classes	A-B-E-F-I-K	A-B-E-F-I-K	A-B-E-F-I-K	A-B-E-F-I-K	A-B-I-K
F test	2.85	1.30	3.38	1.39	1.14
Significance	NS	NS	NS	NS	NS

5. RELATIONSHIP BETWEEN CONTROL GROUPS

The selection of students for the control group could not be done on the basis of random selection, as the author would have preferred. Classes had to be chosen as

whole classes. This obviously leads to the danger that the assumption of normal distribution could be violated. Clearly, Figure 25 shows that the class C starts with a lower error rate than that of class G. This was a point of concern as the experiment progressed. After some investigation, it was found that class C, an all female class, was highly motivated towards learning English. In fact, the homeroom teacher of class C was also an English instructor and the director of the school's English section. This meant that this director/teacher had taught class C's English class consistently over the past five years.

Because the study was already underway, there was no way to change the makeup of the control group. The author, who also was class C's business English instructor, observed that class C had high motivation and appeared to have a high level of skill compared to the norm. These observations were, however, only informal, but they do suggest that achieving a higher error rate with the control group would be difficult.

The results in Figure 25, however, show that class C was not able to reduce errors at the same rate as the test classes. In fact, by the third assignment, class C's error rate was not statistically significantly different from class G (the other control class). Table 18 shows how quickly class C and G come together to nicely form a single population.

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Table 18. ANOVA Among Control Classes for Each Assignment (Full Study)

Assignments	1	2	3	4	5
Classes	C-G	C-G	C-G	C-G	C-G
<i>F</i> test	4.86	8.56	1.90	.004	.13
Significance	.05	.01	NS	NS	NS

6. DIFFERENCES BETWEEN CONTROL AND TEST GROUPS

While most findings of the trial study were confirmed in the full study, one important difference was the inclusion of a control group. Analysis of the differences between the test and control groups confirms the hypothesis that students receiving computer generated feedback have significantly lower error rates than students not receiving such feedback. Table 19 shows the results, comparing the two groups over the five assignments.

Table 19. Comparison of Test Group and Control Group Error Rates

	Test Group Mean Errors	Control Group Mean Errors
Assignment 1	11.45	10.63
Assignment 2	7.87	8.29
Assignment 3	10.60	11.44
Assignment 4	9.35*	10.95*
Assignment 5	4.41*	5.23*

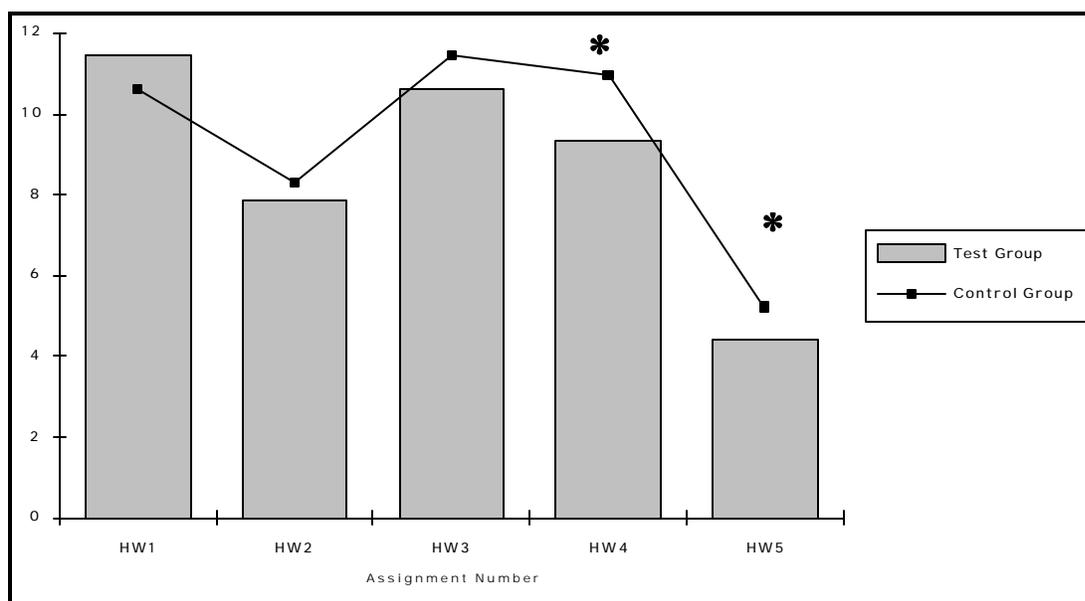
*The two groups' scores were statistically significantly different ($p < .05$) using t-tests

The same results are graphically shown in Figure 30, where it can be observed that the control group's error rate closely follows the test group's error rate. It would appear that the actual specific letter type assigned plays an important role in the error rate. This must be seen, however, in the light of the present experiment's construction. The only difference that separated the two groups was the presence or absence of computer generated feedback. Students in the control group

completed their assignments using QBL Student Version and understood that the reduction in grades, from errors in the body of a letter, was based on a computer system.

That the two groups' error rates raise and fall in parallel should be no surprise. In fact, the assumption that the two groups' error rates would actually form one population seemed highly likely. After all, feedback is only one small part of the writing class. The parallel changes in error rates may actually show that the experiment's constructs were robust. The statistically significant differences, which appear after the second assignment, would then indicate that supplying students with detailed computer generated feedback does reduce error rates and that this reduction can be enlarged by following up the feedback with in-class work.

Figure 30. Control and Test Groups' Mean Errors



*The two groups' scores were statistically significantly different ($p < .05$) using t-tests.

V. FULL STUDY PROFILE OF ERROR TYPES

QBL TOOLS allowed a detailed tracking of error types made by all the participating students.

A. ERROR TYPES

The forty-five specific error types that are found by the QBL system are listed in Table 20.

Because QBL TOOLS saves all students' work, it is possible to perform an analysis on the exact types of errors that occur most frequently in students' writings.

Table 20. *The Error Types Found by QBL System*

1 Subordination	2 Adjective	3 Adverb	4 Article
5 Clause	6 Comma Splice	7 Comparative	8 Conjunction
9 Double Neg.	10 Incomplete Sen.	11 Verb Form	12 Tense Shift
13 Infinitive	14 Noun Phrase	15 Verb Object	16 Poss. Form
17 Preposition	18 Pronoun Case	19 Pron. Number	20 Rel. Pronoun
21 Run-on	22 S/V Agreement	23 Spelling	24 Repeated
25 Ellipsis	26 Number	27 Punctuation	28 Similar Words
29 Capitalization	30 Split Words	31 Custom	32 Archaic
33 Colloquial	34 End Prep.	35 Jargon	36 Abbrev.
37 Long Sen.	38 Overstated	39 Pejorative	40 Ques. Usage
41 Redundant	42 Sent. Variety	43 Split Infin.	44 Trademark
45 Vague Adv.			

B. MOST COMMON ERRORS

Figure 31 shows the breakdown of the types of errors made by all the participating classes over the five assignments. Errors that made up five percent or more of total errors, are labeled. The most frequently occurring error, spelling with 3742 occurrences (see Table 21), would also seem to be the easiest to avoid through improved proofreading practices.

Figure 31. Errors of All Classes Over Five Assignment

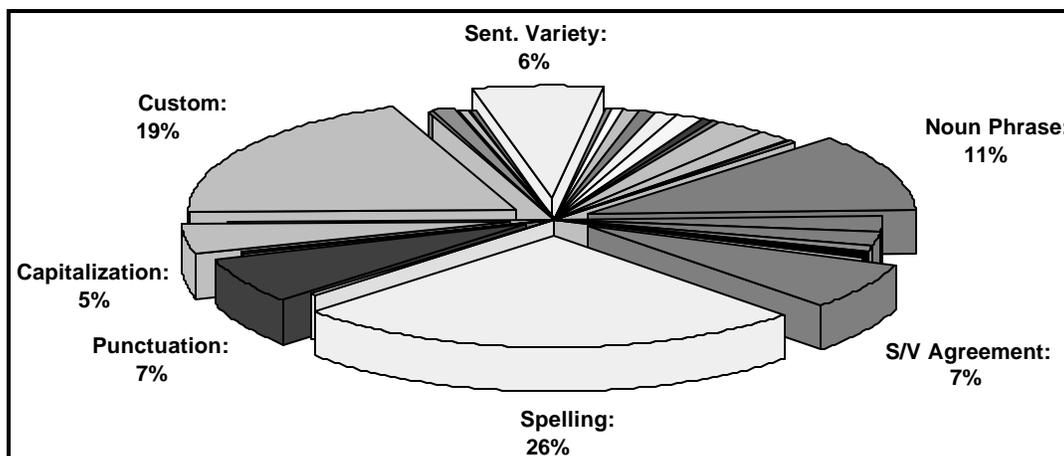


Table 21. Error Type Totals

	Grand Total	A	B	C	E	F	G	I	K
Spelling:	3742	377	298	522	598	499	428	431	589
Custom:	2799	290	253	339	484	467	257	290	419
Noun Phrase:	1649	172	165	241	253	184	169	184	281
S/V Agreement:	1004	86	103	147	160	95	113	132	168
Punctuation:	964	71	71	104	192	158	90	86	192
Sent. Variety:	917	138	102	132	108	105	90	112	130
Capitalization:	673	42	32	38	210	112	124	47	68
Incomplete Sen.:	359	50	41	36	41	38	42	50	61
Verb Object:	329	28	25	52	39	38	40	39	68
Poss. Form:	321	31	42	43	60	44	25	39	37
Verb Form:	264	28	14	48	48	32	28	26	40
Comma Splice:	193	28	18	30	27	11	18	21	40
Long Sen.:	156	22	14	23	16	24	17	21	19
Article:	151	12	16	19	29	17	22	18	18
Adverb:	149	9	16	18	32	21	16	20	17
Pron. Number:	146	14	11	18	21	18	15	23	26
Subordination:	111	14	9	21	15	6	10	18	18
Adjective:	102	10	15	18	13	5	11	8	22
Conjunction:	102	6	7	14	34	16	17	3	5
Pronoun Case:	98	6	5	7	22	19	10	14	15
Ques. Usage:	90	6	0	3	22	36	14	9	0
Tense Shift:	42	0	0	3	7	7	7	11	7
Repeated:	40	3	3	7	5	6	4	8	4
Redundant:	35	3	3	4	4	7	4	7	3
Infinitive:	28	2	3	4	8	0	2	0	9
Vague Adv.:	25	1	2	3	7	4	2	3	3
Double Neg.:	21	2	1	1	1	1	1	8	6
Preposition:	21	3	2	1	3	5	1	3	3
Similar Words:	21	3	3	6	1	4	0	1	3
Overstated:	20	2	0	4	4	1	1	6	2

