DOCUMENT RESUME

ED 464 827 SE 066 110

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TITLE	Implications of Mediated Instruction to Remote Learning in Mathematics.
INSTITUTION	Educational Testing Service, Princeton, NJ.
PUB DATE	2002-04-00
NOTE	21p.; Paper presented at the Annual Meeting of the American Educational Research Association (New Orleans, LA, April 1-5, 2002). Supported by Ohio University, Center for Innovation in Technology for Learning and Department of Mathematics.
PUB TYPE	Reports - Research (143) -- Speeches/Meeting Papers (150) -- Tests/Questionnaires (160)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Cognitive Style; *Computer Uses in Education; Higher Education; Mathematics Education; Teaching Styles; Technology Education
IDENTIFIERS	*Learning Environment

ABSTRACT

Mediated learning utilizes multimedia-based instructional modules to provide students with individualized access to information in alignment with their individual learning styles (Kinser, Morris, & Hewitt). In contrast with traditional pedagogy, the mission of the instructor in a mediated learning environment is to facilitate learning rather than to deliver information through lecturing. This fundamental difference in the role of the instructor in a mediated environment may set the stage to offer remedial mathematics courses via a remote learning model. The purpose of this study was to examine the feasibility of converting a specific remedial-level college math course from a traditional classroom-delivery model to a remote learning mode when learning was supported by mediated instruction. A commercially prepared mediated-learning system that featured Web-based classroom management with a CD-ROM based instructional delivery platform was used for this project. Appended are related materials from study including course evaluation forms and basic skills test. (Author/YDS)

Implications of Mediated Instruction to Remote Learning in Mathematics

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The work reported herein was supported by the Center for Innovation in Technology for Learning at Ohio University. The opinions expressed herein are solely those of the authors and do not necessarily represent those of either Educational Testing Service or Ohio University. The authors would like to express thanks to the Department of Mathematics at Ohio University for operational support of this project.

Introduction

Mediated learning utilizes multimedia-based instructional modules to provide students with individualized access to information in alignment with their individual learning styles (Kinser, Morris, & Hewitt). In contrast with traditional pedagogy, the mission of the instructor in a mediated learning environment is to facilitate learning rather than to deliver information through lecturing. This fundamental difference in the role of the instructor in a mediated environment may set the stage to offer remedial mathematics courses via a remote learning model.

The purpose of this study was to examine the feasibility of converting a specific remedial-level college math course from a traditional classroom-delivery model to a remote learning mode when learning was supported by mediated instruction. A commercially prepared mediated-learning system that featured web-based classroom management with a CD-ROM-based instructional delivery platform was used for this project.

Background

Prior to this study, research efforts on this subject focused on the comparison between traditional and mediated-learning pedagogical models (Jewett, 1998; Coscia, 1999). In contrast, our research focuses solely on mediated learning. It addresses questions regarding the best environment for the implementation of mediated learning for remedial-level mathematics.

Faced with limited resources in terms of teaching staff and of classroom space, the offering of college-level courses in remedial mathematics can be a controversial issue (Abraham & Creech, 2000; Smith, 1996). The teaching of such courses is perceived by many to be a questionable drain of resources. There are some state legislators who have argued that the government should not pay twice for the same service (Oklahoma State Regents for Higher

Education, 1998). That is to say, there should be no redundancies between the secondary and post-secondary curriculums. Some college faculty and administrators, however, consider that though teaching remedial-level mathematics is not congruent with their academic mission, it might be the only way for certain students to prepare for their core courses (Abraham & Creech, 2000; Hagopian, 1996). On the other hand, there also are faculty and administrators that argue that remedial-level courses should not be taught at the university level at all, and that the material covered in this type of course should be required as prerequisite to university entrance.

In order to meet the needs of all students, remote learning may provide colleges and universities the flexibility they need to accommodate all levels of learners. While the greater issue may be whether or not remedial courses should even be taught at the university level, that is not the purpose of this paper. Instead, we focus on the questions of feasibility and adequacy of an alternative method of instructional delivery.

