Evaluating the Efficacy of Computer Courseware Designed to Support Concept Learning in College-Level Physiology

By

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ABSTRACT

EVALUATING THE EFFICACY OF COMPUTER COURSEWARE DESIGNED TO SUPPORT CONCEPT LEARNING IN COLLEGE-LEVEL PHYSIOLOGY

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Claims of benefits of instructional uses of new technologies are often based on anecdotal statements from faculty and students rather than on empirical and objectively measured data secured by educational research methods. This study was conducted to: (1) determine the effects of using computer courseware programs, designed to teach college-level physiology concepts, on students' learning achievements; (2) assess the level of importance of courseware characteristics in promoting effective learning as perceived by experts; (3) assess the extent to which the quality of courseware characteristics helped in promoting effective learning as perceived by students and experts; and (4) construct a framework for analyzing and evaluating computer-based multimedia courseware.

Exam grades for students in Physiology 431 course, offered at Michigan State University during the Fall Semester of 1995, were collected and analyzed as a measure of the effect of courseware programs on learning achievement. The students and two groups of experts interacted with and evaluated the programs using evaluation instruments constructed by the researcher. Data collected from the subjects were analyzed using simple descriptive statistics, oneway analysis of variance (ANOVA), multidimensional

scaling, and stepwise regression procedure. Their comments on the programs were compiled, categorized, and analyzed.

The major findings of the study were: (1) students who used all three programs significantly performed better than other students; however, gender and GPA were the significant predictors of learning achievement; (2) only courseware 2, the program on Control Systems, enhanced learning achievement. Interestingly, while the students rated the courseware as least in quality, the experts rated it as best; (3) only students' class level and previous experience using courseware had a significant relationship to their perceptions regarding the quality of courseware characteristics; (4) nearly all the students liked the programs and expressed deep interest in using similar courseware in other courses; (5) the experts rated "presenting complete, accurate, or current lesson content" as the most important characteristic in promoting effective learning; (6) gender and age were the demographic factors that differentiated the experts in their perceptions regarding courseware characteristics; (7) while the experts were more stringent in rating the quality of courseware characteristics, the students were more detailed as to the specific ways the programs enhanced learning; and (8) while most of the students liked the way humor was used in the programs, most of the experts did not.

In conclusion, "A Framework for Analyzing and Evaluating Computer-Based Multimedia Courseware" was constructed based on the results and findings of the study in light of established theoretical paradigms in educational psychology.

DEDICATION

To the praise and glory of God,

in whom I live and move and have my being,

the source of all wisdom,

the perfect evaluator of life,

and the ultimate and righteous judge of all.

ACKNOWLEDGMENTS

My special gratitude to Dr. Norman Bell, my advisor and the chairperson of my doctoral committee, for his enduring patience, valuable suggestions, professional assistance, and guidance at every step of my graduate studies and doctoral research. His trust and confidence in me to strive for excellence has made this study possible, for which I am deeply honored and grateful.

Special thanks to other members of my committee, Dr. Leighton Price, Dr. Timothy Little, and Dr. Kent Creswell, for their support, advice, and helpful comments with the dissertation from the proposal stage to the final version. I am especially grateful to Dr. Leighton Price for his painstaking attention to details, incisive comments, and the personal trips he made to my office to encourage and shepherd me through my data analysis. I am deeply honored by his friendship and grateful for his mentoring.

Words are inadequate to express my sincere and profound gratitude to Dr. Thomas Adams, Professor of Physiology at Michigan State University, for enthusiastically allowing me to use his courseware programs and the Physiology 431 class for the study. His support, encouragement, and invaluable suggestions in conducting the study provides the model by which I may always measure my achievement as a scholar and my humanity toward those who may seek my help and guidance. Thanks to him for all his help.

Special thanks to the students in the Physiology 431 class, during 1995 Fall semester at Michigan State University, and the experts who participated in the study for their time and support. They meant much to me than words can describe.

Special thanks to Dr. Paul Hunt, Vice Provost of Libraries, Computing and Technology and to my friends, colleagues, and the management of the Computer Laboratory at Michigan State University, in particular, Dr. Lewis Greenberg, Diana D'Angelo and, Robert Matson for their unqualified support, encouragement, and the opportunities provided me at work, which, in many significant ways contributed to the completion of this study.

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Thanks to Mr. David Bolig and Nancy Lucas, of Michigan State University Libraries, for going beyond the call of duties to assist me in obtaining important resources for my research.

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Very special thanks go to my mother, Serah Obielodan, my brother, Joseph Obielodan, and other relatives for their unwavering love and support for me over the years. My success in life is in large measure due to their confidence in my abilities and capabilities, their moral and prayer support, and their enduring patience with me in my quest for "encyclopedic" knowledge. Most especially, special and deep thanks to my uncle and his wife, Michael and Lydia Obielodan, who, out of very little resources, raised me through my early years. Their unqualified love and support in sponsoring me from elementary through secondary education laid the foundation for my academic achievements and spiritual development. Thanks to them for being my hero and a model example of hard work, sacrificial love, and spiritual integrity.

Finally, there are many other friends and individuals who, although it is impossible to mentioned them individually, nonetheless, have inspired, encouraged, and supported me along the way, some consciously, some never knowing. Thanks to them for their love and kindness. God bless.

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CSTRA

Abbreviations used in three-dimensional plots of the perceptions of respondents in the Expert Rating Form Group regarding the level of importance of the courseware characteristics in promoting effective learning.

Variables	Characteristics
CCSCRNL	Consistency of the screen layout and elements (graphics, color, button, text, etc.
CCSCRNE	Coherence among screen elements or components (background, foreground, pages, navigational tools, etc.)
CMENU	The use of MENU to access information
CGRAPH	The use of graphics in enhancing learning of the course materials
CEPBEHA	Provides opportunity for the learner to practice making choices related to the attitude learned
CLOGORG	The logical organization of lesson content
CICHUNK	The amount (chunk) of information presented on each screen or in each lesson unit
CINTERA	The level or degree of interactivity the learner has with the lesson materials (opportunity for the learner to participate)
CNAVIGT	The use of courseware navigational tools (buttons, hotwords, etc.)
CHELP	The use of HELP function to get context sensitive information
CAPNOVP	Tests the learner on solving a variety of novel or unique problems
CGASITU	Introduction focuses learner attention on the learning situation or context
CSSCRNL	Simplicity of the screen layout and elements (graphics, color, button, etc.)
CLGFACT	Provides instruction to guide the learner in linking simple to more complex lesson content
CERSKIL	Provides additional opportunities for the learner to practice the skills learned
CNISIMP	Presents information in simple and concise statements
CLBWREV	Review of relevant content (prerequisite skills) at the beginning of the lesson
CAPCONC	Tests the learner on applying concepts and rules to new situations or examples
CAPPSIM	Tests the learner on making choice of action in a real or simulated situation
CERSREV	The use of spaced reviews including a variety of examples throughout the lesson
CNIACCU	Presents complete, accurate, or current lesson materials
COBJCON	Match between courseware objectives and lesson content
CLGSKIL	Requires the learner to practice the skills learned and provides feedback on the learner's performance
CUSEHOW	Directions on how to use the courseware
CCLAOBJ	Statement of objectives
CISTRAT	The use of instructional strategies (e.g., hints, examples, illustrations,

