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ABSTRACT

Designed to present a rationale for evaluating the implementation of computer assisted instruction (CAI) in higher education, this paper describes a multi-paradigmatic approach to the evaluation of CAI pilot implementation efforts and its application in various math and English courses at the New York Institute of Technology (NYIT). Students in two math courses--Developmental Math and College Algebra--and four different English courses--Communication Skills, Composition, Business Writing, and Technical Writing--spent significant portions of class time working in a microcomputer laboratory utilizing Apple/Franklin and Commodore 64 computers. Evaluations of instructional effectiveness focused on a process analysis, but a quantitative evaluation was also conducted. Included are discussions of: (1) CAI and student role changes; (2) CAI and faculty role changes; (3) faculty professional development; (4) points unique to the math experience; (5) points unique to the English experience; (6) student attitudes toward computers and math CAI; (7) students' perceptions of word processing in the learning of writing; and (8) unanticipated negative consequences. Findings indicate that: CAI students demonstrated a good conceptual grasp of subject matter; their difficulties were identified quickly; they often worked in pairs, which provided mutual support; and faculty were able to interact individually with students, observe the learning process closely, and intervene directly and immediately. (JB)

TOWARD A MULTI-PARADIGMATIC APPROACH TO EVALUATION OF CAI: EXPERIENCES FROM THE N.Y.I.T. COMPUTER-BASED EDUCATION PROJECT *

By

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CONTENTS

INTRODUCTION

The purpose of this paper is to present a rationale for evaluating the implementation of CAI in higher education. We refer to this rationale as multi-paradigmatic since it seeks to inte-grate multiple paradigms or approaches to evaluation research. Briefly, we are arguing for the complementary uses of experimental and case study designs, the merging of outcome and process analyses, and obtaining qualitative as well as quantitative data. Furthermore, change is assessed at various levels--including student, faculty, and institutional.

We view computer-based interventions as complex and systemic in nature. They affect basic teaching-learning roles, curriculum contents, and the very structure of educational delivery. Therefore, we feel that it is essential to use multiple research designs, data sources, and assessment criteria. It is especially important that the research questions seek to obtain information on so-called "unanticipated consequences" (both positive and negative) of CAI interventions.

We will illustrate the application of our multi-paradigmatic approach to the evaluation of the CAI pilot implementaion efforts in various math and english courses at N.Y.I.T., in connection with the Title III grant from the USDOE. Our objective is to convey the evolutionary nature of our approach. That is, it is not a fixed model or finished product. Our ideas about how to approach the issue of CAI evaluation are constantly changing with additioanl experience.

Overview of 1983-84 T-3 Intervention Procedures

During the 1983-84 academic year CAI was introduced into two math courses-Developmental Math and College Algebra (3004 and 3011) and four different English courses-Communication Skills, Composition, Business Writing and Technical Writing (1005,1010 1042,and 1043).

Significant portions of class time were held in the microcomputer laboratory. Math students used Drill and Practice programs and LOGO based problem solving on Apple/Franklin computers. English students used word processing software on Commodore 64 computers. "Free Acess" hours to the lab were allowed for student assignments.

Given the wide variations of faculty implementation of CAI and diverse student backgrounds, we decided to focus our evaluation on a process analysis. However, in keeping with the multi-paradigmatic rationale, we also conducted a quantitative evaluation to complement the process evaluation. We begin our discussion with the process analysis.

PROCESS ANALYSIS

Research Procedures

Four primary sources of data provided the basis for our process analysis: (1) faculty interviews, (2) faculty end-term experiential questionnaires, (3) student end-term experiential questionnaires, and (4) laboratory observations of CAI in action. These data give a sense of the rich contextual nature of computer-based interventions and, we believe, suggest guidelines for implementing computer-based projects in other settings and in different disciplines.

Findings

We have selected some of the more salient findings pertaining to both Math and English.

CAI and Student Role Changes. Faculty observed the following changes in student role as a consequence of the CAI experience:

* CAI students demonstrated a better conceptual grasp of subject matter.
* CAI induced a more active and participatory role in learning.
* CAI students asked more questions.
* Students reported a sense of mastery due to their ability to control the computer.
* Greater perseverance at math problem-solving and at revising and editing English writing assignments was reflected in many students' working after lab sessions were over.

* Student difficulties were often identified sooner than usual and addressed more quickly.
* CAI encouraged more independent work.
* At the same time, CAI students often worked in pairs, providing peer-based mutual support.
* Peer-teaching led to greater social cohesiveness and created a positive social climate among students.

Some of the above changes were due to the uniqueness of the computer experience itself, while others (e.g., increased peer support) were more probably consequences of the lab setting.