The timeliness and relevance of this study stem from the fact that remote mediated learning may permit the continuation of the offering of remedial-level courses without undue drainage of resources since this approach will minimize the usage of faculty time and classroom space. It is therefore imperative to know the potential impact of a remote-learning environment to the academic performance of remedial-level college students (Hagopian, 1996).

Methodology

Three sections of Math 101 were offered in the spring quarter (2000) at Ohio University. Math 101 is a remedial-level course in mathematics; the core content of Math 101 is basic arithmetic and algebra. Spring quarter consisted of ten consecutive weeks of classes.

Each section had an enrollment cap of 20 students. This limitation was due to space constraints in the technology-based classroom where the classes were held. A total of 25

computers were available in the assigned classroom. Seating capacity was limited to 20 students in order to allow for the possibility of up to five malfunctioning workstations on any given day.

Each of three sections (Section I, Section II, and Section III) was assigned specific attendance policies prior to the start of this study. All students enrolled in Section I were required to attend all scheduled classes (4 classes per week). Students registered in Section II were required to attend at least one class per week in addition to one day for weekly tests. Students enrolled in Section III had no attendance requirements other than to attend one day per week for testing. Attendance policies were not made public prior to enrollment.

Students enrolled into Math 101 according to regular enrollment procedures. Because students could not be randomly assigned to a particular section, this study is not a scientific experiment.

In alignment with Ohio University's Institutional Review Board (IRB) guidelines for research on human subjects, this project received an exempt status regarding the usual requisite of informed consent. Since students involved in this study would not be treated any differently than Math 101 students from any other academic quarter, and since no names or identifiers would be used for research purposes, signed consent was not required. Instead, informational flyers were distributed to all sections of Math 101 (see appendix for copy). No students declined to participate.

Data was gathered on the following five measures for each student:

- Daily attendance,
- Daily time spend on-line,
- Pretest score,
- Post-test score,

- Final course grade.

In addition, a summative course evaluation, designed specifically for this project, was administered to all students on the last day of class. Feedback from this evaluation was used to assess student satisfaction. It is university policy to administer final course evaluations.

Extreme care was given to proactively consider the possible consequences of the proposed pedagogical changes and the potential impact on students' learning. A central part of this study was the consideration of whether student performance in the course would be affected by attendance.

A basic skills pre-test (BST) was administered to all students enrolled in Math 101, regardless of section assignment. This criterion-referenced test was designed specifically for use in Math 101. It was produced to be in alignment with a table of specifications that were developed and endorsed by members of the department of mathematics at Ohio University; the test consisted of 20 constructed response items. Completed tests were scored according to a detailed scoring rubric. The BST had a computed Kuder-Richardson measure of internal consistency (reliability) of .92.

The intended use of the BST was the assessment of basic arithmetic and pre-algebraic skills. The specific content of this test included basic operations on integers, rational and real numbers. It also included basic algebraic manipulations, including but not limited to, combining similar terms, factoring algebraic expressions, and solving linear equations and inequalities.

Analyses

Pre-test

An analysis of variance (ANOVA) was performed on the pre-test scores in order to investigate initial group equivalence across groups.

Attendance

Attendance was recorded daily in order to ensure compliance with sectional attendance policies.

Time on-line

Time spent on-line was automatically recorded by the instructional software program used in this study. Instructors could access this information at any time by logging-on to the project server. The purpose of gathering this information was to observe study patterns, if any, for the different groups. An analysis of variance was performed on the dependent variable *time-on-line*.

Post-test

Post-test scores were obtained from a second administration of the Math 101 Basic Skills Test. An analysis of variance was performed in order to look for post-course mean differences between the three groups. In addition, filtered correlations between pre- and post-test scores were computed (within-group correlations). This was done in order to examine the within-group relationship between pre- and post-test scores.

An analysis of variance was performed on the dependent variable *post-test*.