CTESTOB
CFEEDBK
CCATASK

CILCONC

CILFACT
CILPROB

CNVARY
CEPPROB

CPFFACT

CPFCONC

CPFPROB
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CSRCONC
CNSKIL

CPFCONS

CLGCONC

CSRFACT

CSRSKIL

CNTAUD
CPFSKIL

CEPSKIL

CSRESUB

CLGPROB

CAPSKIL
CNBEHA

	analogies, flowcharts, outlines)
CTESTOB	Match between performance tests and lesson objectives
CFEEDBK	Feedback to students responses
CGATASK	Introduction focuses learner attention on the tasks and skills to be learned
CILCONC	Describes and demonstrates concepts, principles, and procedures to be learned
CILFACT	States what the learner will be able to say or do after the lesson
CILPROB	Clarifies the general nature of problem solutions expected from the learner
CNIVARY	Presents varied examples of concepts and rules or principles
CEPPROB	Provides a variety of opportunities for the learner to practice or use cognitive strategies learned
CPFFACT	Confirms the correctness of learner's response to question about statements of facts
CPFCONC	Confirms the correctness of learner's use or application of concepts and rules
CPFPROB	Confirms the correctness of learner's solution to problems presented
CREVCON	Review of the main concepts and principles at the end of the lesson
CREVQUE	Review questions to clarify the lesson content
CLCONTR	Learner control over the rate of information presentation
CSRCONC	Stimulates recall of prerequisite concepts and principles or rules
CNISKIL	Presents instruction on and demonstrates proper steps required for the motor skill performance desired
CPFCONS	Shows direct consequences of personal actions taken or decisions made by the learner
CLGCONC	Provides instruction to guide the learner in following the proper sequence of steps to master the lesson content
CSRFACT	Stimulates recall of relevant facts and context that will make the learning tasks or processes meaningful
CSRSKIL	Stimulates recall of skills, situations and actions that will be involved in the learner making personal choices or decisions
CINTAUD	Identification of intended audience
CPFSKIL	Provides feedback on the degree of accuracy and timing of the learner's performance of skills
CEPSKIL	Provides opportunity for the learner to practice performing all physical skills or tasks taught in the lesson
CSRESUB	Stimulates recall of subskills (part skills) and the process of integrating subskills (executive subroutine) neccesary to learn the performance of the total motor skills desired
CLGPROB	Provides prompts and hints to help the learner find novel solution to stated problem
CAPSKIL	Tests the learner on using all physical skills taught in the lesson
CNIBEHA	Presents information to be learned about desired behaviors or attitudes by modeling or illustrating actions and consequences related to the behaviors or attitudes

CRCCO
CLOBEI

CSRBEH

CLSKIL

CLEVDI
CLBEH

CNCOG

CPFORIC
CCOMPL
CEPCON

CCERRO
CVISUAL
CBSCRN

CSEFECT

CTXTCO
CHLNKS
CTABCO
CGLOSSA

CTXTSIZ
CTXTSTY
CICONS
CANIMA
CVIDEO
CAUDIO
CNPROB
CEFFACT
CAFFACT

Note: When
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CRCCONT	Statement or demonstration of the courseware relevance to the learner
CLGBEHA	Describes or demonstrates the desired behavior or attitude by simulating, modeling, or illustrating actions and consequences related to the behavior or attitude
CSRBEHA	Stimulates recall of skills, by modeling or illustration, that the learner can imitate in learning new behaviors or attitudes
CILSKIL	Demonstrates performance of motor (physical) skills expected of the learner
CLEVDIF	The level of difficulty of lesson materials for the intended audience
CILBEHA	Provides example of the kind of behavior or attitude (action choice) expected of the learner
CNICOGS	Describes and shows the use of mental strategies or procedures to solve problems (e.g., strategy of asking proper questions; a strategy to "work the problem in steps backward from the goal")
CPFORIG	Confirms originality of learner's solution to problems presented
CCOMPLX	The complexity of lesson structure for the intended audience
CEPCONC	Asks the learner to apply concepts and rules to instances not previously encountered in the lesson
CCERROR	The ease of correcting errors (e.g., typing errors)
CVISUAL	General visual appeal of the overall screen design
CBSCRNL	Balance in the screen layout and elements (graphics, color, button, text, etc.)
CSEFECT	The use of special effects (text animation, highlighting, transition effects, etc.)
CTXTCOL	The use of color to enhance the readability of text
CHLINKS	The use of branching or hyperlinks
CTABCON	The use of INDEX or TABLE OF CONTENT to access information
CGLOSSA	The availability of GLOSSARY to provide meaning of terms or additional information
CTXTSIZ	The use of text sizes to enhance the readability of text
CTXTSTY	The use of text styles to enhance the readability of text
CICONS	The use of icons to communicate meaning or expected action
CANIMAT	The use of animations in enhancing learning of the course materials
CVIDEO	The use of video in enhancing learning of the course materials
CAUDIO	The use of audio in enhancing learning of the course materials
CNIPROB	Presents novel problems for the learner to solve
CEPFACT	Asks the learner for information in his/her own words
CAPFACT	Tests the learner on restating lesson information in his or her own words

Note: Wherever the first letter C of an abbreviation is followed by 1, 2, or 3, the abbreviation signifies a component characteristic of courseware 1, courseware 2, or courseware 3 respectively.

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CHAPTER I

INTRODUCTION

Statement of the Problem

The jury is still out among researchers and experts on the characteristics and objective measures of successful computer courseware. For the purpose of this study, successful computer courseware refers to any computer-based educational material (computer-based or computer-assisted instructional program with or without interactive audiovisual media components) that produces specified educational outcomes including learning motivation, learning achievement, and transfer of knowledge skills in effective and efficient ways.

Although the emerging technologies have been much heralded for their sophisticated capabilities to provide effective instruction (Bosco, 1986; Cronin & Cronin, 1992; DeBloois, 1988; Fletcher, 1990; Gayeski & Williams, 1985; Gold, 1989; Kalowski, 1987; Kearsley & Frost, 1985; McNeil and Nelson, 1991; Smith, 1987), claims of benefits from academic uses of new technologies are often based on anecdotal statements from faculty and students rather than on evaluation data secured by educational research methods (Boettcher, 1993). The lack of empirical, or objectively measured data, on the success, or efficacy, of computer courseware has generated a number of important issues and questions concerning the need for and viability of academic uses of computer-related technology systems (Hannafin, 1985; Boettcher, 1993). For instance, educational psychologists are concerned about the kinds of knowledge and knowledge representations for which en

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for which emerging technologies are most suitable. A closely related issue is the concern about the kinds of learning processes that emerging technologies best facilitate. There is also concern about the extent to which computer courseware incorporates research findings on instructional and learning theories about effective instruction and effective learning. Educators want to know how students learn from computer-based educational materials. They also want to know the cognitive effects that emerging technologies have on both students and faculty. Courseware developers are interested in knowing the factors that influence the effective and efficient utilization of the full instructional potentials of emerging technologies. Educational researchers and psychometricians are concerned about how to authentically measure or assess students' learning and achievement from using computer courseware. And administrators, publishers, and even students, are interested in knowing the worth of computer courseware.