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Colloquial:	9	0	0	2	0	3	4	0	0
Rel. Pronoun:	8	0	1	4	1	0	1	1	0
Split Infin.:	6	0	1	0	1	3	0	1	0
Abbrev.:	4	0	0	3	1	0	0	0	0
Jargon:	2	0	0	0	0	2	0	0	0
Run-on:	1	0	0	0	0	0	0	1	0
Archaic:	1	1	0	0	0	0	0	0	0
Clause:	0	0	0	0	0	0	0	0	0
Comparative:	0	0	0	0	0	0	0	0	0
Ellipsis:	0	0	0	0	0	0	0	0	0
Number:	0	0	0	0	0	0	0	0	0
Split Words:	0	0	0	0	0	0	0	0	0
End Prep.:	0	0	0	0	0	0	0	0	0
Pejorative:	0	0	0	0	0	0	0	0	0
Trademark:	0	0	0	0	0	0	0	0	0

The frequency of custom error types is more difficult to classify because the rules that make up the custom database do not have any commonality beyond being common to Chinese students (this group of errors has been programmed by the authors and is based on the common errors found in Chinese students' writing, i.e., "I have ever been there."). Noun phrase errors include errors such as: *I went to store to buy milk*. This error type along with subject/verb agreement are notoriously difficult for non-proficient users of English. Most English textbooks and most English classes for that matter spend a large percentage of time on practicing the correct structures of these error types.

C. RELATION OF ERRORS TYPES TO BUSINESS LETTER GENRES

Tracking of the specific error types allowed detailed profiles of errors for each letter genre to be made. Each analysis is a snapshot of what students are writing at that time for the specific type of letter called for in the assignment.

Table 22 shows the ten most common error types, for each assignment, of the control group.

By looking at the control group’s errors, we may be able to create a benchmark of common errors that can latter be used in judging success in efforts to reduce errors.

Table 22. Ten Most Common Error Types for Each Assignment (Ranked in Descending Order)

Application Letter	Inquiry Letter	Response Letter	Sales Letter	Offer Letter
spelling	spelling	spelling	spelling	spelling
punctuation	custom	custom	custom	noun phrase
sentence variety	noun phrase	capitalization	noun phrase	sentence variety
custom	S/V agreement	noun phrase	S/V agreement	S/V agreement
noun phrase	verb object	S/V agreement	verb form	long sentence.
S/V agreement	sentence variety	punctuation	verb object	custom
article	punctuation	incom. sen.	sentence variety	punctuation
incom. sen.	capitalization	verb object	punctuation	poss. form
verb object	incom. sen.	verb form	poss. form	incom. sen.
capitalization	verb form	comma splice	comma splice	verb form

As shown in the trial study, there is a natural decline in error rates as a result of simply writing more: approximately -0.81. This means that both groups should have lower error rates over time irrelevant of the type of letter being written. The decline for the test group (receiving computer feedback) has been shown to be steeper at approximately -1.26. It may be the case that some error types have higher rates in a specific assignment simply because that assignment calls for more use of that type of construction. Thus any specific error type may not follow the same general decline shown in the overall error mean.

Figure 32, Figure 33, Figure 34, Figure 35 and Figure 36 graphically show the errors for each of the five assignments and notes any significant difference between the control and test groups. ($\bar{\quad}$ The two group’s scores were statistically significantly different ($p < .10$) using t-tests)

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Figure 32. Mean Errors of Control and Test Groups (Assignment One/Application Letter)

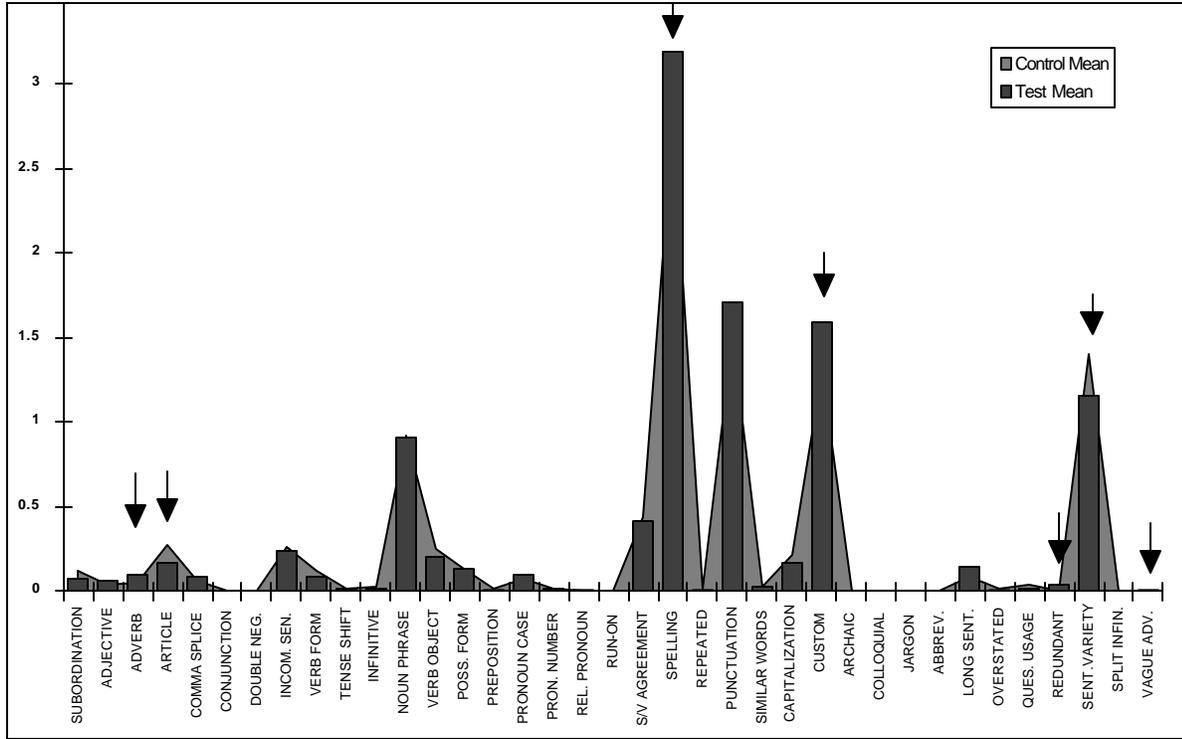


Figure 33. Mean Errors of Control and Test Groups (Assignment Two/Letter of Inquiry)

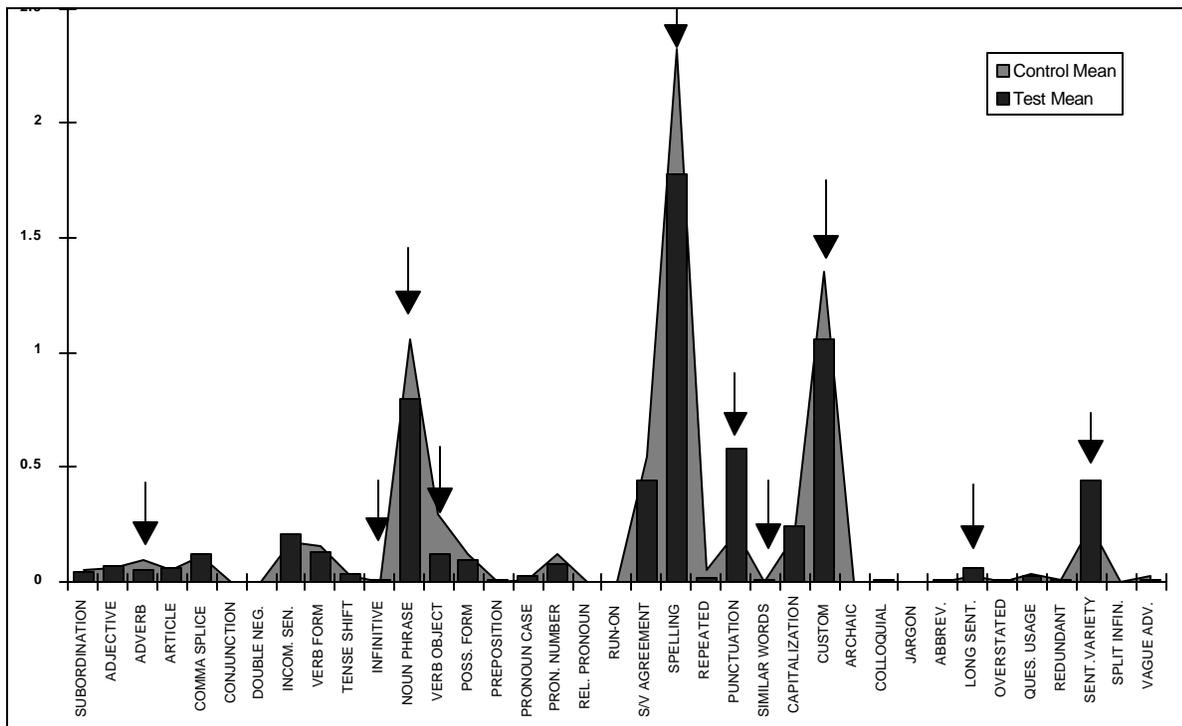


Figure 34. Mean Errors of Control and Test Groups (Assignment Three/Response Letter)