Gain scores

A gain score for each student was computed. Gain scores were computed by finding the difference between post- and pre-test scores. A negative gain score indicated that a student's pre-test score was greater than their post-test score. A gain score of zero indicated that there was no difference between pre- and post-test scores; a positive gain score indicated that a student's post score exceed their pre-test score.

An analysis of variance was performed on the dependent variable *gain score*.

Final course grades

An analysis of variance was performed on the variable *final course grade*. The purpose of this analysis was to investigate whether or not there were any group-level mean differences on *final course grades*.

Research questions

The following two basic questions were addressed:

1. If given a choice, would students naturally gravitate to a remote learning environment?
2. Is class attendance positively correlated with class performance (as measured by post-BST scores)?

Results

Pre-test Scores

Results of an analysis of variance on the dependent variable *pre-test scores* indicated that there were no significant between-group mean differences ($F = .056$, $p = .946$ at $\alpha = .05$).

Table 1

Descriptive Statistics for Pre-test Scores*

Group	N	Mean	Std. Deviation
1	18	11.78	3.32
2	19	12.16	3.20
3	18	12.00	3.86

*This finding was used to establish initial group equivalences.

Attendance

Attendance records were periodically reviewed and recorded throughout the duration of the academic term (Spring 2000) in order to ensure compliance with sectional attendance

policies. All students were found to be in compliance with the attendance policies for their particular sections of Math 101.

Gain Scores

Gains scores were computed to be the difference between Basic Skills pre- and post-test scores. Group I (required attendance) showed greater gains than did either of the other two sections, with Group III (no attendance required) showing the least gains among the three groups. An ANOVA produced a non-significant F-statistic ($F = 2.888$, $p = .065$, $\alpha = .05$); we failed to reject the null hypothesis of no group differences.

Table 2

Gain Scores

Group	Mean Gain Scores	Standard Error
1	4.22	.76
2	2.61	.70
3	2.11	.46

Pre-test to Post-test Correlations

Interestingly, it was observed that a filtered correlation (within-group correlations) between pre- and post-tests were positive and strong in the two groups with more liberal attendance policies (Groups II and III), indicating that weak students remained weak and strong students remained strong, despite equivalent exposure to information and access to instructional opportunities and exposure. Upon examination of student scores, it was observed that weak

students showed marked improved performance under the required attendance condition (Group I). A plot of these corrections is located in Appendix B.

Table 3

Within-group Correlations

Group	N	Correlation
1	18	.475*
2	19	.510*
3	19	.856*

*Statistically significant at $\alpha = .05$, 2-tailed

Upon careful examination of pretest and post-test scores, it was noted that for students in Groups I and II, weaker performers (those scoring poorly on the pretest) showed marked improvement on their post-test. Weaker students in Group I outperformed their counterparts in Group III, indicating that as far as weaker performers are concerned, a more restrictive learning environment may be more conducive to academic success in the course.

Time Spent On-line

Over the course of the academic quarter, there appeared to be no significant difference in the mean amount of time each group spent on-line. An ANOVA produced a non-significant F-statistic ($F = .581$, $p = .563$, $\alpha = .05$). The Pearson correlation coefficient between time on-line and final grade was not statistically significant, neither when data were aggregated across groups ($r = -.171$, $p = .207$, $\alpha = .05$) nor when filtered by group membership (-.330, .113, -.091, respectively). Regardless of group membership, students spent approximately the same amount of time on-line overall. However, it should be noted that the patterns of time spent on-line did differ across groups. Time spent on-line by students in Group I was uniformly distributed over blocks of time between regularly scheduled tests. This is reasonable since these students spent at

least one hour per weekday on-line due to their required class attendance. Time spent on-line by students in Groups II and III was non-uniformly distributed. Actually, students enrolled in these sections did not spend much time on-line immediately following a class; instead, they steadily increased their instructional time (on-line), peaking the evening immediately prior to the next regularly scheduled test. Whereas students in Group I were required to attend class daily and hence were required to log-on at least four days per week, students in Groups II and III evidently were disciplined enough to do the required work from a remote location.

