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IN INCREASING PERFORMANCE
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EFFECTIVENESS OF COMPUTER-ASSISTED INSTRUCTION IN INCREASING PERFORMANCE ON QUALIFICATION EXAMINATIONS

By

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ABSTRACT

EFFECTIVENESS OF
COMPUTER-ASSISTED INSTRUCTION
IN INCREASING PERFORMANCE
ON QUALIFICATION EXAMINATIONS

By

Diane Marie Bender

The purpose of this study is to test the effectiveness of a new computer software program developed for interior designers preparing for their qualification examination.

The sample population consisted of thirty-two undergraduate students at Michigan State University. A pre-test and post-test format was used for the two studies. A t-test was then applied to the data to evaluate the software's effectiveness. Results and recommendations are provided for future research.

DEDICATION

This project is dedicated to the memory of my great aunt and godmother, Rita V. Bender (May 23, 1923-Dec. 26, 1992), a wonderfully spirited and humorous individual who always took interest in my endeavors.

ACKNOWLEDGEMENTS

As this project draws to a close, I would like to extend my gratitude to several persons. Without them, this thesis would not exist. A great big THANK YOU goes out to Jon Vredevoogd, my advisor, mentor and friend who held my hand long enough so I could find my footing.

I would like to thank Dr. Timothy Springer who always found time for me in his busy schedule; Jeanne Halloin who sparked my interest in teaching; Raman Padmanabhan and John Hayes for their computer expertise; Jan Loria and Ronda Coffelt who got me through the red tape here at MSU; and, of course, Marla "Goddess" Goucher who always had the right answer.

I would never have continued in graduate school if it weren't for my friends and family. My undergraduate friends, Alissa Bails, Brigid Rot, and Sharon Zalewski have given a sympathetic ear for the past two years - THANKS! I would like to thank all of my grandparents for helping me financially and emotionally. For my brother Kevin, who thought I was crazy to stay at MSU for a graduate degree, I have just one thing to say - HA! HA! My Spartan parents, Janet and Donnell, deserve some thanks. Not only did they read this thesis over and over to offer constructive criticism and editing tips, but they are also responsible for putting the meaning of education into my life. But, most of all, I want to thank Gregory Tait who gave me the support I needed to complete this project.

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CHAPTER 1

INTRODUCTION

"Since computer-based tests are becoming increasingly common", it is the purpose of this study to investigate the use of computer-assisted instruction in preparation for the professional qualification examination for Interior Designers (Wise, Plake, Pozehl, Barnes & Lukin, p. 486). It is thought that computer-assisted instruction (CAI) may provide improved feedback and visual/verbal stimuli in addition to current teaching techniques.

The competency of interior designers is presently assessed through a technique called qualification, which consists of a combination of education, work experience and examination results. This qualification is critical to career development because it allows the individual entrance into professional organizations and is a requisite for legal licensing in many areas of the United States.

This project focuses on the ability of computer-assisted instruction and testing to better prepare professional interior designers for the examination given by the National Council for Interior Design Qualification (NCIDQ). It is hoped that an analysis of these results will assist in directing the part computer-assisted instruction will play in the future of the learning process.

CHAPTER 2

AN OVERVIEW

Conditions in the learning process that are deemed necessary by most theorists include reinforcement, feedback and repetition (Chambers & Sprecher, 1983). These principles are intertwined in various learning theories proposed by various theorists (i.e. traditional and instructional).

Traditional learning theory emphasizes reinforcement, repetition and motivation through an instructor. The theorists closely associated with traditional learning theory were Pavlov and Thorndike (Snelbecker, 1974).

Instructional theory is defined as "an integrated set of principles which prescribe guidelines for arranging conditions to achieve educational objectives" (Snelbecker, p. 116). Instructional theory is based on the relationship between psychology and the educational practice. Instructional theory is more directly concerned with application than simply the process of learning (Snelbecker, 1974). Reinforcement, repetition and motivation are facilitated through alternate methods, rather than through an instructor.