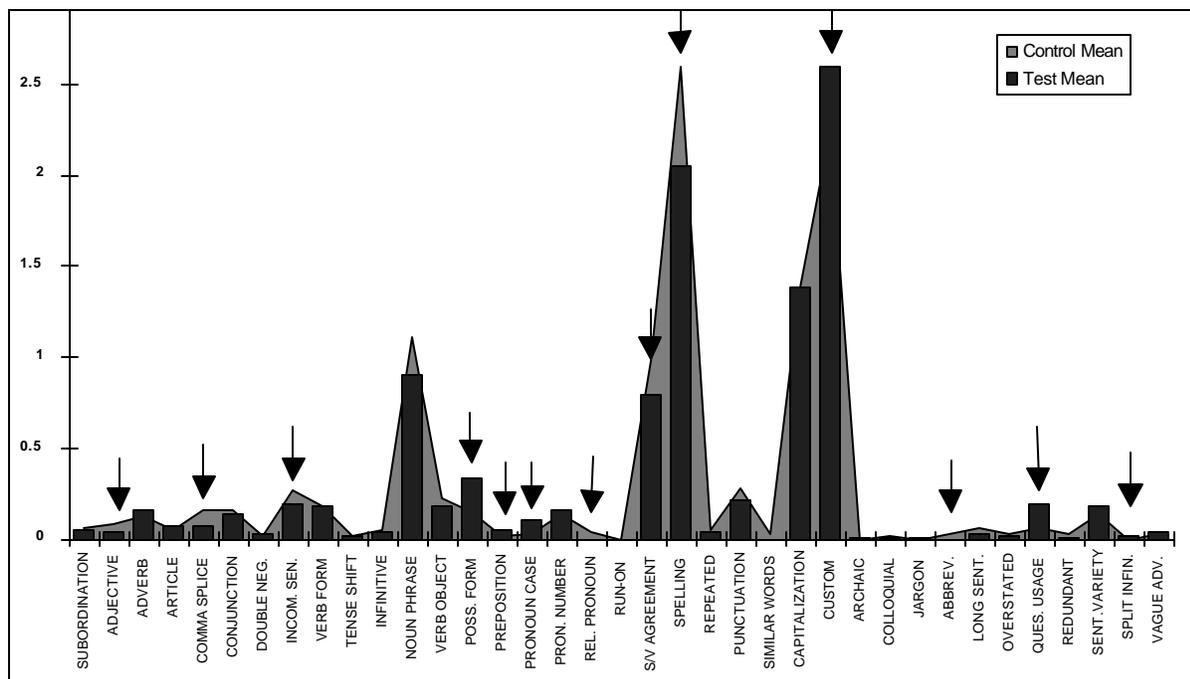
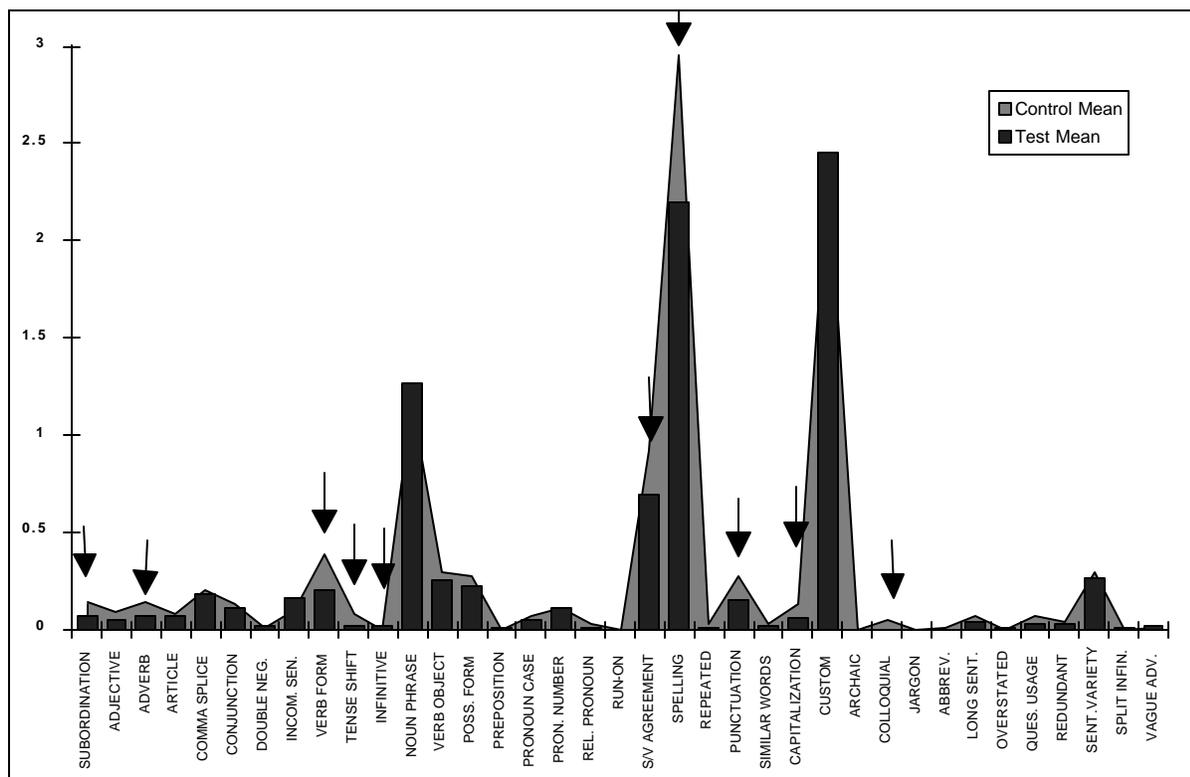
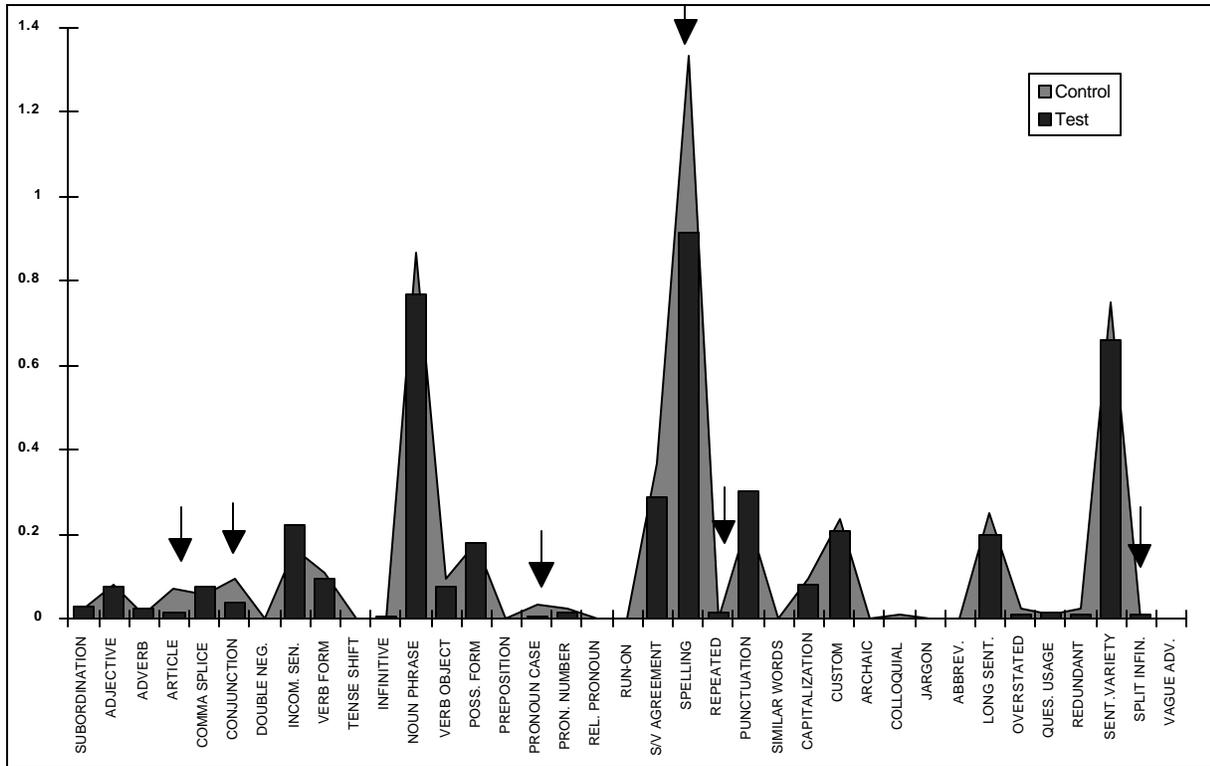


Figure 35. Mean Errors of Control and Test Groups (Assignment Four/Sales Letter)



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Figure 36. Mean Errors of Control and Test Groups (Assignment Five/International Trade Offer)



D. ERROR TYPES MOST RESPONSIVE TO FEEDBACK

1. TEST AND CONTROL GROUPS' AVERAGE ERROR TYPES

When we examine the overall breakdown of error types, the control group and the test group do not appear to differ greatly. In fact, it is a confirmation of the experiment’s design that across teachers and classes, the relative rankings of most common errors are consistent (see Figure 37 and Figure 38): spelling, custom, noun phrase, etc.