Post-test Scores

Post-test mean group scores were not significantly different from one another, indicating no meaningful group differences on the Basic Skills post-test scores. An ANOVA revealed a non-significant F-statistic ($F = 1.937$, $p = .154$, $\alpha = .05$). A Levene Statistic was computed as a test of homogeneity of variances (.534) and was not statistically significant at the .05 level.

Table 4

Post-test Scores

Group	N	Mean Post-test Score
1	18	15.95
2	19	14.83
3	19	14.11

Final Grades

Final grade mean scores were not significantly different across groups. An ANOVA on the dependent variable *final grade* produced a non-significant F-statistic ($F = .059$, $p = .943$, $\alpha = .05$).

Table 5

Final Grades

Group	Final Grades
1	82.11
2	82.89
3	82.11

Attrition for this study was within reason (8%); full data was available on 55 out of 60 students.

Conclusions

Discussion of findings

The results of this study indicate that students enrolled in mediated learning environments naturally gravitate to a remote learning model. That is to say, if attendance is not required, then, for the most part, students will not attend. During the course of this study, students enrolled in Groups II or III were permitted to attend class every day; most chose to only meet the minimum requirements of their prospective groups. It should be mentioned, however, that there was a small number of students from Groups II and III who really wanted to be in class with their instructors, whether attendance was required or not.

Academic performance did not appear to be adversely impacted by the remote learning model. No group differences were detected on any of the variables studied. Also, average group scores on the post-BST as well as average group final course grades were in keeping with other sections of Math 101 from prior years. There is concern, however, for students who scored below

70% on the pretest (BST). These students, for the most part, failed to thrive under the remote model.

Limitations and future projects

The primary limitation of this study is its sample size. This limitation was due to two reasons. First, there were space limitations in the multi-media classroom where the classes were held. A total of 25 computers were available for this project. Maximum seating capacity was realized to the extent of guaranteeing availability of computers to all attending students. This meant that only 20 students could safely be enrolled per section so as to allow for possibly malfunctioning workstations. Second, the demand for Math 101 is rarely greater than twenty-five students per academic quarter. The limitation of sample size certainly restricted the power of our statistical analyses (Stevens, 1986).

Based on the findings of this research, the following recommendations have been made to the Department of Mathematics at Ohio University:

1. All students who are placed into Math 101 by regular university mathematics placement testing should be required to take the Math 101 Basic Skills Test (BST, as developed for this research);
2. Students whose BST score is below 60% (number correct scoring) should be placed into a teacher-directed section of Math 101;
3. Students whose BST score is greater than or equal to 60% (number correct scoring) should be allowed to register for any section of Math 101 and should be encouraged to consider a remote-learning option.

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Appendix A

Note to all Math 101 students

Spring, 2000

To all Math 101 students:

The Department of Mathematics has changed the mode of instructional delivery for Math 101. All sections of students in Math 101 receive instruction from the CD-based system licensed from Academic Systems, Inc.

As part of our assessment of this new way of teaching Math 101 at Ohio University, a team of researchers are gathering information about how students adjust and interact with the software, the class structure, and their instructor. The information used for our research and internal assessment will be limited to the following: the amount of time spent on-line, class attendance, scores on the basic skills test, and final course grades.

We are interested in assessing group performance, not individual performance. At no time will any identifying information about you be given to anyone. Names will always be removed prior to any disclosure or use of information. **In no way does either the research or assessment component affect your grade in this course.**

You have the right, without any penalty or repercussion, to decline the use of your scores in the research component of this assessment. If you wish to exercise this right, you may contact either of the following persons:

