# THE IMPORTANCE OF QUALITATIVE DATA COLLECTION ON STUDIES ASSESSING THE EFFICACY OF COMPUTER-FACILITATED INSTRUCTION

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### ABSTRACT

Traditional instruction in developmental Math course was compared to computer-facilitated instruction using Prentice-Hall's Interactive Math computer program. Two groups of students were used, a control group receiving traditional instruction, and an experimental group using the interactive math software. Toward the end of the semester, qualitative interview data were collected from a subset of subjects and from the course instructor to clarify instructional methods and procedures and provide insight into quantitative findings. Both groups realized improvements in following mathematics achievement instruction. However, while the attitude of the control group toward math learning remained the same, that of the experimental group was greatly improved over the course of instruction.

Analysis of the qualitative data within the context of educational theory revealed that the computer-facilitated instruction was not implemented in a manner designed to make the best use of this instructional modality. The results concerning mathematics achievement cannot be said to denote the superiority of traditional instruction. These findings highlight the importance of collecting qualitative data in otherwise quantitative computer-facilitated studies assessing instruction. What was revealed, however, was a significant improvement in students' attitudes towards learning math. Those using the interactive math program experienced far less math anxiety. Their stress level was reduced and their confidence greatly enhanced.

**Keywords:** Qualitative Data, Computerfacilitated instruction, Attitude toward Math, Interactive Math

### **1. INTRODUCTION**

In an increasingly multicultural educational environment, strategies which accommodate different learning styles, instructional preferences, and educational aims are increasingly important. By undertaking research which will help instructors understand how to best use computerfacilitated instruction, we can ensure that all Mathematics students have the opportunity to make the most of their abilities.

Many studies have shown computerfacilitated instruction to be very beneficial in the teaching of mathematics, with positive effects on attitudes toward mathematics. More research is needed to identify the specific types of programs and instructional circumstances in which computer-facilitated instruction produces superior results, especially as increasing numbers of instructors and programs consider the implementation of computer-facilitated instruction.

Qualitative data can provide invaluable insights into many of the reasons behind quantitative results. With these insights, researchers can better understand important aspects of computer-facilitated instruction, such as issues concerning implementation, which will ultimately deepen the overall knowledge base in the field.

Ellison, Sheets and Lai [1, 2, 3] all collected qualitative data to research the potential differences in achievement between

students taught via traditional methodology and students taught with various computerfacilitated and similar technological methods. They found significant differences between the two groups favoring the computer-facilitated instructional groups. Schwarz and Hershkowitz [4] used qualitative data from a multi-year curriculum change study to assess the effects of computer math tools on concept development and formation among junior high school students. They found that the students who were taught with technologically-based instructional techniques developed richer concept images.

While qualitative data can provide insight into mathematics achievement regarding the use of computer-facilitated versus traditional instruction, they can also lead to a greater understanding of students' attitudes toward mathematics. This is an essential line of inquiry, as the body of research clearly demonstrates that attitudes towards math and motivation to learn math do, in fact, impact math achievement [5, 6]. The advent of computer-facilitated instruction in mathematics has brought a wealth of studies concerning the impact of educational technology upon attitudes, motivation, and related constructs.

Schrock [7], Reglin and Butler [8], Alkalay [9], and O'Callaghan [10], in their qualitative studies of attitudes toward mathematics, discerned improvements in both confidence and attitudes toward math in students taught via computer-facilitated instruction as opposed to those taught in traditional instructive environments.

Qualitative data have also been used to better understand mixed study results. Kinney [11], when comparing the use of lecture-based and computer-mediated classes in developmental mathematics classes. discovered that while no significant differences were found in terms of scores on exams, course satisfaction levels were significantly higher for students in the computer-mediated lecture-oriented classes, in part because students in the computerfacilitated classes had more perceived control over their own learning process. French [12] utilized both qualitative and quantitative techniques to examine attitudes toward mathematics in relation to computer-facilitated

instruction in a college precalculus course. While quantitative measures did not detect a difference in attitudes to math between the treatment and control groups, qualitative measures indicated that the treatment group students developed significantly more positive attitudes.