The lack of empirical data on the effects of technology on learning was clearly noted in the Joe Wyatt project (Boettcher, 1993), the most seminal work to-date on the benefits of the use of information technology. As Boettcher (1993, p. 32), the Committee Chair of the Joe Wyatt project, stated:

> The committee accepted a wide range of type of data—including anecdotal statements from faculty and students—as evidence of benefit. The criteria for documenting the success of the story were straightforward, but not rigorous, despite a strong research orientation by the committee. Many of the projects measured student and faculty attitudes toward the use of the computer, rather than examining quantitative and qualitative measures of the effect of technology on learning.

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The paucity of traditional research-based data on the effectiveness of new information technologies may be attributed to the difficulty in applying "traditional requirements of educational research" to the instructional uses of the new technologies. The difficulty lies basically in the inappropriateness of traditional research methods as a means of securing data on the usefulness of information technology to provide effective instruction. In the words of (Boettcher, 1993):

> ... prominent research measures in use for most of the past fifty years reflected, and appropriately so, the characteristics of a curriculum and its associated teaching and learning resources. The characteristics of these new teaching and learning strategies and resources are different from those available in the past. The new resources provide much richer environments; they engage students much more interactively; the outcomes are less rigid and often can be only generally anticipated. The new learning tools, such as computer-assisted design tools and exploratory data analysis, and the new stimulated multimedia environments encourage and enable students to become actively engaged with interdisciplinary concepts, content, and relationships. The new learning tools require decision making and problem solving and, often, the actual production of designs and products.
>
> Evaluation measures have often focused on testing students' knowledge of factual dates, times, and places, as well as static concepts and situations. Instead, we need to be testing students' understanding of relationships, links, dynamic processes, and strategies.
>
> Once information technology transforms a course from a lecture class to a laboratory class and revises objectives, strategies, and content, then applying traditional evaluation methods becomes difficult. New and more powerful research design strategies and evaluative measures are needed to identify and capture data on the generative, interactive environments and on the generative constructionist learning that we believe is occurring.

Boettcher's assertions, in the Joe Wyatt project report, clearly present four issues of interest for further research on the academic uses of computer-related technology. The first issue is to determine the kind of educational goals that faculty seek to achieve in developing and/or using computer courseware. The second issue is to determine what the effects o

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effects of computer courseware are on teaching and learning processes. The effects may be specified or incidental, they may be enhanced knowledge and comprehension skills, they may be generative or high order cognitive skills (e.g., application, analysis, synthesis, and evaluation), and they may be quantifiable or may only be described. The third issue is to establish how the efficacy, or benefits, of computer courseware on teaching and learning processes can be measured. A closely related issue is concerned with the validity and reliability of the measures of effects obtained. The fourth issue is to determine the characteristics of successful computer courseware. This study is concerned about all but the first issue.

Purpose of the Study

This study was conducted to investigate factors and assess characteristics that determine the success or efficacy of computer courseware designed to support students' learning of college-level physiology concepts. The study serves four purposes. The first purpose was to determine the effects of using computer courseware programs designed to teach college-level physiology concepts on students' learning achievement. The second purpose was to assess the level of importance of computer courseware characteristics in promoting effective learning as perceived by experts. The third purpose was to assess the impact of the quality of computer courseware characteristics in promoting effective learning as perceived by both students and experts. The fourth purpose was to construct an evaluation framework that courseware developers, instructional designers, researchers, project managers, curriculum designers, educators, administrators, program evaluators, and manufacturers of software programs can use to analyze and assess computer courseware programs for the characteristics of instructional quality or efficacy.

Significance of the Study

The study makes a fundamental assumption that the success, or efficacy, of computer-based educational materials depends in large part on the application of instructional and learning theories to the development of computer courseware. Yet, many courseware programs produced and used today for classroom instruction, including college-level academic instruction, are developed based on intuitive hunches rather than on systematically documented, research-based instructional and learning theories. It must be underscored, of course, that in most cases the hunches come from many years of valuable classroom teaching experiences. The challenge posed by academic uses of non-theory based courseware programs is to understand the level of success of such programs, as well as the factors and characteristics that make them successful in promoting effective learning. One major importance of this study, therefore, is in constructing a framework for developing and evaluating successful courseware programs from the findings of the study. The framework will serve as a guide for courseware developers to ensure that their courseware programs fully incorporate research-based findings on the characteristics of effective instruction. It will also serve as a checklist for educators and anyone else concerned about selecting sound, quality courseware.

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This study extends the work accomplished on effective teaching in the classroom setting to the electronic teaching and learning environments which offer capabilities to teach and learn in ways not possible through conventional teaching (Boettcher, 1993, pp. 32-33). Like research on effective teaching in the classroom, this study was also concerned with the characteristics of effective instruction. However, the scope of this study went beyond research on effective instruction *per se*. In addition to assessing instructional activities and presentation of intellectual skills, which constitute the primary focus of research on effective teaching in the classroom, this study sought also to examine how unique pedagogical content and strategies are represented in computer courseware programs to promote effective learning. Another importance of the study, therefore, is gaining useful insights on the kinds of unique learning capabilities and effects that are made possible by the unique capabilities of computer-related technologies.

Research Questions

The research questions that guided this study were based on the purpose of the study. The main purpose was to investigate factors and assess characteristics that determine the success of computer courseware and to construct a framework for evaluating the efficacy or instructional quality of computer courseware programs. Several major sources of information influenced the formulation of the research questions, namely: literature review; my graduate classes in educational psychology; my nine years of experience to-are as a Hype

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date as a Hypermedia Consultant at Michigan State University developing and working with faculty to develop and use computer courseware; informal discussions with various courseware developers and experts at various professional conferences (Society for Applied Learning Technology, Consortium for Inter-Institutional Collaboration In African and Latin American Studies, etc.); my interaction with various electronic listservs devoted to discussions on issues relating to emerging technologies and educational psychology, including: EdTech listserv, American Educational Research Association (AERA) Curriculum listserv, and Problem-Based Learning (PBL) listserv; and my interaction with various World Wide Web (WWW) sites.

The research questions that guided the study were:

Broad Questions

A. What are the effects of computer courseware on students' learning achievement?

B. What are the student respondents' perceptions regarding the quality of the characteristics of computer courseware programs used in this study?