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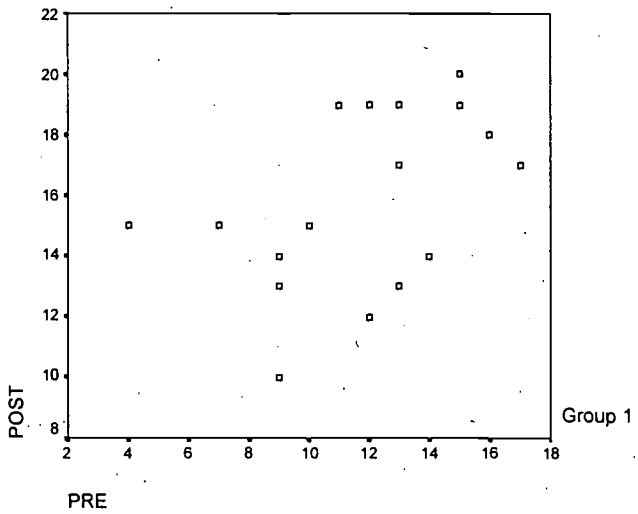
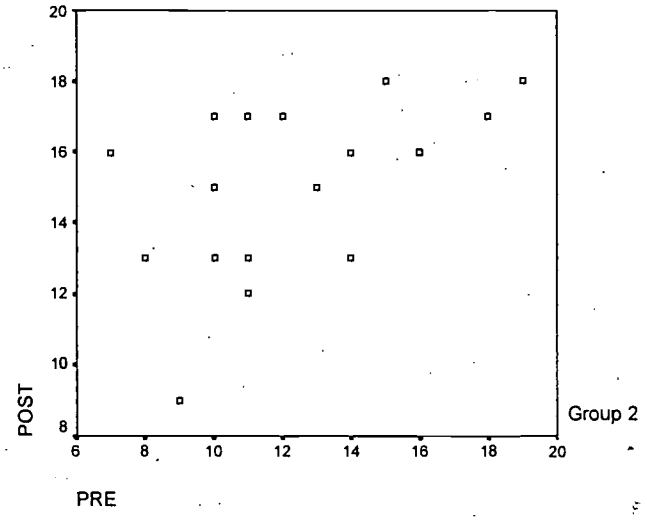
Appendix B

With-in Group Correlations

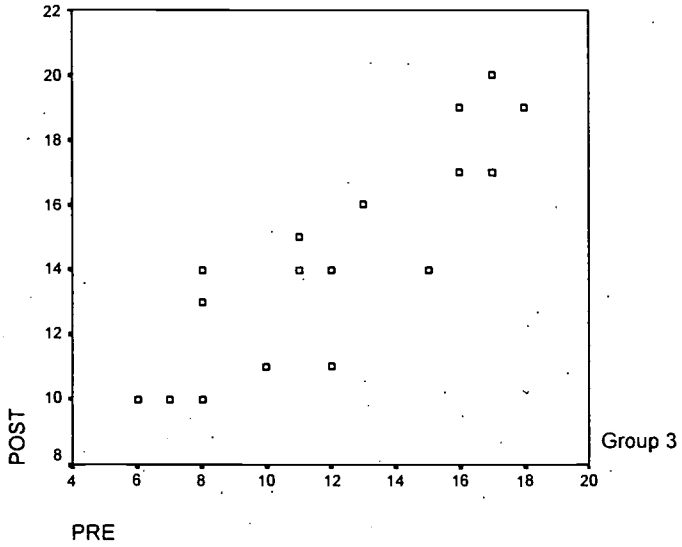
Group 1



Group 2



Group 3



OHIO UNIVERSITY
DEPARTMENT OF MATHEMATICS
COURSE EVALUATION FORM
MATH 101

Directions:
Please **DO NOT** enter your name or any identifying information on this sheet
Be sure to respond to **all** statements on **BOTH** sides of this form

	STRONGLY AGREE	AGREE	NEUTRAL	DISAGREE	STRONGLY DISAGREE
	A	B	C	D	E

Circle the letter which corresponds with your response.