This study used both quantitative and qualitative methods to compare the performance and attitudes of college algebra students taught by means of computerfacilitated instruction to their peers taught by traditional methods to see if statistically significant differences would emerge between the groups. There were two hypotheses. It was hypothesized first that the appropriate implementation of computer-facilitated instruction would result in better performance among college algebra students, and second that such implementation would result in more positive attitudes toward math among college algebra students. While the data did not support either of these hypotheses, a full discussion of possible reasons points to interesting directions for the future.

# 2. METHODS, DESIGN AND PROCEDURE

The participants in this study were N=52 students registered for four sections of Developmental Mathematics / Basic Algebra at an urban public university in the south of the United States. Two of the sections were assigned to the control group (traditional instruction) while the other two sections were assigned to the experimental group (computer-facilitated instruction). All sections were taught by the same instructor.

Participants were given the revised version of the Aiken-Dreger Mathematics Attitude Scale questionnaire [13]. Participants were also given a pretest of existing mathematics skills and knowledge. A panel of three mathematicians examined and reviewed the content for validity and relevance. The posttest reflecting post-instruction mathematics skills and knowledge was the final exam for the course, and was determined by the instructor. The same exam was given to all participants.

Both control and experimental group members completed a take-home test and the

Aiken-Dreger Mathematics Attitude Scale questionnaire both before and after the semester of instruction. Students in the control group received traditional instruction in basic algebra, including three hours of lecture plus two hours of lab per week. Students in the experimental group received computerfacilitated instruction consisting of three hours of required computer lab time per week and an optional number of additional hours either in the lab or online. During each of three required hours, the instructor typically lectured for 20 to 30 minutes, gave a computer assignment, and then walked around the room providing individual assistance. For two of the three required hours, a graduate student teaching assistant was also available to answer questions and offer assistance.

Toward the end of the instructional term, three to six students from each group were interviewed. Interviews were designed according to Strauss and Corbin's [14] Grounded Theory. Qualitative data were collected consistent with Jantzen [15] and Pilliero [16], and have been used to good effect in previous research concerning the effects of mathematics instruction (e.g. Ellison [1]; Sheets [2]; & Zbiek [17]). Following the term, the instructor was also interviewed. At the close of the term, following all instruction, all students took a final pencil-and-paper exam devised by the instructor.

### 3. QUALITATIVE FINDING, AND DISCUSSION

Both groups realized improvements in mathematics achievement following instruction. However, the degree of improvement for the control group was significantly greater than that of the experimental group. In addition, the total mathematics achievement, as measured by the post-test scores, was significantly greater for the control group.

The gain scores of the students taught in a traditional classroom were not significantly higher than the gain scores of the students taught using <u>Interactive Math</u> software. The attitudes of the control group did not change significantly, but the attitudes of the experimental group did become significantly

more positive in the course of instruction. Six students from each group were interviewed.

Most students answered affirmatively when asked if what was learned in the course would be useful later in life. When asked whether their attitude toward mathematics had changed since taking the course, the overwhelming majority of students in both groups answered that it had become more positive.

Students in the experimental group were asked their opinion of the software. Most students indicated a positive opinion, with many citing the innovative or "interesting" aspects of the software.

Students in the experimental group were divided concerning whether they might have picked up the same skills in a traditional classroom environment. Some said yes but others remembered previous failures in traditional classrooms. Most expressed the opinion that whether or not one learns in a specific environment depends upon individual characteristics (i.e., learning style or learning preferences).

Students in the traditional group were divided concerning whether they felt they would personally obtain the same benefits from a computer-facilitated environment. Most expressed the opinion that whether or not one learns in a specific environment depends upon individual characteristics (i.e., learning style or learning preferences).

All students were asked how computers might be made more useful for students. In answering this and the subsequent question about improving mathematics education, most students regardless of group stressed the kinds of features favored by educational theorists, such as independent learning, multi-modal delivery of information, etc. For example, one non-computer student stated:

Maybe some people are more visual, maybe some people would do better to read instructions instead of seeing stuff, so maybe if they had multi ways of showing you the same information like sound or sight.... Some people learn better by seeing things, some people learn better by hearing things, and sometimes having a mix of those things is good for the individual too. These sentiments were echoed by students in both groups.