C. What computer courseware characteristics do experts perceive as important in promoting effective learning?

D. What are the experts' perceptions regarding the quality of the characteristics of computer courseware programs used in this study?

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<u>**Specific Questions**</u>

The main questions were subdivided into specific questions to further define the scope of the research. The subsidiary questions are presented under each main question below.

A. What are the effects of computer courseware on students' learning achievement?

<u>Research Question A1:</u> Does courseware usage predict the students' level of learning achievement?

<u>Research Question A2:</u> To what extent is the students' level of learning achievement dependent on factors other than the use of the computer courseware, for instance, the student respondents' demographic characteristics (gender, age, GPA, academic discipline, class level, previous experience with computers, and computer ownership)?

B. What are the student respondents' perceptions regarding the quality of the characteristics of computer courseware programs used in this study?

<u>Research Question B1:</u> What are the student respondents' perceptions regarding the quality of the characteristics of the computer courseware programs used in this study in promoting effective learning?

<u>Research Question B2:</u> Do the student respondents' perceptions regarding the quality of the computer courseware characteristics vary by their demographic characteristics such as: gender, class level, academic discipline, previous experience using computer productivity tools, previous experience using computer

courseware, previous experience with computer programming, or computer ownership?

Research Question B3: What other features of the courseware programs do student respondents perceive as unique and helpful in promoting effective learning?

C. What computer courseware characteristics do experts perceive as important in promoting effective learning?

Research Question C1: What are the experts' perceptions regarding the level of importance of computer courseware characteristics in promoting effective learning?

Research Question C2: Do the experts' perceptions regarding the level of importance of computer courseware characteristics in promoting effective learning vary by their demographic characteristics such as: gender, age, professional discipline, teaching experience, courseware development experience, experience using computer productivity tools, and computer ownership?

Research Question C3: What other features do experts perceive as important to the success of computer courseware in promoting effective learning?

D. What are the experts' perceptions regarding the quality of the characteristics of computer courseware programs used in this study?

Research Question D1: What are the experts' perceptions regarding the quality of the characteristics of the computer courseware programs used in this study in promoting effective learning?

Research Question D2: Do the experts' perceptions regarding the quality of the computer courseware characteristics vary by their demographic characteristics such as gender, age, professional discipline, teaching experience, courseware development experience, experience using computer productivity tools, and computer ownership?

Research Question D3: What other features of the courseware programs used in this study do experts perceive as unique and helpful in promoting effective learning?

Assumptions of the Study

An increasing phenomenon in educational practice today is the integration of computer courseware into classroom instruction by the same instructor who developed the program. There is no question that the instructors are experts in their academic disciplines. They may or may not be well grounded in instructional and learning theories, however. The challenge in this situation, as in any situation in which computer courseware is integrated into classroom instruction, is determining the success of academic uses of courseware programs developed by the same instructor who teaches the class. A sely rela

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closely related and heretofore elusive challenge is determining factors or characteristics that make computer courseware programs successful in promoting effective learning.

One possible solution to the problem of understanding factors that affect the success of computer courseware programs is to examine the programs in light of research-based instructional design theories. Most instructional design theories are derived from a plethora of research findings, especially the results of effectiveness studies in the classroom. This study assumed, therefore, that successful computer courseware programs will at least manifest characteristics of effective instruction and effective learning based on findings from research in the classroom.

The study assumed also that different courseware programs will, in varying degrees, incorporate sound instructional design theories and principles. The differences are assumed to be due to a combination of differences in courseware development experience and in the knowledge of instructional theories and design principles. Thus the more experienced the courseware developers, the higher the degree to which their courseware programs will manifest characteristics that promote effective instruction and learning and, therefore, the more likely it may be that the programs will succeed in promoting effective learning.

From the foregoing discussions, it is assumed that the different courseware programs used in this study will manifest different levels of characteristics of effective instruction and effective learning and, therefore, will differentially affect students' levels of learning achievements. In this case, the differences are assumed to be due to progression in the developer's experience in courseware development.

Another assumption of the study was that students will pay careful attention to courseware programs and gain significant learning achievements only if the courseware programs are fully integrated into academic curriculum. Thus, even when a program is well designed, consistent with instructional design principles, the full potential of the program to engender effective learning may not be fully realized if the program is made available only as an option.

The study assumed also that the students taking the course in which the computer courseware programs are used are fairly homogenous with respect to academic abilities. The students have fairly equivalent educational experience.

More importantly, the study assumed that the extent to which computer courseware succeeds in promoting effective student learning processes depends in large part on the degree to which the programs provide cognitive tools that challenge and allow the learner to find solutions to real life problems and to construct new knowledge. Only by fully integrating computers as tools for problem solving and knowledge construction into every aspect of an academic curriculum will there be any significant impact of computers on "meaningful learning" and academic achievement.

In sum, this study makes a fundamental assumption that the success of computer courseware programs in promoting learning achievement is a function of several factors including: the pedagogical content of the courseware programs, pedagogical strategies used in the courseware programs, how the programs are used, environmental variables that conditioned the use of the programs, characteristics of the learners, and the components

of the programs that interact with learners' characteristics and environmental variables to produce the observed effects.

Finally, the study assumed that Gagné's theory of instruction and multidimensional scaling procedure are appropriate theoretical framework and methodology to study the extent to which research-based findings about the characteristics of effective instruction and effective learning are incorporated into computer courseware programs. The combination of both the theoretical framework and the procedure will provide non-biased portrayal or representation of the content and potential effects of computer courseware.

These assumptions form the underlying rationale and thrust for this study. The justifications for the assumptions will be established in the section for theoretical framework and under literature review in the following chapter.

Theoretical Framework for the Study

Computer courseware is essentially an information processing system. As such, a meaningful understanding of the factors that influence the success of computer courseware programs requires an information processing theory-based framework for conceptualizing effective teaching and effective learning with computer courseware. Gagné's theory of instruction, based on cognitive information processing theory, provides a versatile theoretical framework for conceptualizing the psychological processes, or factors, that influence the success of courseware programs as instructional, as well as information systems. The theory provides a wealth of empirical research-based

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information for constructing an evaluation framework for deciphering components of the courseware programs that impact on the success of the information systems.

The cognitive information processing theory holds that learning is an active mental process of acquiring, remembering, and using knowledge. The process involves attention, selective perception, rehearsal, encoding, and retrieval of information that when properly orchestrated results in meaningful retention of information (Woolfolk, 1995; Travers et al., 1993). Meaningful retention or learning occurs when people obtain and process information in ways that solve problems or generate new insights (Woolfolk, 1995, p. 241). Retention is greatly influenced by the kind and strength of cues used in encoding information. The stronger and more varied the cues involved in information processing the more the information will be retained (Borsook and Higginbotham-Wheat, 1992; Driscoll, 1994, p. 96). The multi-sensory nature of new computer-related technologies offers a great potential of using cues that can significantly enhance learning processes. As Borsook and Higginbotham-Wheat (1992) noted, "Strong cues, such as those cues which may be generated in hypermedia, are more likely to be present at recall."