A significant form of instructional theory was developed by B. F. Skinner in the 1930s. He soon dominated the field with his widely accepted concepts of operant conditioning (Chambers & Sprecher, 1983). Operant conditioning removed the

stimulus from traditional psychological thinking and used only the response and reward. This reward, also known as reinforcement, can be divided into two categories: primary and secondary (Keller, 1954). Primary reinforcers include stimuli such as food, drink and electric shock. Secondary reinforcers, also known as conditioned reinforcers, strengthen or weaken responses through the approval or disapproval of others (Keller, 1954). Skinner's learning model states that a correct response should be followed by positive reinforcement. This involves a contingency statement, or "if-then" statement, about the relationships among actions, situations, and consequences (Snelbecker, 1974). His main thesis is that this positive reinforcement should follow each desired response until the level of mastery is reached (Chambers & Sprecher, 1983). Negative reinforcement in the form of a reduction in computer-based test score serves as mild punishment for an incorrect response. This situation places the user in the role of an active learner who controls the learning situation. This approach by B.F. Skinner made it possible for the introduction of computer-assisted instruction.

CHAPTER 3

COMPUTER-ASSISTED INSTRUCTION

Computer-assisted instruction (CAI) is defined as the "use of a computer to provide course content instruction in the form of drill and practice, tutorials, and simulations" (Chambers & Sprecher, p. 3). Computer-assisted instruction is also referred to as computer-assisted learning,computer-assisted education, computer-based testing, etc. This educational tool combines computer technology developed from science, mathematics and engineering with learning theory, instructional strategies and motivation from the field of psychology (Chambers & Sprecher, 1983).

Computer-assisted instruction includes drill and practice, dialogue-type learning, simulations, and educational games. Drill and practice involves repetition that emphasizes rote memorization. On a higher level, tutorials use the computer in a question-and-answer, dialogue-type learning (Chambers & Sprecher, 1983). Simulations allow the student to assume a role and fully interact with the computer. In addition to these three categories, educational games are identified by many people as another form of learning. All computer-based programs include one or more of these instructional learning methods.

Reinforcement, repetition and motivation from instructional theory are applied to computer-assisted instruction. Reinforcement is often presented in the form of feedback. Feedback is the event that verifies to the learner that his learning has accomplished its task (Tabachneck, 1982). Informative feedback may also be an important condition in determining an individual's performance (Tabachneck, 1982). Informing students that their response to a question is correct increases the amount of information that they will recall at a later date (Tabachneck, 1982).

The study of feedback on student performance has resulted in the division of feedback into two groups: immediate feedback and delayed feedback. Both provide benefits to the learner; the extent of this benefit remains to be determined. The concept of reinforcement involves immediate feedback in which students receive feedback immediately after answering a stated question (Tabachneck, 1982). With this option, examinees are able to monitor their test performance (Wise et al., 1989). On the negative side, item feedback may increase user anxiety (Wise et al., 1989). Based on a review of past literature and the completion of a case study by A. S. Tabachneck (1982), delayed informative feedback, in which the examinees receive their test results upon completion of the test,seems to be favored. This gives the student the opportunity to forget his or her incorrect answers, complete the task at hand and receive feedback at a later time.

Studies on item feedback and test performance have indicated that user anxiety may impair test results (Wise et al., 1989). According to a study conducted in 1989 by Wise et al., item feedback and test performance increased anxiety, but did not decrease overall performance. "The capability to provide immediate feedback after every test item, an apparent advantage of computer-based tests over paper-and-pencil tests, may in fact have little effect on examinees" (Wise et al., p. 486). Though more research in this area is desirable, the development of computerized tests can be affected by choice of feedback.

Computer-assisted instruction also allows the user to repeat material. There is general agreement among theorists that "repeated occurrences of the response followed by reinforcement are necessary in order for learning to occur and for the materials to be retained" (Chambers & Sprecher, p. 91). Another aspect of computer-assisted instruction involves the user's desire to use the computer program. An individual's sense of motivation can greatly increase or decrease the learning experience. When using the CAI program, an individual may derive personal approval and satisfaction upon successful completion. An individual's concept of success can be viewed in terms of the potential to continue in the endeavor, the sense of personal accomplishment or the acquisition of skills that may be needed in the future. This sense of success can be used by the CAI user to assess his/her level of competence in the subject matter. It is assumed by

the program developer that increased success will lead to increased use of the computer tutorial, which will in turn increase the skill level of the user.