I. INSTRUCTIONAL MATERIALS:					
1. I liked being able to repeat instructional sections.	A	B	C	D	E
2. The instructional units were well organized.	A	B	C	D	E
3. The material was presented in an understandable manner.	A	B	C	D	E
4. There were enough examples to help my learning.	A	B	C	D	E
5. The instructional materials were too expensive.	A	B	C	D	E
II. TECHNOLOGY:					
1. I liked being able to work at my own pace.	A	B	C	D	E
2. The technology confused me.	A	B	C	D	E
3. I was comfortable using e-mail to communicate with my instructor.	A	B	C	D	E
4. By mid-way through the course, I was comforable with the technology.	A	B	C	D	E
5. Learning math with the computer is harder than learning math the usual 'non-computer' way.	A	B	C	D	E
III. ASSESSMENT PROCEDURES:	A	B	C	D	E
1. The practice tests were useful to my learning.	A	B	C	D	E
2. I always knew how I was doing, in terms of my grade.	A	B	C	D	E
3. I liked having extra chances to improve my section grade.	A	B	C	D	E
4. My in-class tests were fair.	A	B	C	D	E
5. I think my current grade accurately reflects my ability with this material.	A	B	C	D	E
IV. CLASSROOM MANAGEMENT:					
1. I liked having a teacher available during class time.	A	B	C	D	E
2. Class attendance should be completely optional for the student.	A	B	C	D	E
3. Working in class was easier than working at a remote site (like at home, in the library, etc.)	A	B	C	D	E
4. If class attendance were optional, I would still attend class most of the time.	A	B	C	D	E
5. I worked harder outside of class (at remote sites) than I did when in class.	A	B	C	D	E
V. OVERALL OPINION:					
1. Overall, I like this way of learning math.	A	B	C	D	E
2. I would recommend this method of learning math to my friends.	A	B	C	D	E
3. If attendance were optional, I would work at my remote site more than in my scheduled classroom.	A	B	C	D	E
4. Considering the usual costs of textbooks and computer lab fees, the cost for this course is reasonable.	A	B	C	D	E
5. Studying math with the aid of a computer makes learning easier.	A	B	C	D	E

(TURN PAGE OVER---->)

OHIO UNIVERSITY
DEPARTMENT OF MATHEMATICS
COURSE EVALUATION FORM
MATH 101

_____	_____	_____
Instructor's Name	**Course Call #**	**Quarter/Year**

Your comments are VERY important to us. We use this feedback to improve our courses.
Please take a few minutes to comment about the strengths and/or areas needing improvement.

Remember:

All comments you make will be read and taken into consideration.
Please write clearly!

I. What do you think about learning math via CD-ROM instructional delivery? Is this approach helpful? Hurtful? Confusing? Refreshing? Please elaborate.

II. Was your instructor's presence in the classroom helpful to you? Was he/she clear when answering your questions? Was your teacher respectful? Responsive? Knowledgeable? Please elaborate.

III. Are there any comments you would like to make about this course, the materials, your instructor, or our technology classroom? If so, please do!

Thank you for your input! We appreciate your time and effort.

Math 101: Basic Skills Test

_____ _____

Name Today's Date

Please answer all of the following questions. Show all work. Write your final answer in the space provided.

1. $217 + 56 =$ _____

2. $425 - 136 =$ _____

3. $96 \times 131 =$ _____

4. $4,320 \div 16 =$ _____

5. $-43 + 15 =$ _____

6. $-20 - 11 =$ _____

7. $-39 \times -21 =$ _____

8. $18.13 - 3.14 =$ _____

9. $9.14 + 3.095 =$ _____

10. $16 \div 0.2 =$ _____

11. $0.8 \times 1.12 =$ _____

12. 8% of 16 = _____

13. 3% of 9 = _____

14. $\frac{3}{4} - \frac{1}{3} =$ _____

15. $\frac{1}{2} \times \frac{2}{3} =$ _____

16. $\frac{1}{4} \div \frac{1}{2} =$ _____

17. $\frac{11}{15} + \frac{1}{3} =$ _____

18. Solve for x where $2x + 3 = 8$. _____

19. Solve the following inequality for y:
$5y - 4 \leq 11$ _____

20. Solve for w when $\frac{1-w}{3} = \frac{1}{2}$ _____

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Corporate Source: Educational Testing Service, Ohio University

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