Gagné's theory of instruction is a particularly suitable framework for conceptualizing effective teaching and learning because it combines "a cognitive information processing perspective on learning with empirical findings of what good teachers do in their classrooms." (Driscoll, 1994, p. 330). Driscoll asserts also that the theory has served well as a "basic framework for a prominent instructional design theory" (p. 330). The theory offers a well-tested and validated comprehensive approach for conceptualizing multiple instructional methods for multiple learning outcomes (Driscoll, 1994, p. 333).

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Multidimensional scaling (MDS) procedure was utilized in this study to examine patterns of perceptions among experts with regards to the level of importance of characteristics of computer courseware in promoting effective learning. The MDS technique provides the ability to examine relationships among entities in similarity or dissimilarity matrices and offers a best fit to an Euclidean distance space with relatively few dimensions (Wilkinson, et al., 1992). The result of MDS analysis helps to simplify abstract and complex sets of relationships by reducing a matrix to a spatial analogue in which each entity is represented by its coordinates on a few dimensions (Kruskal and Wish, 1978). The MDS technique permits the use of data which satisfies minimal assumptions regarding level of measurement and satisfies some basic triangulation assumptions regarding relationships among entities (Kruskal and Wish, 1978; Donthu and Rust, 1989; Wilkinson, et al., 1992; Jones and Koehly, 1993).

The combination of Gagné's instructional theory, as a way of conceptualizing instructional and learning processes, and multidimensional scaling technique, as a procedure for understanding patterns perceptions, offers a set of powerful frameworks for understanding factors and characteristics that make courseware successful in promoting effective learning. The operationalization of the frameworks in this study should provide useful information on more effective ways to assess the results of academic applications of computer courseware.

Definition of Terms

In this study, important concepts are defined as follow:

Computer courseware — refers to any interactive educational material delivered by means of computers, or computer-related information technologies, including multimedia or hypermedia technologies, CD-related technologies, videodisc technology.

Courseware characteristics — refers to characteristics of effective learning and effective instruction incorporated into the computer courseware programs.

Courseware quality — refers to the degree to which courseware characteristics match research findings on effective instruction and effective learning using the rating scale: very good, good, fair, poor, very poor, and not applicable.

Effective instruction — refers to the achievement of specified educational (instructional and learning) outcomes.

Efficacy of computer courseware — refers to effective and efficient achievement of educational outcomes (including learning motivation, learning achievement, and transfer of knowledge skills) specified for the use of computer courseware. It refers also to the power (potential/ability) of any computer-based educational material (computer-based or computer assisted instructional program with or without interactive audiovisual media components) to produce specified educational outcomes including learning motivation, learning achievement, and transfer of knowledge skills in effective and efficient ways.

Efficient instruction — refers to the achievement of specified educational (instructional and learning) goals within the time framework (estimated or scheduled) for the completion of learning the computer courseware.

Expert — refers to any individual (university faculty or staff) with at least three years expertise or professional experience in college-level physiology instruction, classroom teaching using computer courseware, computer courseware development, instructional design, or research and evaluation.

Evaluation — is defined as a systematic process of gathering, synthesizing, and interpreting information in support of making prudent decisions about the quality of the object evaluated based on defined criteria

Learning processes — refers to how information is acquired, stored, manipulated, and retrieved.

Meaningful learning — refers to appropriate and effective use of relevant information, problem solving skills, and knowledge transfer, as well as generating useful information. It also refers to effective use of problem solving skills.

Learning motivation — refers to interest in learning. For the purpose of this study, the term refers to the computer courseware used in this study to generate and sustain students' interests in learning the content materials presented.

"The same instructor" — refers to a faculty member who developed computer courseware and also uses it as an integral component of an academic curriculum.

Pattern of courseware use — refers to patterns of students' behavior in using the computer courseware programs. Pattern of use is classified as follows: did not complete

any program, completed one program at least once, completed some program(s) once and some program(s) two or more times, and completed two or more programs two or more times.

Time on courseware — refers to the amount of time students spent interacting with computer courseware programs relative to the time specified for completing the programs. Time on courseware is categorized as follows: below specified (expected) time, within specified (expected) time, above specified (expected) time.

Successful computer courseware — refers to any computer-based educational material (computer-based or computer-assisted instructional program with or without interactive audiovisual media components) that produces specified educational outcomes including learning motivation, learning achievement, and transfer of knowledge skills in effective and efficient ways.

The Dissertation Plan

Chapter One of this dissertation presents the context for the study which includes the introduction, statement of the problem, the purpose, the significance of the study, research questions, assumptions, and the theoretical frameworks for the study. The chapter closes with the definition of terms and concepts used in the study.

Chapter Two presents a review of literature. It delineates the theoretical constructs underlying the study.

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Chapter Three describes the design of the study. It contains a description of the selection of subjects for the study, the methods employed for the study, the development of the research instruments, sources of data, and procedures for data collection and analysis.

Chapter Four presents data analyses addressing research questions A — effects of computer courseware in students' learning achievements. It also contains analyses of data collected to answer research question B — students' perceptions regarding the quality of the characteristics of computer courseware used in the study.

Chapter Five presents data analyses addressing research questions C — experts' perceptions regarding the level of importance of computer courseware characteristics in promoting effective learning. It also contains analyses of data collected to answer research question D — experts' perceptions regarding the quality of the characteristics of computer courseware used in the study.

Chapter Six presents the summary of findings, discussions, and conclusions of the study. It also contains recommendations for further studies and policy implications. In this chapter, a prescriptive framework for evaluating the success, or efficacy, of computer courseware based on the findings of the study and literature review is presented.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

This chapter reviews the literature from five major areas pertinent to this study: (1) effective teaching and effective learning; (2) technology in education; (3) cognitive information processing theory; (4) evaluation; and (5) multidimensional scaling. This review provides the basis for investigating ways of understanding and evaluating factors and characteristics that promote effective learning via computer courseware.

Effective Teaching and Effective Learning

Society has always been interested in understanding how teaching and learning occur. Various aspects of these topics have engaged the attention of researchers and scientists who study human thought processes and behavior. Research on these topics has traditionally focused on teaching and learning processes in the classroom. With the advent of modern technologies, however, research on teaching and learning processes has also focused on the role and effects of technology on the way we teach and learn.