It is also assumed that increased visual and auditory input will motivate the user to continue to use the instructional software longer and lead to increased learning. Techniques to achieve this include full spectrum visual display terminals (VDTs) and auditory enhancement to further stimulate the user. There is a need for further research in this area.

The hypothesis that is the primary interest in this study is as follows:

Hypothesis: Individuals preparing for the NCIDQ examination who supplement traditional learning approaches with computer-assisted instruction will be better prepared and score higher on the qualifying examination than individuals who implement only traditional study methods.

CHAPTER 4

METHOD

The term interior design can be defined as "a group of related projects that are involved in making any interior space into an effective setting for whatever range of human activities are to take place there" (Pile, p. 15). Those individuals who practice the profession of interior design are referred to as interior designers.

Current legislation in many states regulates the usage of the title of interior designer to those qualified to practice (Rus, 1992). Interior designers who desire licensing and/or membership into various professional interior design organizations are required to meet educational and experience standards and pass a qualifying examination.

The test for measuring the minimum competency of interior designers is known as the NCIDQ examination (Ballast, 1992). It has acquired its name from its administrating organization, the National Council for Interior Design Qualification (NCIDQ), formed in 1972 (Rus, 1992). This test is based on the principle that all interior designers "share a common body of knowledge from which a minimum level of competency can be judged" (Rus, p. 33). Administered throughout North America twice a year and in various locations, the examination process has been divided into various parts: identification and

application, building and barrier free codes, problem solving, and programming. Three test methods are used: multiple choice questions, practical application of graphic interior design skills, and a written scenario. The multiple choice question portion of the examination is the focus of this study.

Various study methods are employed by designers to prepare themselves for the NCIDQ examination. These methods vary with the applicant's education and work experience. Common study procedures include review of school materials, comprehension of books related to design principles and optional attendance at various workshops offered throughout the country. A computer program will soon be available to aid in the preparation for this test. This software, which utilizes CAI theory, was used in this study. It consists of a database with questions from past NCIDQ examinations. The NCIDQ database was divided into ten sections (see table 1).

Table 1

Software Sections

1	Design elements and principles
2	Human factors
3	Programming, planning and presentation
4	Costs and contracts
5	Construction
6	Furniture and finishes
7	Lighting, mechanical and electrical systems
8	Codes and barrier-free
9	Professional practice
10	History

The reference sample for this study consisted of thirty-two interior design students at Michigan State University (MSU). The interior design program at MSU is nationally accredited with the Foundation of Interior Design Education Research (FIDER) and its enrolled students are representative of other students enrolled in accredited design programs in the United States. From this particular population of interest, every applicant has an equal opportunity of participation (Schmitt & Klimoski, 1991).

By soliciting for volunteers in a randomized manner, chance events that may skew the data have been avoided. "Randomization prevents uncontrolled sources of variation from influencing the responses in a systematic manner"

(Bhattacharyya & Johnson, p. 299). Demographics such as age, gender, race, income, educational background, work experience, class standing, overall university grade point average, and affiliation with professional organizations, therefore, did not interfere with this study.

This reference sample was involved in an exploratory research design to determine if the computer-assisted instruction in question increases motivation and preparedness, thus aiding the applicant to achieve higher results on the NCIDQ examination. Consent of all participants was obtained prior to participation (see Appendix B).

Upon agreement to participate in this confidential study, the volunteers were randomly divided into two groups. Each group had access to the computer-based drill and practice program mentioned above. A pre-test that consisted of 50 multiple-choice NCIDQ questions was given to all participants. Group A (the experimental group) used the computer software for two weeks while Group B (the control group) used these two weeks to study in a traditional manner. The software was available in an on-campus computer laboratory that was open 7 days a week for 8 to 13 hours each day. To reflect actual conditions of test prepartation (within limits), students in both groups were neither restricted to the amount of study time nor was time demanded of them. After this two-week period, all participants gathered to take a post-test similar to the pre-test administered earlier. The control group had

the opportunity of viewing this software for the remaining two weeks of the study.