Figure 37. Errors of Control Group

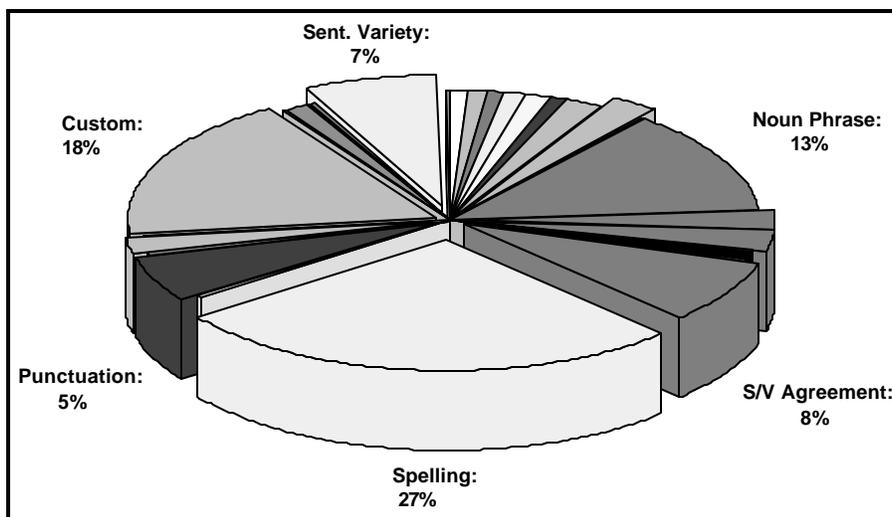
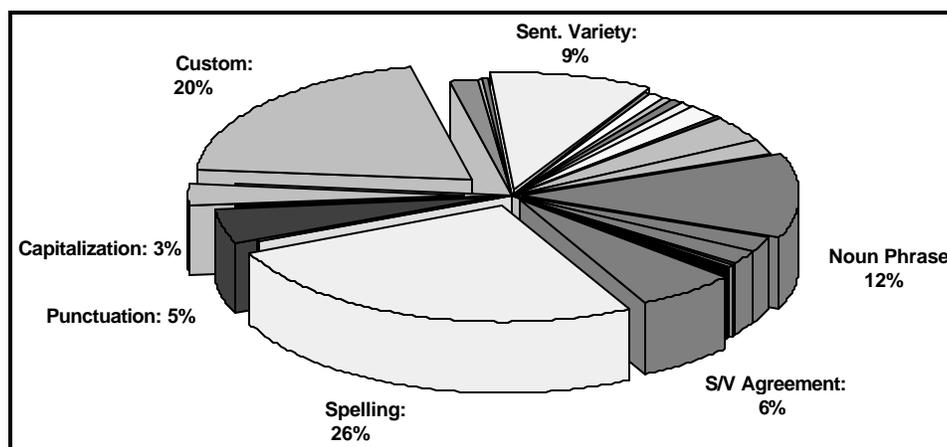


Figure 38. Errors of Test Group



There are, however, differences between the two groups which do not readily appear in a simple percentage breakdown. Importantly, results from the first assignment are not influenced by the feedback in any way, since students only receive exposure to the expert system's output after completing the first assignment. The first assignment produces a large percentage of errors, for some classes it is the assignment with the most errors. A better understanding of any changes in specific error types can be found by examining results from each assignment after the first in detail. To quantify changes for each error type, the test

group's errors were subtracted from the control group, for each error type, and the result summed across all assignments(i) after the first (see Equation 5). Resulting positive numbers show that the test groups errors were less than the control group over the last four assignments (when the computer feedback had its impact). Negative numbers show which error types were occurring at a higher rate in the test group than in the control group.

Equation 5. Quantifying the Changes of a Single Error Type

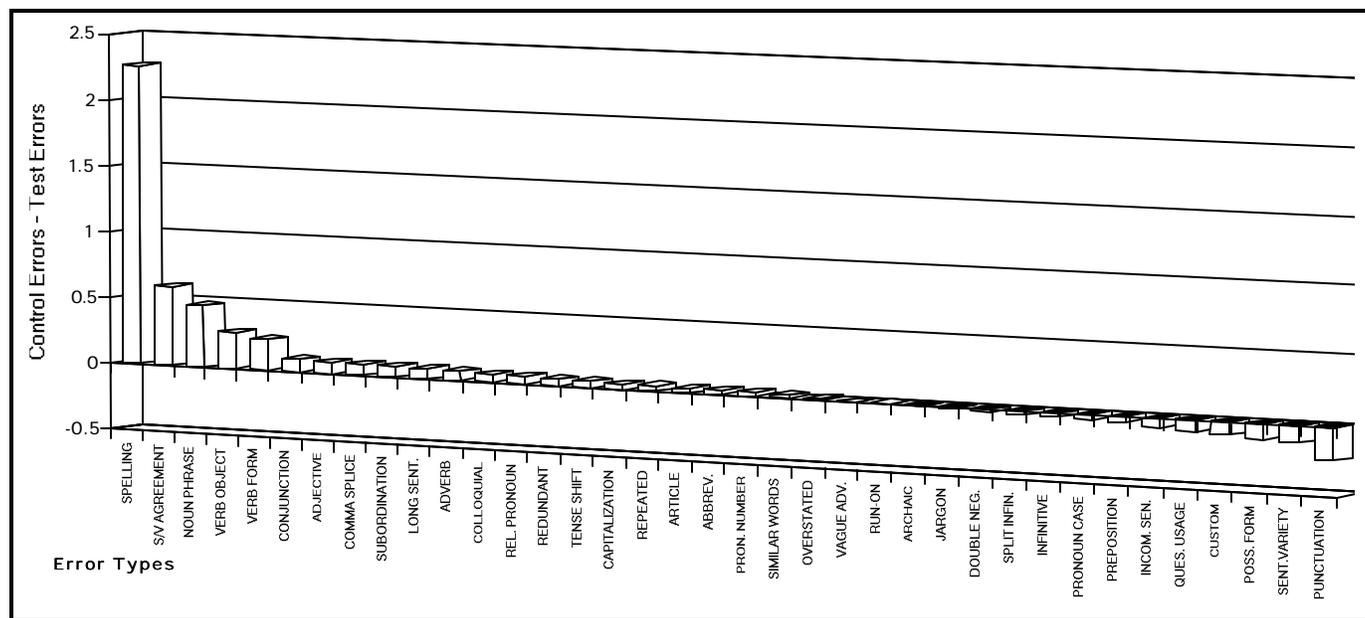
$$\sum_{i=2}^5 (ControlErrorMean_i - TestErrorMean_i)$$

Figure 39 graphically depicts the results of Equation 5. By examining the extreme positive and negative results, we can conclude which error types are most easily reduced and which are most difficult to reduce through CAI. Figure 39 shows that the spelling error type is by far the error type most influenced by computer generated feedback. This is also the largest error type of both groups and therefore most open to easy observation and correction.

Surprisingly, the most resistant error type turns out to be punctuation. Since punctuation would seem to follow a finite number of rules, students should be able to quickly compensate for this type of error and reduce it. In fact, the data shows that the test group had more punctuation errors than the control group. This may be a sign that simple behaviors can quickly be activated, such as proofreading, however more complex rules, such as grammar, are less easy to activate or reinforce through a computer based system.

In cases such as punctuation and spelling, we may be able to view the perfect merging of teacher and automated system. Spelling is highly responsive to computer feedback, indicating that the teacher need spend less time concerned with such errors, being confident that the automated system will assist the students to make sufficient progress. On the other extreme, writing assignments which tend to have large numbers of punctuation errors give an opportunity for the teacher to provide special attention and instruction. The automated system can then quickly supply an analysis of the results, which under perfect circumstances would show that spelling errors reduced and that the special effort, by the teacher, also reduced the error rate of punctuation (pushing it into the positive zone).

Figure 39. Total of Control Errors Subtract Test Errors for HW2 to HW5



2.CHANGES IN TEST AND CONTROL GROUP'S ERROR TYPES

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Table 23 breaks-out the details of any statistically significantly different error types between the two groups from every assignment. Differences between the two groups are highlighted at or below the .10 level of significance, using t tests.