In a comprehensive review of more than 650 studies of effective instruction conducted by Group for the Study of Effective Teaching (Lillie et al., 1989) listed sixteen characteristics of effective instruction which should also be the guiding "research-based instructional principles" for the design and development of computer-based instructional software. The review pointed out that students learn more when instruction (i.e., lessons and activities) incorporates these principles:

1. Beginning lessons with review
2. Beginning lessons with an introduction
3. Presenting instruction fluently and precisely
4. Using understandable language and concepts
5. Using relevant examples and demonstrations
6. Ensuring high rates of success
7. Presenting instruction at a brisk pace
8. Making smooth transitions within and between lessons
9. Making assignments and instructions clear
10. Summarizing the main points of the lesson
11. Maintaining reasonable standards
12. Checking student performance routinely
13. Posing questions one at a time
14. Providing instructional feedback
15. Affirming correct responses
16. Providing sustained feedback after incorrect responses

Similar factors that influence effective teaching have been identified by others. For instance, Mastropieri and Scruggs (1987, p. 4) identified the following as "general teacher-effectiveness" variables: time on task; content covered in terms of scope and sequence, objectives, and pacing; providing information, i.e., teacher delivery of content; questioning; feedback; guided and independent practice; and formative evaluation.

These principles have serious pedagogical implications. Any instruction that incorporates these principles can be expected to be effective. Conversely, any instruction that lacks any or some of these characteristics will be less than optimal in quality and effectiveness, and perhaps will be ineffective.

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Clearly, the body of literature on effective teaching is replete with very useful information on principles of effective instruction for either the classroom setting or computer-based instructional software. However, most of the work remains essentially prescriptive rather than a descriptive study examining the extent to which courseware programs actually incorporate the principles which facilitate learning processes.

Technology in Education

The computer technology has been hailed as perhaps the most significant innovation on the landscape of education since the advent or invention of printing technology. This section of the review of literature examines some of the important advances in computer-based technologies and their implications for instruction and learning.

Computers as Information Processing Systems

Computers are information processing systems with unprecedented capabilities. Their information processing capabilities far surpass those of other technologies including print, radio and television (Heinich, 1996; Kozma, 1991). For instance, unlike television that offer the viewer little or no control over the nature of televised information, the computer allows the user to work with data and information in dynamic and multi-dimensional ways. Whereas television viewers only have control over sound and video components of the information they receive (essentially by being able to turn them on or off), computer

users can work with and dynamically manipulate various forms of data and information including text, graphics, audio, and video.

> Computers can juxtapose, or transform, information in one symbols system to that in another ... A learner can type in printed text, and a computer can with a voice synthesizer transform it into speech. The computer can take equations, numerical values, or analog signals and transform them into graphs. (Kozma, 1991, p. 195).

Since the multi-symbol processing capability of computers make it possible for humans to process information in a variety of ways, computers hold a great potential for a wide variety of applications in education and training. Computers can facilitate teaching and learning at all levels of education and cognitive processes (Kleinman, 1984, p. 120). They can empower teachers to provide a wide variety of instructional materials to a variety of learner groups in highly effective, efficient, and motivating ways. Computer-related technologies, such as hypermedia systems, can provide opportunities for collaborative work and thereby foster meaningful interaction between the teacher and students or among students (OTA, 1991). The flexible information processing capabilities of computers make them powerful tools for learners to control their own learning experiences. Computers can enable learners to control the type and amount of information accessed, set the pace of learning, and experience dynamic and meaningful interaction with information. Computers can provide learning experiences which are not possible or very difficult to accomplish through other means.

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Technological Horizons in Education

Over the past decade, several forms of new information technologies have emerged over horizons in education and with important implications for educational practice. These technologies are commonly referred to in terms of either the functions they perform or the very nature of the specific technology. By functions, new information technologies may be referred to as new technologies, emerging technologies, computer-related technologies, multimedia, hypermedia, or hypertext. Often the technologies are referred to in terms of the specific nature of the technologies such as interactive video, digital video interactive (DVI), CD-ROM, compact disc interactive (CDI), or virtual reality. The element that is common to all the technologies is the utilization of computers to dynamically access and display a wide variety of "nonsequentially" organized and stored information including text, graphics, audio and video.

Hypertext, Hypermedia, and Multimedia

Distinctions have been made in the literature among technologies commonly referred to as hypertext, hypermedia and multimedia (Heinich et al., 1996). Hypertext is a term used to refer to computer-based "nonsequential documents" composed of text, audio, and visual information which are linked and annotated into a web of related chunks of information. In contrast, hypermedia is a generic term used in referring to a "computer hardware and software system that allows the composition and display of nonsequential documents that may include text, audio, and visual information and in which related information may be linked into webs by author or user." (Heinich et al., 1996, p. 407).

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Multimedia refers to computer hardware and software systems for the composition and display of presentations that incorporate text, audio, graphics, animation, and video images.

The constant and increasing change in the sophistication of new technologies has practically blurred any substantive differences among hypertext, hypermedia and multimedia technologies. Little or no differences exist today in the nature of the technologies used for creating hypertext, hypermedia, or multimedia applications. As such, the three terms are used interchangeably in this study.

Hypermedia systems hold great promise for providing effective instruction and meaningful learning experiences. They function in the same manner as the human mind processes information. The mind can organize or structure information by establishing relationships, links and associations among symbols, concepts and other forms of information. Similarly, hypermedia allows hyperlinks and annotation among related chunks of information. The similarity between hypermedia capabilities and the associative properties of the human mind offer the potential of extending human information processing abilities. Hypermedia can empower or enable individual learners to engage in active, as well as creative learning experiences. Also the multisensory capabilities of hypermedia technologies offer the potential for meaningful, "real-world" or "all-at-once", learning experiences for individuals and groups. As Heinich et al. (1996, p. 261) pointed out, "individual learners respond differently to various information sources and instructional methods, so the chances of reaching an individual are increased when a variety of media is used."

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Interactive Video

Computer-based interactive video system combines the technologies of computers and television to provide a multimedia learning environment in which audio, graphical, and video materials are presented under the control of the computer and/or the interactive responses of the users (Heinich, 1996; Semrau and Boyer, 1994; and Cronin and Cronin, 1992). As Heinich et al. (1996) described the technology, "The video portion of interactive video is provided through a videocassette, videodisc, or compact disc. The images can be presented in slow motion, fast motion, or frame by frame... The audio portion of a videodisc may occupy two separate audio channels, making possible two different narrations for each motion sequence."

Interactive video offers various levels of interactivity, random access, and branching capabilities. The Constant Angular Velocity (CAV) videodisc has capacity to hold 30 minutes of motion video or 54,000 frames of still images on each side. Combining these capabilities with powerful decision-making algorithms of authoring software programs offer the potential for providing learning environments in which learners can interact with materials at their own pace. A typical interactive video program provides "fully interactive response-driven instruction featuring embedded questions, response feedback, and branching within a lesson. In addition, student response records can be used to help make instructional decisions." (Heinich et al., 1996, p.268). Interactive video has played an important role in providing problem-solving and simulated learning experiences

especially in areas or fields that are too dangerous, costly, or take too much time to provide real-life learning experiences.