CHAPTER 5

ANALYSIS

Two studies were conducted with different participants to insure validity; one beginning in February 1994 and one beginning in April 1994. Upon completion of the initial study, which took place from February 8, 1994 to March 8, 1994, it was decided that a second study be conducted to verify the findings from the first study. The second study took place from April 8, 1994 to May 6, 1994 with identical design parameters, but different participants. The presentation of findings includes both the first and second study plus an analysis of the combined results.

To study the traditional learning approach in comparison with computer-assisted instruction (CAI), data has been collected and analyzed from these two independent random samples. Since relatively small samples were used in both studies, it is assumed that (a) both distributions are normal, and (b) the population variances are equal (Bhattacharyya & Johnson, 1977). The difference between the pre-test and post-test scores were calculated for groups A and B to evaluate the effectiveness of the CAI tool. If the total mean score of the experimental group is greater than the total mean score of the control group, the hypothesis would be proved. If the reverse occurred, the hypothesis would not be proved.

First Study

A total of 22 students participated in the first study; 10 in the experimental group and 12 in the control group. An analysis of the difference in pre-test and post-test scores is presented in Table 2. For the experimental group, the mean score was -2.50 and the standard deviation was 3.8658. For the control group, the mean score was -2.75 and the standard deviation was 3.4674. After calculation, the t-distribution was .1599, which is not statistically significant (see Table 4).

Table 2

Difference in Mean Test Scores for First Study

Group A (Experimental Group)

Subject	Pre-test	Post-test	Difference
1	29	27	-2
2	30	30	0
3	25	24	-1
4	24	23	-1
5	32	31	-1
6	35	28	-7
7	35	39	+4
8	31	28	-3
9	36	26	-10
10	29	25	-4

Group B (Control Group)

Subject	Pre-test	Post-test	Difference
1	27	30	+3
2	25	20	-5
3	34	30	-4
4	24	22	-2
5	26	24	-2
6	34	33	-1
7	29	30	+1
8	36	29	-7
9	29	28	-1
10	32	29	-3
11	31	21	-10
12	33	31	-2

Second Study

A total of 10 students participated in the second study; 4 in the experimental group and 6 in the control group. An analysis of the difference in pre-test and post-test scores are presented in Table 3. For the experimental group, the mean score was -4.00 and the standard deviation was 6.9282. For the control group, the mean score was -3.33 and the standard deviation was 7.4536. After calculation, the t-distribution was -.1422 which is not statistically significant (see Table 4).

Table 3

Difference in Mean Test Scores for Second Study

Group A (Experimental Group)

Subject	Pre-test	Post-test	Difference
1	31	26	-5
2	23	22	-1
3	25	26	+1
4	30	19	-11

Group B (Control Group)

Subject	Pre-test	Post-test	Difference
1	29	32	+3
2	30	30	0
3	35	21	-14
4	26	29	+3
5	22	14	-8
6	33	29	-4

Combined Results

Though the studies were conducted at different times, they have similar samples and were conducted under similar conditions. In order to better assess the unusual statistical results obtained from both studies, a combined analysis has been completed. Of the total 32 participants, 97% were female

and 3% were male. Volunteers were solicited primarily at the senior level with the intention of obtaining participants who would have a good base of interior design knowledge. Surprisingly, more students at the junior level (14) volunteered than graduating seniors (13) while only 5 sophomores participated. There were no freshman involved.

The combined means for Group A (the experimental group) and Group B (the control group) were -2.92 and -2.94, respectively. The standard deviation of all Group A participants was 10.5591 and the standard deviation of all Group B participants was 12.1403. After calculation, the t-distribution of these combined results was only .0039, which is still not statistically significant (see Table 4).