Table 23. Test & Control Differences of Mean Errors

	HW1		HW1	HW2		HW2	HW3		HW3
	Control Mean		Test Mean	Control Mean		Test Mean	Control Mean		Test Mean
ADJECTIVE	0.0400	NS	0.0583	0.0610	NS	0.0648	0.0864	P=.09	0.0413
ADVERB	0.0533	P=.01	0.0958	0.0976	P=.09	0.0486	0.1235	NS	0.1570
ARTICLE	0.2800	P=.09	0.1708	0.0488	NS	0.0567	0.0494	NS	0.0702
COMMA SPLICE	0.0667	NS	0.0833	0.1098	NS	0.1174	0.1605	P=.03	0.0702
INCOM. SEN.	0.2667	NS	0.2417	0.1707	NS	0.2065	0.2716	P=.09	0.1901
INFINITIVE	0.0267	NS	0.0125	0.0000	P=.04	0.0121	0.0494	NS	0.0413
NOUN PHRASE	0.9200	NS	0.9083	1.0610	P=.03	0.8016	1.1111	NS	0.9008
VERB OBJECT	0.2533	NS	0.2083	0.2927	P=.008	0.1215	0.2222	NS	0.1777
POSS. FORM	0.1333	NS	0.1292	0.1220	NS	0.0931	0.1481	P=.001	0.3388
PREPOSITION	0.0133	NS	0.0083	0.0000	NS	0.0040	0.0123	P=.02	0.0496
PRONOUN CASE	0.0800	NS	0.1000	0.0122	NS	0.0243	0.0247	P=.001	0.1033
REL. PRONOUN	0.0000	NS	0.0042	0.0000	NS	0.0000	0.0370	P=.04	0.0000
S/V AGREEMENT	0.4400	NS	0.4167	0.5488	NS	0.4413	0.9753	P=.10	0.7975
SPELLING	2.7600	P=.08	3.1875	2.3293	P=.012	1.7773	2.5926	P=.02	2.0537
PUNCTUATION	1.4933	NS	1.7083	0.2195	P=.003	0.5789	0.2840	NS	0.2149
SIMILAR WORDS	0.0267	NS	0.0333	0.0000	P=.08	0.0081	0.0247	NS	0.0000
CUSTOM	1.2933	P=.06	1.5917	1.3537	P=.06	1.0607	2.2346	P=.04	2.5992
ABBREV.	0.0000	NS	0.0000	0.0000	NS	0.0040	0.0247	P=.08	0.0000
LONG SENT.	0.0933	NS	0.1458	0.0244	P=.06	0.0607	0.0617	NS	0.0248
QUES. USAGE	0.0400	NS	0.0167	0.0366	NS	0.0243	0.0617	P=.002	0.1901
REDUNDANT	0.0000	P=.003	0.0375	0.0122	NS	0.0040	0.0247	NS	0.0041
SENT. VARIETY	1.4000	P=.01	1.1625	0.2439	P=.002	0.4453	0.1358	NS	0.1818
SPLIT INFIN.	0.0000	NS	0.0000	0.0000	NS	0.0000	0.0000	P=.04	0.0124
VAGUE ADV.	0.0000	P=.08	0.0083	0.0244	NS	0.0040	0.0247	NS	0.0413

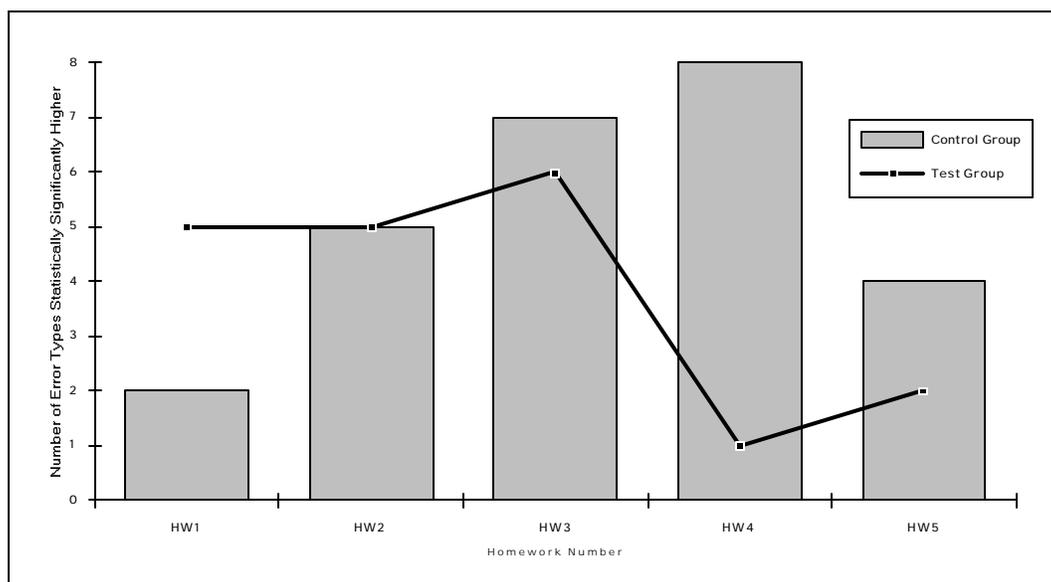
Table 24. Test & Control Differences of Mean Errors (Continued)

	HW4		HW4	HW5		HW5
	Control Mean		Test Mean	Control		Test
SUBORDINATION	0.1410	P=.05	0.0685	0.0238	NS	0.0287
ADVERB	0.1410	P=.07	0.0726	0.0119	NS	0.0230
ARTICLE	0.0769	NS	0.0685	0.0714	P=.037	0.0172
CONJUNCTION	0.1282	NS	0.1129	0.0952	P=.10	0.0402
VERB FORM	0.3846	P=.01	0.1976	0.1071	NS	0.0977
TENSE SHIFT	0.0769	P=.03	0.0161	0.0000	NS	0.0000
INFINITIVE	0.0000	P=.013	0.0202	0.0000	NS	0.0057
PRONOUN CASE	0.0641	NS	0.0444	0.0357	P=.08	0.0057
S/V AGREEMENT	0.9231	P=.055	0.6895	0.3690	NS	0.2874
SPELLING	2.9487	P=.012	2.1976	1.3333	P=.02	0.9138
REPEATED	0.0256	NS	0.0081	0.0000	P=.041	0.0172
PUNCTUATION	0.2692	P=.09	0.1532	0.2381	NS	0.3046
CAPITALIZATION	0.1282	P=.041	0.0565	0.0952	NS	0.0805
COLLOQUIAL	0.0513	P=.02	0.0000	0.0119	NS	0.0000
SPLIT INFIN.	0.0000	NS	0.0040	0.0000	P=.079	0.0115

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Figure 40 summarizes the number of statistically significantly different means, $P \leq .10$, from Table 24. Overall, the test group has more error types that are significantly lower than the control group starting from the third assignment.

Figure 40. Number of Statistically Significantly Higher Error Types for Each Assignment



VI. INFLUENCE ON STUDENT ATTITUDE

A. SURVEY DESIGN

1. CLASSES PARTICIPATING IN THE SURVEY

Twelve classes of business English classes, from two schools in central Taiwan (one junior college and one university), participated in a comprehensive study of QBL's ability to reduce errors and track error types. Ten of the twelve classes that participated in the QBL study were given the survey. Two of the ten classes were two year students and therefore not included in this analysis, the English background of two year students is much weaker than that of the other students, thus leaving eight classes. A total of 365 responses were collected from the remaining eight classes at both the start and the end of the semester. The response rate was well over 90 percent, as all surveys were administered during regular class time. All students who answered the survey questions were also participants in the QBL error reduction study.

2. PROFILE OF SUBJECTS

Five of the classes were international trade majors, while the remaining three were accounting & statistics majors. A total of 122 accounting & statistics students participated which is 33.42 percent of all the students in the eight classes. Two classes were chosen to be control groups: one from the international trade department and one from the accounting & statistics department. The total control group contained 81 students made up of 32 from accounting & statistics and 49 from

international trade, corresponding to 39.51 percent and 60.49 percent respectively.

The remaining students formed a test group of 284 students with 90 accounting & statistics students and 194 trade students, corresponding to 31.69 percent and 68.31 percent respectively.

3. THE SURVEY INSTRUMENT

The impact of this CAI approach was measured by a pre and post survey administered to the two groups of students. Before and after exposure to the QBL system, students were asked to answer questions concerning their attitudes about their own English and business English skills. For this part of the experiment, a survey instrument was generated that allowed students to indicate perceptions about their own skills as well as their own desires. The questions inquired about skills related to business English. The survey was constructed of seven parts, the first five being objective questions including seat number, sex, and GPA, etc. Parts six and seven were multiple questions using a five-point Likert-type scale. Part six questions dealt with specific English and business English skills, asking the student to rate his/her skill in a range from “very good” (1) to “very poor” (5), thus a lower score indicates a perceived higher level of skill. Part seven contained three questions about the respondent’s attitude towards English and business English. Again the range was from 1 (“very much agree”) to 5 (“not agree”). Lower scores on these questions indicate a more positive attitude. All questions were specifically

asked in relation to English, not the students' native language, Mandarin. Figure 41 shows the actual survey instrument.