CAI and Faculty Role Changes. The CAI experience led to changes in faculty role as well:

* The lab experience allowed faculty to observe the learning process more closely and to intervene more directly and immediately.
* A greater number of individual interactions with students resulted.
* New ways of explaining important concepts emerged as as consequence of the computer's requirement that problems be broken down into logical segments.
* In lab setting, the professor tended to become more a facilitator of learning than an authoritative lecturer.

It is clear that these faculty changes are potentially far-reaching and are likely to translate into new patterns of faculty-student interactions, besides stimulating more active student learning.

Faculty Professional Development. The impact of the CAI experience on faculty development was multi-faceted and dramatic. Some consequences of Title III participation were:

* Learning a new teaching skill, i.e., CAI.
* Gaining new insights into the teaching of math problem solving and the writing process.
* Feeling a sense of rejuvenation about teaching mathematics and writing, especially in the difficult developmental courses.
* Participating in the design of original microcomputer software and accompanying instructional materials.
* Participating in research on CAI.
* Acquiring some programming skills.
* Achieving visibility and gaining recognition on campus for computer-related activities.
* Collaborating with colleagues from other disciplines.
* Presenting conference papers on their CAI experiences.

Since faculty are the primary mediators of students learning, their new professional development will, in the long run, contribute to improved student learning. Furthermore, we view such faculty development as crucial in catalyzing institutional change. Such change will, no doubt, include larger-scale adoption of computer-based educational delivery systems. In turn, these new delivery systems should continue to facilitate student learning.

Points Unique to the Math Experience.

* Commercial software was excellent for first-semester developmental math students. Its ease of use and structured formats provided an excellent introduction for inexperienced students. As students became experienced with CAI and more sophisticated mathematically, commercial programs were of less interest. The drill-and-practice nature of such programs has time-limited appeal.
* LOGO, which offers possibilities for free exploration, filled the gap of failing student interest and introduced a much broader dimension in CAI.

Points Unique to the English Experience.

* The use of word processing added a new kind of "writing workshop" into the course.
* Student writing became more public on the computer monitor and more accessible to change during the writing process; faculty moved from station to station providing immediate feedback.
* Students tended to produce longer and more ambitious papers and carried their papers through more revisions than in a conventional course.
* The longer essays and greater number of revisions placed an extra burden on the faculty.

Student Attitudes Toward Computers and Math CAI.

Students' attitudes toward computer use were, overall, very positive. Several general observations emerged from their responses to the questionnaire.

* The overwhelming majority of students saw the computer as helplful, useful, and necessary.
* The computer was viewed as providing a structure for organinzing learning--requiring studnets to proceed sequentially and carefully through the problem-solving process.
* CAI permitted more opportunities for practice on math problems and exercises.
* CAI was seen as providing immediate feedback--reinforcing correct responses, pointing out errors, and guiding correct problem-solving.
* Computer exercises assisted in studying and in preparing for exams.
* The computer appeared to stimulate greater perseverance, yielding longer task-performance periods.
* The computer appeared to engender greater interactivity, responsibility, and accountability in the learning process.
* Some students felt "burdened" at the outset of the CAI experience by the extra demands placed on them.

Students Perceptions on Word Processing in the Learning of Writing.

The following patterns of observation emerged.

* Word processing aided mostly in revising and editing.
* It was viewed as making writing more fun.
* It helped students pull ideas together.
* It was seen as making writing easier.
* It saved time.
* Word processing made grammar and spelling errors more visible.
* It allowed concurrent comparisons of multiple versions.

Unanticipated Negative Consequences

* Hardware problems continually plagued the English faculty especially, costing class time and causing much frustration over the unnecessary loss of student work.
* Weaker students required much guidance in learning to work with the hardware, the menu-driven math software, and word processor.
* Free exploration of LOGO applications proved difficult for weaker students.
* The developmental students (1005) took longer to learn word processing than those whose language skills were already at college level. A significant number (33%) required over 4 weeks.

* Most of the advanced students (those in the technical and business writing course) required fewer than 4 weeks.
* Likewise for math, developmental students (those in 3004) took longer than more advanced students (those in 3011).
* Approximately 50% of developmental students required 4 weeks for computer comfort, while 33% required more than 4 weeks.
* The majority of advanced students required fewer than 4 weeks for computer comfort.

QUANTITATIVE ANALYSIS

The purpose of the quantitative pilot studies was to determine the sensitivity of our assessment instruments, the appropriateness of the dimensions (variables) targeted for assessment, and the utility of our quasi-experimental research design.