Table 4

Study Analysis for Both Studies and Combined Results

Study One	Group A	Group B
Mean	-2.50	-2.75
Standard Deviation	3.8658	3.4674

T-distribution=.1599

Study Two	Group A	Group B
Mean	-4.00	-3.33
Standard Deviation	6.9282	7.4536

T-distribution=-.1422

Combined Results	Group A	Group B
Mean	-2.93	-2.94
Standard Deviation	10.5591	12.1403

T-distribution=.0039

CHAPTER 6

RESULTS

The results of this study neither prove nor disprove the hypothesis that:

Individuals preparing for the NCIDQ examination who supplement traditional learning approaches with computer-assisted instruction will be better prepared for and score higher on the qualifying examination than individuals who implement only traditional study methods.

CHAPTER 7

RECOMMENDATIONS

Although the results are not statistically significant, I believe there is the potential for future studies of a similar nature by other researchers. The methodology of this study is sound, but the data collection was difficult. Any time changes are made to provide a benefit in one way, a researcher risks altering or even losing other aspects of the study design. However, using this study as a springboard, changes for future studies could be justified in the following areas:

Weather

The extremely bitter temperature and the snow on the night of the pre-test seemed to have a negative impact on the volunteers' willingness to participate. If at all possible, future researchers should consider the external environment when planning their studies.

Timing

As stated, this study was conducted two different times, covering four weeks each. During the first time, weather provided a challenge for the researcher. The study was conducted a second time at the end of the spring semester at MSU. Since all of the participants were students, final exams, end of the semester projects and job interviews were

rightfully foremost in the students' eyes. Therefore, the amount of time requested by the researcher for active participation may have been unrealistic for many students. Future researchers should plan with this in mind.

Monitoring

Another difficulty with this study was the researcher's inability to monitor the use of the computer tool. A self-reported questionnaire was administered to all study participants (see appedix C). A total of 8 were returned; all of which were from members of the experimental group. The average reported time spent using the software was 45 minutes. Because these questionnaires were completed on a voluntary basis, it is assumed by the researcher that they are neither very accurate nor reliable. Though detailed instructions were provided for use of the software, it became apparent, based on responses by the participants, that getting to know the CAI tool was part of the challenge. For future studies of this kind, the researcher may consider providing verbal instructions as well as a demonstration on the use of the computer hardware and software.

Incentives

It was assumed by the researcher that the students who would volunteer to participate in this study would do so: 1) for the opportunity to use a computer software package that is currently unavailable to the public, 2) because they would be able to view and study approximately 500 multiple choice questions from past NCIDQ examinations, 3) to become familiar

with the general design of the qualification examination and 4) to better access his or her level of knowledge in the core areas of interior design. Obviously, these reasons were not enough. Future researchers may consider integrating a study of this kind into a college-level class as a graded assignment or as extra credit.

Sample

The ideal reference sample for a study of this kind would be interior design professionals who are preparing to take the official NCIDQ qualification examination. These individuals might have a more dedicated interest and commitment to the study process in order to pass the NCICQ examination.

Conclusion

Many of the participants verbally expressed their appreciation to the researcher for having the opportunity to view the database of test questions and use the experimental software. Because of the large number of unavoidable inhibitors in this project, combined with the small positive change, I believe more research is desired in the area of computer-assisted instruction and its effectiveness on test preparation.

APPENDICES

APPENDIX A

DEFINITION OF TERMS

A. **American Society of Interior Designers (ASID)** - an organization that offers membership to qualified interior designers who may include the initials ASID in conjunction with their professional title; an organization that "conducts programs, monitors legislation, and coordinates interior design concerns with those of related professionals" (Pile, p. 521).

B. **Cognition** - the act or product of the act of knowing.

C. **Computer Assisted/Aided Instruction (CAI)** - "the use of a computer to provide course content instruction in the form of drill and practice, tutorials, and simulations" (Chambers & Sprecher, p. 3).

D. **Effectiveness**- the degree by which a result is produced by a cause.

E. **Efficiency** - the degree to which a desired effect is achieved with the least amount of resources used.

F. **Feedback**- the positive or negative response that follows an action.

G. **Foundation for Interior Design Education Research (FIDER)** - the organization that is "concerned with design education and the accreditation of design schools and their programs" (Pile, p. 521).