Figure 41. The Survey Instrument

Please answer these questions about yourself.				
Your Seat Number:	<input type="text"/>	1		
Your Sex	Male Female	2	What Year Student Are You <input type="text"/>	
			3	
What Was Your Grade In Business English Class Last Semester	<input type="text"/>	4		
About What Is Your Average Grade For all Your Classes (GPA)	<input type="text"/>	5		
Please answer the following questions by marking one of the numbers 1, 2, 3, 4, or 5. The number 1 means you think your ENGLISH skill is VERY GOOD The number 5 means you think your ENGLISH skill VERY POOR.				
	VERY GOOD		VERY POOR	
			VERY MUCH AGREE	
			NOT AGREE	
My English spelling	1 2 3 4 5	6	I Would Like To Study English Writing More	1 2 3 4 5
My Grammar	1 2 3 4 5		I Like To Write English Letters	1 2 3 4 5
My English Sentence Structure	1 2 3 4 5		I Think English Writing Skills Are Important To Get A Good Job	1 2 3 4 5
My English Listening Comprehension	1 2 3 4 5			
My understanding of Business Letters	1 2 3 4 5			
My English skill for Business World	1 2 3 4 5			
				7

The six skill questions included four questions that were most likely to be influenced by the computer system: ‘Spelling Skill,’ ‘Grammar,’ ‘Sentence Structure’ and ‘Listening Comprehension.’ Two other skill questions were included to verify the similarity between the control and test group’s classroom experiences: ‘Understanding of Business Letters’ and ‘English Skill for Business World.’ Part seven questions dealt with attitudes toward business English: ‘I Would Like to Study English Writing More,’ ‘I Like to Write English Letters’ and ‘I Think English Writing Skills are Important to Get a Good Job.’

B. SURVEY RESULTS

1. MEASURABLE DIFFERENCES

Differences in the pre and post survey indicate that there was some measurable effect on student perception as a result of the computer generated feedback. Pre-test means, generated from the first survey, reveal that the control group and the test groups differ somewhat in attitude to start with. Table 25 shows the means from both groups for each question administered before the test was conducted. Four of the nine questions show significant variation between the two groups using an F test. This result is largely contributed to by the smaller size of the control group, two classes compared with eight for the test group, which results in higher variation values in the statistic. Because the objective was to measure the actual change in attitude of each group, and not to directly compare the two groups, the difference in variation was not considered important. (See Appendix G for a full breakdown of survey results)

Table 25. Pre-test Mean Ratings of Students' Perception

Skill/Attitude	Mean Ratings of Test Group	Mean Ratings of Control Group
Spelling	3.26*	3.51*
Grammar	3.45*	3.68*
Sentence Structure	3.48	3.86
Listening Comprehension	3.55	3.76
Understanding of Business Letters	3.48	3.82
English Skill for Business World	3.96	4.16
Like to Study Writing More	2.22*	2.47*
Like to Write Letters	3.05	3.37
Writing Skills are Important to Get a Good Job	1.52*	1.90*

*The two groups' scores were statistically significantly different ($p < .10$) using F-tests.

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Correlation coefficients were generated to test for any correlation between number of errors found in the first assignment and the students' pre-test survey responses. Table 26 shows that there was no strong correlation between the survey responses and the first assignment (homework one: HW1). It would appear that none of the survey questions are good indicators of actual English writing errors.

Table 26. Correlation Coefficients (Pre-test)

	<i>Home- work 1</i>	<i>Sex</i>	<i>GPA</i>	<i>Spelling</i>	<i>Gram- mar</i>	<i>Sentenc e structur e</i>	<i>Listening compre- hension</i>	<i>Business letter under standing</i>	<i>English Skill for business more</i>	<i>Like to study</i>	<i>Like to write letters</i>	<i>English writing skill is import- ant</i>
Home- work 1	1											
Sex	-0.2950	1										
GPA	-0.1403	0.4030	1									
Spell	-0.2638	0.2502	-0.1508	1								
Gram	0.0430	0.0475	-0.2306	0.6122	1							
Sentence	-0.0528	0.0074	-0.3301	0.6392	0.6995	1						
Listenin g	0.0142	-0.0857	-0.3008	0.6233	0.5745	0.6667	1					
BusLet	-0.0605	-0.4102	-0.2529	0.2269	0.1354	0.3314	0.2754	1				
Skill	-0.0718	-0.1934	-0.2704	0.1902	0.2719	0.3127	0.3733	0.3809	1			
More	-0.1346	0.0330	-0.0909	0.0244	-0.0759	0.1154	0.1116	0.2054	-0.0385	1		
Like	-0.1414	-0.1568	-0.1673	0.2741	0.1599	0.3051	0.3174	0.4261	0.3166	0.3944	1	
Importan t	-0.0127	-0.0400	0.0132	-0.0342	-0.0847	-0.1101	-0.0476	0.1680	-0.1166	0.4864	0.1224	1

Multiple regression was performed to test if the number of first assignment errors could be contributed to answers on the pre-test survey. Again, no strong relationships were shown. Table 27 reveals an R square of .016. This means that roughly 1 to 2 percent of the variability in errors for the first assignment (HW1) can be contributed by the responses to the survey, far too small to be of importance.

Table 27. Regression of First Homework with Pre-questions

Multiple R	0.126203771
R Square	0.015927392
Adjusted R Square	-0.012550594
Standard Error	6.246400665
Observations	321

The post survey means were closer to forming a single population than the pre survey with only two questions differing significantly using an F test, see Table 28.

Both groups had completed five assignments by the time of the post survey.

Table 28. Post-test Mean Ratings of Students' Perception

Skill/Attitude	Mean Ratings of Test Group	Mean Ratings of Control Group
Spelling	3.27	3.42
Grammar	3.32*	3.58*
Sentence Structure	3.30*	3.56*
Listening Comprehension	3.43	3.63
Understanding of Business Letters	2.94	2.99
English Skill for Business World	3.59	3.66
Like to Study Writing More	2.25	2.70
Like to Write Letters	2.88	3.32
Writing Skills are Important to Get a Good Job	1.65	2.01

*The two groups' scores were statistically significantly different ($p < .10$) using F-tests.

2. DIFFERENCES IN ATTITUDE OF CONTROL AND TEST GROUPS

Comparing the pre and post test survey means revealed that both groups underwent changes in attitude as a result of business English class and the computer generated feedback. The test group showed significant changes in mean score for seven out of the nine survey questions. For the control group, three of the nine means changed significantly (see Table 29). Both the groups showed a perceived improvement in understanding business letters and English skills needed for the business world. These two areas were most influenced by in-class instruction and

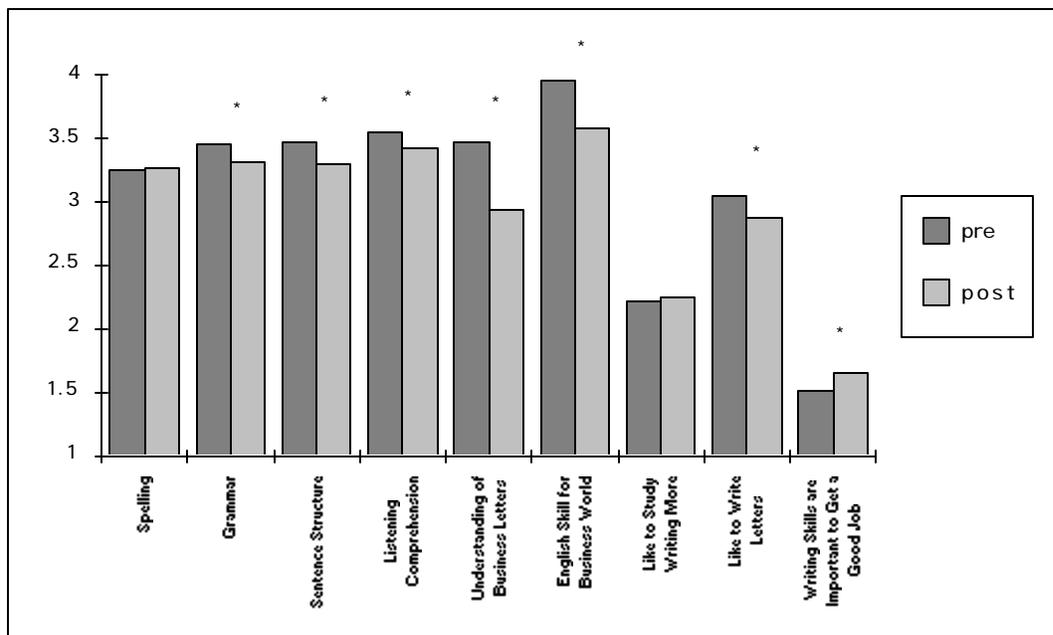
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exercises. Perceived improvement in sentence structure also improved in both groups. Of special interest was the improvement in listening comprehension skill for the test group. Differences in feedback would appear to be unrelated to listening comprehension and the reason for perceived improvement is unclear. Wedell and Allerheiligen (1991) showed a similar change in attitude towards listening ability for students using a computer based writing and correction system. Figure 42 graphically shows the changes in the means of students' responses from the test group, while Figure 43 shows the changes for the control group. Both groups actually show similar trends. This confirms that most influence on students' attitudes comes not from the assignment feedback but from other class factors. The addition of specific feedback, in this case generated by a computer, does accelerate the trends generally seen across both groups.