CD-ROM

CD-ROM is a high capacity optical storage medium with high quality audio capability. CD-ROM discs can hold over 650 megabytes worth of digital information including text, graphics, photo images, animation, audio, and video. The high capacity, ideal portability, durability, versatility for multimedia development, and decreasing cost of CD-ROM have gained the technology wide acceptability in education. CD-ROM is currently the preferred medium for a wide variety of applications in education including: making available significant and timely research databases such as the Educational Resources Information Center (ERIC) databases; publishing multimedia encyclopedias and other electronic books such as titles published by Discis Books; and delivery of interactive multimedia instructional programs such as: the Pathology Lab Review CD-ROM program, Exploring the Michigan State University Libraries, and a number of other CD-ROM based programs in which the present researcher has been involved in producing at Michigan State University. The search capabilities of CD-ROM technology can foster the attitude and skill of exploring interrelationships among concepts and ideas as between people, places, and events.

DVI/CDI

Digital video interactive (DVI) is a variant of the compact disc technology. DVI combines the powers of the computer, CD-ROM technology, and a video compression and decompression board to provide 72 minutes of full-motion video. A closely related technology to DVI is compact disc interactive (CDI) technology. CDI consists of a highly intelligent special compact disc player connected to a standard television set. It is used in providing programs or information that integrate text, audio, graphics, animation, and broadcast quality video.

Academic Uses of Computer Courseware

Computer courseware programs have been classified under several nomenclatures. Programs have been classified based on the type of instruction and/or learning experiences they provide and how a program is integrated into curriculum.

The traditional classification system used for categorizing educational software programs are: drill and practice, tutorial, problem solving, simulations, and intelligent tutoring systems. This category system is based on the role(s) that programs are designed to serve in learning processes. The roles are determined by the kinds of events of instruction the programs provide (Wager and Gagné, 1988).

How programs are integrated into an academic curriculum is another basis of classifying computer courseware programs. According to this category scheme, four basic

types of academic software exist (Syllabus, September 1994): stand-alone content software, software specifically designed for use with a textbook, software specifically designed for classroom interaction, and studyware.

Cognitive Information Processing Theory

Information Processing Components

The way the human memory functions is the primary lens through which information processing theorists view learning. The human memory is conceived to function much like the computer system. As Woolfolk (1995, p. 243) noted:

> Like the computer, the human mind takes in information, performs operations on it to change its form and content, stores the information, retrieves it when needed, and generates responses to it. Thus, processing involves gathering and representing information, or *encoding*; holding information, or *storage*; and getting at the information when needed, or *retrieval*. The whole system is guided by *control processes* that determine how and when information will flow through the system.

According to the cognitive information processing view, the human memory consists of three major components or processes. These are sensory memory, short-term memory, and long-term memory. Basically, the processes involve encoding of information "in the sensory register where perception determines what will be held in short-term memory for further use. Thoroughly processed information becomes part of long-term

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long-term memory and can be activated at any time to return to working memory." (Woolfolk, 1995, p. 244).

The sensory memory or register refers to a system of receptors which functions to hold sensory information very briefly. Each of the five senses (hearing, seeing, tasting, touching, smelling) has a sensory memory associated with it. And although they all operate alike (Driscoll, 1994, p. 69), each sensory memory functions in a unique way. As Woolfolk (1995, p. 245) noted, "The content of sensory memory resembles the sensations from the original stimulus. Visual sensations are coded briefly by the sensory register as images, almost like photographs. Auditory sensations are coded as sound patterns. It may be that the other senses also have their own codes."

In sensory memory, both perception and attention play critical roles in the selection and organization of information for further processing. It is perception that allows us to attach meaning to raw information received through our senses. The construction of this meaning is a function of both objective reality and prior knowledge. On the other hand, attention is the ability to focus on certain stimuli and ignore others. Woolfolk (1995, p. 246) underscores the importance of attention as follows:

> The first step in learning is paying attention; students cannot process something they do not recognize or perceive. Many factors in the classroom influence student attention. Eye-catching or startling displays or actions can draw attention at the beginning of a lesson.... Bright colors, underlining, highlighting of written or spoken words, surprise events, and changes in voice level, lighting, or pacing can all be used to gain attention.

Once information in sensory memory is transformed into patterns of images or sounds or other types of sensory codes, it passes into the short-term memory system. Short-

term memory is working memory which holds a limited amount of information briefly. According to Woolfolk (1995, p. 247) "The information in short-term memory may be in the form of images that resemble the perceptions in sensory memory, or the information may be structured more abstractly, based on meaning."

A number of processes can help to foster the retention of information in short-term memory. One strategy to keep information activated in short-term memory is to rehearse information mentally. Rehearsal which involves repeating information in the mind is known as maintenance rehearsal. Whereas rehearsal which involves associating new information with prior knowledge is known as elaborative rehearsal. Another strategy for keeping information activated in short-term memory is by the control process of chunking. This process involves grouping individual bits of data into meaningful larger units.

Information that is well activated in short-term memory (by control processes such as rehearsal and chunking) is commonly assumed to be well-learned. The well-learned information passes into long-term memory for permanent storage. The capacity of long-term memory is practically unlimited. However, much time and effort are required to process information for permanent storage in or retrieval from long-term memory.

The contents of long-term memory are regarded to be either visual images, or verbal units, or both. Thus, some cognitive psychologists maintain that information coded both visually and verbally is easier to remember. Others "suggest that many images are actually stored as verbal codes and then translated into visual information when an image is needed." (Woolfolk, 1995, p. 250)

The third stage in the information processing theory is the long-term memory. This memory represents the permanent storage of information. The long-term memory is commonly categorized as semantic, episodic, and procedural. While the episodic memory is memory for specific events, semantic memory "refers to all the general information stored in memory that can be recalled independently of how it was learned." (Driscoll, 1994, p. 86). In the words of Martindale (1991, p. 181), "Semantic memory contains the basic elements of knowledge, and episodic memory is made up from these elements."

Semantic memory is also referred to as memory for meaning. This memory is stored as propositions, images, and schemas. Woolfolk (1995, p. 250) defines images as "representations based on perceptions—on the structure, or appearance of the information...Images mirror what they represent—they preserve the physical attributes and spatial structure of information." Thus, images are useful in fostering conceptualization and proceduralization of practical operations as well as abstract reasoning. A schema, on the other hand, is an abstract data structure that organizes vast amounts of information. It "is a pattern or guide for understanding an event, a concept, or a skill." (Woolfolk, 1995, p. 251)

Procedural memory is the third category into which long-term memory is distinguished. This is the memory for how to do things. According to Woolfolk (1995, p. 254), "Procedural memories are represented as condition-action rules, sometimes called productions. Productions specify what to do under what certain conditions: if A occurs, then do B.... The more practiced the procedure, the more automatic the action..."

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Information processing in long-term memory, and thus learning, is affected by elaboration, organization, and context (Woolfolk, 1995, p. 254). Elaboration promotes learning as we apply our schemas and draw on prior knowledge to construct an understanding of new information. In the case of organization, Woolfolk (1995, p. 254) noted that: "Material that is well organized is easier to learn and to remember than bits and pieces of information, especially if the information is complex or extensive. Placing a concept in a structure will help you learn and remember either general definitions or specific examples. The structure serves as a guide back to the information when you need it." As for the role of context in information processing, learning improves when the context in which information will be recalled is linked with the physical and emotional aspects of the original context in which the information is processed.