Students were divided when asked whether they themselves would prefer learning mathematics with a computer or learning mathematics in a traditional classroom, with some students expressing a decided preference for one or the other but the vast majority indicating a preference for a mixture between the two modes of instruction. It should be noted that those students who indicated a preference for one or the other were not always in the group that was consistent with their preference.

The course instructor chose to implement the computer-facilitated instruction program in a relatively limited manner. The program was used as an adjunct to lectures rather than as the primary instructional modality, with students directed to use the computer program to solve specific problem sets in a specific order, rather than as an individualized learning tool. The instructor noted one potential problem with the program itself: the possibility that students gain a false sense of security upon completing problems correctly while using the computer and, not being forced to do more problems, fail to complete enough problems to gain a full understanding.

The qualitative data obtained through student interviews was quite illuminating. Student responses suggest that neither instructional method was particularly effective in sparking students to understand the "real world" implications of the course material. This finding is particularly striking in relation to the computer-facilitated group, since one of the purported benefits of interactive, computer-facilitated instruction is that students are offered more opportunities to discover the uses of the mathematics studied. Since this particular program does have features intended to have that effect, a new question arises. Did the students utilize those features and find them uninspiring, or were those features underutilized due to the manner in which the instructional program was implemented?

Given the students' and the instructor's descriptions of the class procedure, it appears that the latter possibility is more likely. As noted above, based upon the results gained from the interview with the instructor, it was learned that the course instructor chose to

implement the computer-based instruction program in a relatively limited manner. As the instructor stated:

> I give a lecture for usually no more than 20 minutes. Then I give them an assignment... I tell them exactly which exercises I want them to do on the computer. And usually it's based on that day's lecture.

The manner in which the computerfacilitated instruction program was implemented in this mathematics classroom discouraged students from accessing the most valuable aspects of the program. The implementation of the computer software package did not fully test its instructional potential, and causality cannot easily be assigned in the failure of the class to meet or exceed the performance of a traditional class.

A majority of interviewees from both groups expressed the belief that a combination of computer-facilitated and traditional instruction, rather than one or the other, would be the ideal learning modality. Instructional flexibility was also cited numerous times as a significant factor in student learning.

This points to a possible shortcoming in the existing research concerning computer-facilitated instruction: the practice of placing traditional and computer-facilitated instruction into a sort of either/or situation. The students interviewed expressed an almost unanimous conviction that they would be best served by a combination of computer-facilitated instruction. Thus, it appears that it might be best to test a combined approach.

Insights have emerged which can be translated into definite recommendations about the creation and implementation of computerfacilitated instruction programs for college mathematics classrooms and the process of assessing computer-facilitated instruction.

## **4. CONCLUSION**

The qualitative findings, especially concerning attitudes toward mathematics, were useful in that they drew attention to the issue of implementation and illuminated persistent problems with the manner in which computerfacilitated instruction is generally assessed. The students interviewed came very close to arriving at a consensus favoring a mix of computer-facilitated and traditional instruction which provided a high degree of choice to the student. They spoke in favor of multi-modal delivery of information and in favor of implementations that recognize differences in learning styles. Future research concerning computer-facilitated instruction should attend carefully to implementation when designing the study and interpreting the results. Different implementations of the same program should be tested in order to ascertain which is most effective.

This study revealed the importance of collecting and analyzing qualitative data in the context of quantitative date. In terms of math learning, future research should not be limited to comparing traditional to computerfacilitated instruction, but should also examine combinations of these instructional modalities in various permutations in order to ascertain whether an admixture of the two would better serve students.

Research and development into interactive computer programs for teaching mathematics should certainly be promoted and funded. Based on overall results and from interviews with students, computer based instruction shows a significant reduction in student stress and math-learning anxiety. Reduced anxiety promotes confidence, and confidence enhances the ability to think, learn, understand and solve complex problems.

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