Research Procedures

Quantitative data were obtained within the context of a quasi-experimental design. Where feasible, we employed additional sections of the same course not exposed to CAI to serve as comparison groups. No special designations were noted in the college course catalogue to indicate a CAI section, thus minimizing self-selection to the extent possible.

The following is a listing of the measures obtained on students in the experimental and comparison classes. Most of the information was gathered through administration of an assessment package during the first (pre) and last (post) weeks of the semester. Final grades and retention data were obtained archivally (i.e., from official college records).

TABLE I

LIST OF STUDENT VARIABLES

Mathematics
Attitude Towards Computer Scale (Pre and Post)
Computer Literacy Test (Pre and Post)
Attitude Towards Math Scale (Pre and Post)
Diagnostic Exam (Pre and Post)
Final Grades (Post)
Retention (Post)
Demographic Information (Pre)
English
Attitude Towards Computer Scale (Pre and Post)
Computer Literacy Test (Pre and Post)
Attitude Towards Writing Scale (Pre and Post)
Final Grades (Post)
Retention (Post)
Demographic Information (Pre)

Findings

Math

A significant pre-post difference emerged on the Math Diagnostic Test for Math 3004, indicating a positive gain in knowledge. Only this one experimental class was administered the pre-post diagnostic exam during Spring, 1984. In the current semester, Fall, 1984, all CAI and conventional math classes were administered a revised diagnostic exam. This will make our current outcome research more meaningful.

No significant pre-post changes emerged between the CAI and non CAI classes on the Attitude Toward Computer and Math Scales and the Computer Literacy Test.

We compared grades and retention for Spring, 1984, math CAI and conventional classes. The mean grade for CAI classes was 2.54 versus 2.12 for comparison classes. The percentage of course withdrawals for CAI classes was 27%, compared to 36.82% for non-CAI classes. We have refrained from a statistical analysis, because the conventional and CAI classes were not equivalent. However, the trend does appear to favor the CAI intervention.

English

No significant pre-post changes emerged between the CAI and non CAI classes in the Attitude Towards Writing Scale, Attitude toward Computer Scale and the Computer Literacy Scale.

Concerning grades and retention the data was not conclusive. The mean grade for CAI classes was 2.47 versus 2.37 for comparison classes. The percentage of course withdrawals for CAI classes was 18.89, compared to 15.99 for non-CAI classes.

We cannot draw any conclusions from these data because the groups were not truly comparable. Furthermore among the

CAI classes widely divergent student populations were represented and instructor interventions were not standardized.

We did not include a standard diagnostic measure last year. However, we are experimenting with a Standard Writing Diagnostic Measure during this current, Fall, 1984, semester, making outcome research more meaningful.

Discussion

The issue of grades as an index of outcome in measuring the effects of CAI needs to be addressed at this point. There is no clear basis to expect overall improvement in grades due to the CAI intervention because the intervention only encompassed a fraction of class time and work, while grades are based on 100% of the work.

Furthermore, assignment of final course grades do not adhere to a standard criteria across classes, as different professors vary in their grading procedures.

In addition, since CAI and non-CAI classes cannot be matched in a quasi-experimental design, there is no control group to provide a true basis of comparison. Even more so, the conditions cannot even be created through random assignment. Thus, differences between groups exist on such variables as native ability, motivation, time available to study, personal problems, and interest in CAI. The above factors are more likely to contribute to attrition -- more so than being in a CAI or non-CAI class.

The nature of our CAI intervention is such that it does not "teach to test." Rather, a more general problem solving tool (in the case of math) or writing tool (for English) constitutes the core of the intervention. It follows, therefore, that grades are a very narrow indicator of CAI success. This rationale also applies to the diagnostic test (reported for math). We plan to test the impact of CAI on creative problem solving, on learning to learn, and on conceptual abilities.

Concerning the attitude measures two major factors can explain the general lack of between group difference. First, the intervention was not geared to inducing such attitudinal changes. Second, our instruments may not have been sensitive enough to detect subtle changes in attitude which have occurred, as we discussed earlier in this report.

Also, it should be pointed out that great variations existed in the implementation of CAI among the professors. This was purposely left unstandardized so that each faculty member could adopt his/her own style for experimenting with CAI. This fact also made it difficult to rigorously evaluate outcome at this time.

Finally, concerning retention, we feel that the prescence of CAI will, over time, attract more qualified students to NYIT, and thereby reduce attrition.

In conclusion, we feel that CAI shows great promise for teaching students both academic and real-world work skills. As a career oriented institution it is to our advantage to continue the incorporation of CAI in various disciplines.

The microcomputer is emerging as a powerful aid for presenting and organizing factual material across many disciplines. As a more advanced problem-solving tool, the features of the computer are indeed unique and require our further exploration.