Table 29. Significance of Changes in Mean Ratings for Test and Control Groups Using a t-Test

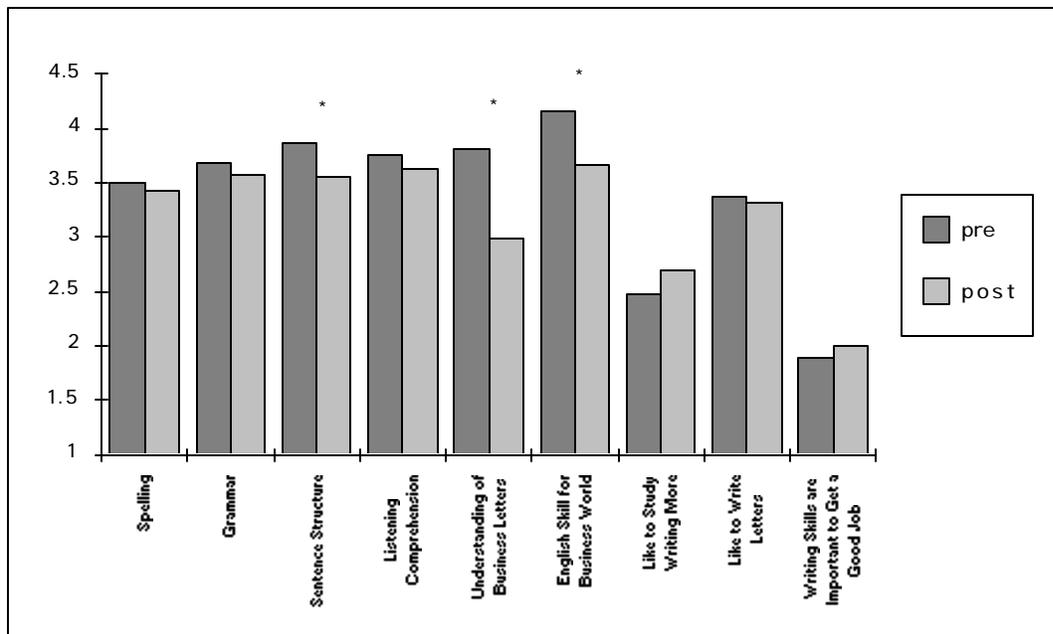
Skill/Attitude	Significance of Change in Test Group	Significance of Change in Control Group
Spelling	NA	NA
Grammar	.025	NA
Sentence Structure	.005	.025
Listening Comprehension	.05	NA
Understanding of Business Letters	.0005	.0005
English Skill for Business World	.0005	.0005
Like to Study Writing More	NA	NA
Like to Write Letters	.05	NA
Writing Skills are Important to Get a Good Job	.05	NA

Figure 42. Change in Response Means of Test Group



*The two means were statistically significantly different ($p < .05$) using t-tests.

Figure 43. Change in Response Means of Control Group



*The two means were statistically significantly different ($p < .05$) using t-tests.

C. INFORMAL OBSERVATIONS

Interviews with participating students showed that they were interested in viewing the computer generated feedback. They also generally found the QBL Student

Version program to be interesting and useful for writing their assignments.

Students stated that they did in fact change their approach to completing the assignment in order to improve their grades. However, since all grades were based on the final draft turned into the instructor, simply depending on the computer was not satisfactory. Students generally completed their work early and sought classmates for proofreading.

Although not all classes that participated in using the expert system were actually included in the statistical study, some useful observations can be made from these excluded classes. For example, night school students generally have a lower English ability than their daytime counterparts. Night school students, however, have much more working experience and some even use English on the job. A general observation is that night school students were very surprised at the number of errors in their writing. They often worked in groups, outside of school or during non-English class times, to create drafts and proofread. Day school students, on the other hand, seemed to cooperate to a lesser extent and expressed more interest in being given more specific solutions to correcting their errors.

Upon returning homework assignments, including feedback, students in both day and night school would form small groups of three to six people and begin discussing what errors had been found and what the causes were. This was without the prompting of the instructor and took place while homework assignments were still being returned. Students realized that solutions to writing errors could be better

found and understood through peer discussion. Although the same behavior may take place, to some extent, with teacher generated feedback, the sheer volume of computer generated feedback reveals the advantages of using the expert system. Students in the control group also tended to work in groups, but to a lesser extent than the test group. The lack of specific error feedback (the treatment withheld from the control group) made such work more difficult and less rewarding for students in the control group.

VII. CONCLUSIONS

A. SUMMARY OF STUDY

Numerous studies have investigated the influence that computer use has on students' attitudes and skills. Results have generally been mixed, in part due to unavoidable problems with experiment design (Pearce & Barker, 1991). This experiment addressed these problems by stringently controlling most factors influencing students in both a control and test group. Rather than measuring the impact of computer use, the influence of very specific computer generated feedback was measured. With all differences between the two groups removed, including the actual grades assigned, any difference in attitude or error rates could be directly attributable to the computer generated feedback. This study did not test how the specific expert system would be used in a classroom setting. Instead, a more conservative approach was taken so as to minimize differences between the control and test groups. All grading, teaching, assignments and other forms of feedback were kept exactly the same in both groups. Under such conditions, any results which show differences in errors between the groups can more confidently be attributed to the specific computer generated feedback.

Results support the finding that CAI can have a positive impact on student attitude.

Both control and test groups showed trends of improving their perceived skills.

More specifically, the returning of computer generated feedback was shown to

increase the improvement of students' actual error rates as well as their perceived abilities in most measured areas. Rather than radically changing any trends, such feedback tended to reinforce existing trends.

Such similarities may actually be a reflection of the similarity of the classes thus confirming that differences between classes were minimized. We cannot overlook the fact that all participating students were motivated to obtain the highest grades possible and that both test and control groups were continuously in close proximity to each other. A certain amount of exposure, of control group members to the test group's feedback, must have taken place. Once again, such a situation would only reinforce the validity of any differences found as such influences would tend to minimize differences between the groups.

B. RESEARCH FINDINGS

1. EXPERT SYSTEM DEVELOPMENT

The specific five hypotheses described in 1990, dealing with the development of an expert system, can now be reexamined:

1) Complex programs, such as an expert system, can be developed with limited funding from the host educational institution (preferably near the amount of zero dollars).

The completed expert system, including QBL TOOLS and QBL Student Version, incurred the direct cost of the development tools, i.e., QuickBASIC and Visual

BASIC. These tools were made available through the author's school's computer department. No other costs were incurred directly in development, beyond the actual man-hours spent in design and coding. Actual man-hours ranged from between 1500-1800, not including teacher training and follow-up debugging. Although certainly no small amount, such costs will decline as object oriented programming languages become more object based and less reliant on coding. For example, since development was begun on the DOS based QBL Student Version, Microsoft released Visual BASIC for DOS. This is an object oriented programming environment for DOS and its use would certainly have cut development time significantly.

Cost of using the expert system was also kept to a minimum, requiring no expenditure from the host institutions, through the application of a unique distribution system. Each student purchased the 360K disk, including the QBL Student Version program and user's manual, for NT\$100 (approximately US\$4). This price was sufficient to cover the expense of the student's disk, manual, teacher's program disk (QBL TOOLS) and user's manual (to date, the system has been used at five educational institutions, consisting of over 2500 students).

2) Such software can be created in a short amount of time (a six month period, from conception to completion, for a single program).

The actual design and coding required approximately one semester for each of the two programs developed. However, approximately one more year, two semesters of testing, were required to remove coding errors and design inconsistencies. Whether this length of time is normal for debugging or was caused by the author's lack of programming experience is not clear.

3) Instructors of English, with little programming experience, can create the needed coding for such software.

By first understanding the new, easy-to-use, software development tools, teachers have the opportunity to create specialized software. The breakthroughs made by Windows, in OLE (Object Linking & Embedding) and DDE (Dynamic Data Exchange), allow a teacher to actually use existing programs in combinations and ways not predicted by the original developers. In this case, the already developed packages of Grammatik and MS Excel were directly accessed in order to increase the ability and professional appearance of this study's customized software, while greatly reducing development time. The recent release of Microsoft's improved standard, OLE 2.0, makes linking of programs easier and more efficient (Kennedy, 1994). Even more exciting is the inclusion of a Visual BASIC language in new release of Microsoft programs (named Visual Basic Applications Edition, VBA). In essence, this means that a commercial program can be used to open and control other programs, e.g., Excel 5.0 opens Word 6.0, types in some text and then creates a graph that is then copied and pasted into Viso, etc. (VBPJ Staff, 1993). As other

vendors follow Microsoft's direction, teachers will have increased opportunities to create customized software as programs become building blocks that can be put together in an infinite variety of ways.

4) Software can be created that matches the unique needs faced in a Taiwan business English class setting.

By working closely with the instructors who were to use the software, the QBL expert system met most of the expectations of the users (both students and teachers). Research showed that students' attitudes about their own business English writing skills increased significantly more than students not using the expert system (Warden, 1994). Although measuring success in a general fashion is slippery at best, feedback from instructors has been positive and numerous inquiries into adopting the system have been received from around Taiwan. Ongoing research will look into the specific results of using an expert system in an EFL writing class.

5) Customized software can have the "look and feel" of new commercially available "user friendly" software (specifically the use of professional appearing GUIs).