H. **Hypothesis** - the proposition or conclusion implied by a theory (Schmitt & Klimoski, 1991).

I. **Institute of Business Designers (IBD)** - an organization that offers membership to qualified interior designers who are primarily involved in the contract and commercial fields.

J. **Interior design** - "a group of related projects that are involved in making any interior space into an effective setting for whatever range of human activities are to take place there" (Pile, p. 15).

K. **Interior Design Educators Council (IDEC)** - an organization that concerns itself with design education; composed of teachers and others involved in design education.

L. **Interior designer** - one who practices interior design; one who manages technical issues and the efficient layout of spaces and their contents.

M. **Learning** - "a relatively permanent change in a behavioral tendency that occurs as a result of reinforced practice" (Snelbecker, p. 12); "...how behavior is changed through experience" (Snelbecker, p. 13).

N. **Licensing** - legal acceptance of an individual as being competent to practice his or her profession; "includes giving evidence of training, experience, and competency" (Pile, p. 521).

O. **Motivation** - to make learning more enjoyable to the pupil

by promoting a better attitude toward the subject being studied.

P. **National Council for Interior Design Qualification (NCIDQ)** - the organization that administers and scores the standard examination required, in conjunction with experience and education, for professional licensing in some states; also required for admittance into various professional interior design organizations.

Q. **Qualification** - a means of determining the knowledge and skill level of an individual in order to assess his or her competence in the desired field.

R. **Reinforcement** - the act of strengthening an individual's desire to act in a particular way, either by positive or negative rewards.

S. **Repetition** - to act or say again and again.

T. **Self-instruction** - the use of instructional materials by students with or without the assistance of an educator.

U. **Technique** - the methods and procedures of a science or art.

V. **Technology** - the science of applying a technique in a desired field.

W. **Theory** - an organized body of ideas that goes beyond identifying variables and their relationships to describing how the functions interact.

APPENDIX B

CONSENT FORM

A new piece of computer software has been developed. It's purpose is to assist people in preparing for professional qualification examinations. Since the majority of you will be taking the National Council for Interior Design Qualification (NCIDQ) exam sometime after graduation, you will have the opportunity to take two sample tests of NCIDQ-type questions now. If you agree to participate, you will be taking a pre-test and a post-test.

After the pre-test, half of you will have access to the computer software while the other half can use traditional study methods (books, course notes, etc.) to prepare for the post-test. (The second group will have access to the software at the completion of the study). A post-test will then be given. By comparing the scores of both groups for both tests, the software's effectiveness can be evaluated.

Approximately an hour will be needed for each test plus 15 minutes of instruction before the first test. The amount of time (if any) that you choose to study or prepare between tests is up to you. Please read and complete the bottom portion of this form if you wish to participate in this study.

NOTE: This software will be available in the Human Ecology computer lab, which is located on the first floor in the Human Ecology building near the dean's office. Lab hours are as follows:

M	8am to 9:45pm
Tu	8am to 9:45pm
W	8am to 9:45pm
Th	8am to 9:45pm
F	8am to 4:45pm
Sa	10am to 4:45pm
Su	Noon to 9:45pm

I, _____, do consent to fully participate in this experiment as described to me by the researcher. I am aware that my test results will be kept confidential. Only the principle researcher will have access to this information. Upon completion of data analysis, all data will be destroyed. In addition, I understand that I may discontinue my participation in this study at any time. This study has no effect on any of my course grades. Results of this study will be available to me at a later date.

Signature:_____

APPENDIX C

NCIDQ QUESTIONNAIRE

In order to better access the effectiveness of the NCIDQ software, it is important for the researcher to know approximately how much time was spent using the software. Please be honest! If you used the software a great deal, write down the amount of time. If you didn't use the software much at all, it is still important to write down the amount of time (even if the time spent was zero).

I spent approximately _____hours and _____minutes during a three week period on the NCIDQ software.

Any comments on the software:

Please return this questionnaire to the researcher at the post-test on April 15 or anytime thereafter. Questionnaires may be left in room 309 HEC in Diane Bender's mailbox. Thank you for your participation!

Diane Bender
Graduate Student
ID/FM

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