Modern programming tools have made it possible to create totally professional appearing programs. The QBL TOOLS interface has been examined by professional programmers with no objections about the interface. In fact, when

asked to guess what programming language was used for development of QBL TOOLS and QBL Student Version, professional developers consistently think C language was used. Issues such as speed, responsiveness and memory management really do not negatively impact programs developed through these BASIC development tools.

During testing, users familiar with the Windows interface had no difficulty understanding the interface or the user's manual. Users not familiar with Windows did have more difficulty as the concept of mouse usage to control buttons and windows is fundamental to QBL TOOLS. The obvious shortcoming of object oriented programming is the GUI environment itself. Although easier to use than past environments, it still is not 100 percent intuitive and requires some learning time.

2. ABILITY TO ACCURATELY CORRECT SOME ERRORS

There is no doubt that Grammatik 5 finds many English errors of students.

Furthermore, the use of Grammatik 5's expanded database greatly enhances its application in EFL settings such as those found in R.O.C. English classes. The ability of a teacher to find the same errors that Grammatik 5 finds is also not in question. The advantage of a technologically based approach lay in the fact that an automated system, such as the one used in this study, can continuously find the same errors over hundreds of students' papers and many different assignments.

Seen in the light of large class sizes, automated systems present an opportunity to introduce some objectivity to student feedback. Such a system also offers to increase the number of assignments that can be handled effectively by a teacher. The removal of the need to find small repetitive errors, can also contribute to a teacher's feeling of self-fulfillment as he/she may spend more of the grading time actually looking at more advanced subject matter—such as concepts contained in the homework (Noel & Wysocki, 1990).

3. ACTUAL ERROR REDUCTION

The full study showed that even while most factors were kept constant between the two groups, the group of students receiving computer generated feedback lowered errors significantly more than the group not receiving the feedback. The original hypothesis stated as:

6) Feedback generated from such an expert system can have measurable and statistically significant effects on students' writing.

is thus proven to be true. The advantages to such a finding are obvious in that time spent in finding specific objective errors can be reduced and redirected to more process oriented instruction. There also is evidence to support the assertion that simply by supplying computer generated feedback, errors tend to be reduced at a constant rate, i.e., a slope of approximately -1.2. This occurs with no other special instruction or reinforcement. When constraints such as class size and heavy

workload face an instructor, this independent decline in errors, requiring no extra work on the part of the instructor, can be a valuable tool.

4. ABILITY TO MEASURE STUDENT PROGRESS

A further benefit of automated correction is the ability to make and save specific measurements. Because all students' assignments and feedback are saved on floppy disks held by the instructor, progress can be tracked, not only for a semester but for many years. Further detailed analysis, over a long period of time, can reveal important trends such as:

- 1) Errors common to specific business letter types
- 2) Errors common to specific student groups
- 3) Errors resistant to reduction
- 4) Errors easily reduced

This study revealed that while overall reduction in errors does take place, specific error types do not neatly follow such trends. Although general error reductions naturally impact specific error types, it is clear that each business letter has its own predisposition toward specific error types.

For the ten most common errors, the pattern of error reduction followed by both groups is similar with the control group (specific feedback withheld) having a higher rate of errors 26 percent of the time. Once again, what we see here are pre-existing

trends that are somewhat amplified by the returning of the specific computer generated feedback.

Hypothesis seven, stated as:

7) An expert system can inform instructors what the most common type of student writing errors are, thus helping to form a more specific curriculum.

was found to be true as detailed statistics were gathered on very specific error types. The instructors who used the QBL TOOLS system also found that the summaries of a class' errors were helpful in directing what areas of English writing needed special attention during class.

5. RELATIONSHIP BETWEEN STUDENT AND EXPERT SYSTEM

Results support the finding that CAI can have a positive impact on student attitude.

Both groups showed trends of improving their perceived skills. More specifically, the returning of computer generated feedback was shown to increase this improvement of students' perceived ability in most measured areas. Interviews with selected members of each group showed that there was an interest in seeing the computer generated feedback. Additionally, students did consciously change editing practices in order to prevent errors. Assignments were begun early in order to leave time for proofreading and to avoid last minute problems with computer and/or floppy disk.

From the instructors' view point, fewer students turned work in late. Most importantly, all completed assignments achieved a much higher level of professionalism as far as appearance and general quality than the work of students not participating in the study. Students with more working experience, but a lower English ability, expressed surprise at the number of errors in their writings. For all students receiving computer generated feedback, group work was fostered as students had many specific errors to discuss with peers.

Lastly, Hypothesis eight, stated as:

8) Exposure to computer generated feedback influences students' attitudes about their own abilities as well as their desires and interests in writing English.

was also found to be true as significant differences were found between the control and test groups' pre and post responses.

C. IMPLICATIONS FOR WRITING CLASSES

While most teachers would agree that more frequent writing assignments can help EFL students, it is often not practical for an instructor to deal with the normal class size of 40 to 70 students. The evidence that simply using a computer based writing system, such as a word processor, has some positive impact on students' writing skills has been shown, to some extent, in research to date. Importantly, it is clear

that computers now play a central role in the workplace. Preparing students for using computer writing tools is helpful from the perspective of workplace efficiency.

Encouraging students to complete their writing assignments on personal computers, using non-network based software, is effective in dealing with the problems of inconsistency in large class writing assignments. Students can be repeatedly exposed to the normal letter writing formats, guided by the software, while using computer editing features that have become standard in the workplace environment.

Business English instructors can take advantage of a low cost and medium level technological solution to the basic problem of correcting assignments presented by large writing classes. With no interference to individual teaching methods or traditions, a computer based correction system can supply effective feedback to students while having a generally positive influence on student attitudes and error rates.

When reviewing the results of our initial questions, we can conclude that this project was a success. The expert system, however, developed by the author, does share the shortcomings of most expert systems in existence today, summarized by Fischler and Firschein (1987) as:

- 1) Lack of true learning capability
- 2) Lack of ability to generalize
- 3) Lack of causal explanation

4) Lack of reasoning

5) High level of fragility (because the system is so narrowly focused)

Solutions to each of these problems are being sought and certainly advances have been made in just the few years since this list was compiled. In the case of specific custom applications, it is important to understand exactly what the computer software can and cannot do. By applying the computer to areas where it can function well, without interfering with an instructor's traditional teaching pedagogy, learning can be enhanced. Just as an overhead projector is not a replacement for a blackboard and chalk, CAI or CALL (Computer Assisted Language Learning) is not a replacement for other teaching tools and modalities. An analogy may be helpful in understanding the role an expert system can play in R.O.C. writing instruction:

It may be the case that the use of computer generated feedback acts in a similar manner as a referee performs in a basketball game. The referee does not assist either team in winning, but he/she does enforce the ground rules making sure that each team lives up to a minimum standard (no personal fouls, no walking with the ball, etc.). The expert system laid down rules that were clear to the participants of this study, i.e., English errors in the areas of grammar, mechanics and style will be consistently flagged. Students could, for the most part, count on unattended errors patterns being found again in the next assignment.

A referee does not insist on either team playing the game at a high level of skill, only that the rules must be followed. Needless to say, a team that desires to play basketball at a high skill level, must first overcome errors that interfere with their success. It is no surprise that in a basketball game, the team with many more rule violations has a difficult time to overcome such problems and win the game.

Students who understand the error patterns found by the expert system can then go on to develop their writing skills, or they may not. This question is in the realm of teaching methodology used in class by the instructor. It is the case, however, that students who persist with these error patterns, actually reinforcing them (fossilization) as they study writing, will have a much more difficult time to develop into good writers.

Of course, one can argue that a good game of basketball can be played with no referee present. This is true of highly motivated players with little or nothing at stake. However, when a reward or punishment awaits the players, it is only a matter of time before rules are readily violated with confidence that such violations will have no repercussions. Similarly, we, as business writing instructors, are asked to appraise students' ability and differentiate between skill levels through the application of grades. Results of such appraisals are then expected to be used as accurate indicators for success in the business environment vis-à-vis English business writing. The reality of teaching in the R.O.C., with large class size, general

emphasis on testing, grade assignments and the overall English language teaching pedagogy, informs us that students will perceive (whether it exists in reality or not) that a reward or punishment awaits them.

The results of high spelling errors on the first assignment, for both the trial and the full studies, show that students do not worry about the presence of a referee. After years of studying vocabulary, these students simply are not worried about spelling errors in their writing (although they may be very concerned about spelling errors on standardized tests). A case could be made that the behavior of writing with errors has simply been reinforced through writing classes that do not give students accurate, consistent nor intelligible feedback on such errors. In the R.O.C., it is even common that business writing classes avoid the problems associated with writing English by simply working on word-for-word translations from Chinese to English. Again, such behavior can only reinforce the view that errors have little importance, since the goal is to create Chinese sentences that contain English words. A survey of the most commonly used business English textbooks, in the R.O.C., will quickly reveal that English sentences with numerous errors are often used as examples of good writing and the idea of direct translation is consistently reinforced as a valid technique for writing English business correspondence.

The application of an expert system, such as the one studied here, can give instructors an opportunity to move away from the problems cited above. We cannot wait for, nor may many people even desire, the assumptions surrounding R.O.C.

business writing classes to drastically change. Rather than continually blame all instructional difficulties on large class size, it is time to address this problem through the careful application of CAI and CALL technology. If technology can reduce, even in a small way, the teaching difficulties we now face, instructors will find more opportunities to apply the process teaching modalities that have become widely accepted in language instruction around the world.

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