Retrieval is another psychological process that plays a crucial role in learning. One way in which information is retrieved from long-term memory is through the spread of activation. This means that remembering, or retrieval of a piece of information, activates the recall of associated information. Another means of retrieving information from long-term memory is through reconstruction, a problem-solving process of "recreating information by using memories, expectations, logic, and existing knowledge." (Woolfolk, 1995, p. 255). Thus, given the right cues, information can be effectively retrieved from long-term memory.

In sum, the cognitive information processing theory suggests a number of psychological processes that are necessary to foster effective learning. The processes include raising attention, expectations, motivation, activating prior knowledge, and perfor

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performance monitoring (Shuell, 1992). A number of important theories of learning and instruction have evolved from the cognitive information processing theory in the efforts to apply it as a framework for conceptualizing educational practice, including the educational uses of computer courseware, as information processing systems. One such instructional theory is Gagné's theory of instruction. The next section briefly describes the theory as a framework for conceptualizing factors that influence the success of courseware programs in promoting effective learning.

Gagné's Theory of Instruction

Gagné's theory of instruction is a model example of a comprehensive instructional theory built on information processing theory. The theory incorporates multiple learning outcomes and provides multiple instructional models. As Driscoll (994, p. 333) noted, "Gagné's theory incorporates three major components: a taxonomy of learning outcomes, specific learning conditions required for the attainment of each outcome, and the nine events of instruction." Each of the components are briefly described in the subsequent paragraphs.

Learning Outcomes

Gagné (1985) describes five major categories of learning outcomes: (1) verbal information; (2) intellectual skills; (3) cognitive strategies; (4) attitudes; and (5) motor skills. Verbal information refers to "knowing what" or "knowing about" organized bodies of inf

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of information. Knowledge of verbal information is demonstrated in learners' ability to state previously learned material such as facts, concepts, principles, and procedures.

Intellectual skills refer to procedural knowledge. They are learning outcomes that involve "knowing how" to solve a problem, apply a rule, or use a concept. Intellectual skills are divided into five, hierarchically ordered levels: discriminations, concrete concepts, defined concepts, rules, and higher order rules.

Cognitive strategies are mental processes by which learners control their own feelings, learning processes, thinking, and constructing or choosing solutions to problems. According to Gagné (1985), cognitive strategies represent the executive control functions of the human information processing system. "As such," remarked Driscoll (1994, p. 341), "learners employ cognitive strategies to monitor their own attention, to help themselves better encode new information, and to improve their success at remembering critical information at test time." There are no specific, observable learning outcomes directly associated with cognitive strategies. As Driscoll (1994, p. 341) pointed out, "Frequently, because cognitive strategies are employed in the service of other learning goals, it is the attainment (or not) of those goals which is noticed."

Attitudes as learning outcomes refer to previously learned mental states that influence choice of personal action toward some objects, persons, or events. Attitudes may be learned as a means for achieving other learning outcomes or they may be learned as ends in themselves.

Motor skills refer to skillful execution of bodily movements. Gagné (1991) described motor skill as the "capability that enables the individual to execute some smoothly and precisely timed pattern of muscular movement such as is seen in swimming, in planing the edge of a board, or in printing a letter."

The differences inherent within the learning outcomes mean that each of the learning outcomes will differ with respect to instructional content, instructional conditions , and assessment procedures that are all designed to engender the learning outcome (Hannum, 1988). As Travers et al. (1993) aptly remarked, "Each of the learning outcomes demands a different set of conditions for optimizing learning, retention, and transferability." The next section describes various kinds of learning conditions that are required to bring about the learning outcomes.

Learning Conditions

Learning conditions are the essential building blocks for effective instruction. (Gagné and Driscoll, 1988). Both instructional goals and learning outcomes are achievable by the kinds of internal conditions activated and/or external conditions constructed to facilitate learning processes.

Verbal information is best learned when the information is presented in meaningful chunks and in a wide variety of meaningful contexts. Instructional strategies often used to facilitate effective learning of verbal information include imagery, cognitive organizers, themes, mnemonics. The strategies should be used to direct learners' attention to significant points by variations in print or speech (Driscoll, 1994, p. 345). The multisensory capabilities of multimedia technologies offer a great potential for providing learn

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learning experiences that draw learners' attention to distinctive features and ensure that cues used during initial learning match the retrieval cues.

In the case of intellectual skills, learning conditions must direct learners' attention to distinctive features of the concept or rule to be learned. Retention and transfer of intellectual skills are best facilitated by providing spaced reviews and opportunities for practice using a variety of examples and problems.

Conditions that promote effective learning and use of cognitive strategies include: demonstration of strategies to be learned, providing a variety of contexts for practice using the strategy, and providing informative feedback as to the creativity or originality of the learning outcome (Driscoll, 1994, p. 345).

Attitudes are learned primarily by modeling. The following conditions are required to effectively learn or establish attitudes: creating an expectancy of success associated with the attitude to be learned, making the modeling experience relevant to the learners' needs, providing opportunities to demonstrate choice of personal action related to the desired attitude, and providing feedback for successful performance (Driscoll, 1994, p. 349).

Motor skills "consist of component skills that must be mastered separately before they can be assembled into the single, terminal performance." (Driscoll, 1994, p. 350). Therefore, conditions for effective motor skill learning include: presenting learning guidance to cue the executive subroutine, providing opportunities for practice, presenting immediate feedback concerning the accuracy of performance, and providing encouragement to use mental practice.

In sum, learning conditions are essential factors for achieving learning outcomes. They constitute the building blocks for instruction. Conditions of learning include internal and external conditions. While internal conditions refer to prerequisite skills, external conditions refer to various ways that instructional events outside of the learner function to activate and support internal processes of learning. Gagné referred to pedagogical strategies as events of instruction (Gagné, 1985). The events of instruction provide ways of determining prescriptions to facilitate different types of learning outcomes.

Events of Instruction

Gagné proposed nine events of instruction to facilitate activation and regulation of executive control processes that modify flow of information as it passes through the stages of memory. Table 2-1 presents the nine events of instructions together with the internal processes that they support.

Table 2-1: Events of instruction and their relation to processes of learning

	Instructional Event	Internal Learning Process
1	Gaining attention	Attention; alertness
2	Informing learner of the objective	Expectancy
3	Stimulating recall of prerequisite learning	Retrieval of prior learning to working memory
4	Presenting stimuli with distinctive features	Pattern recognition; selective perception
5	Providing learning guidance	Semantic encoding; cues for retrieval
6	Eliciting the performance	Retrieval and responding
7	Providing feedback about performance correctness	Reinforcement
8	Assessing the performance	Cueing retrieval; retention
9	Enhancing retention and transfer	Retention, retrieval, and generalization

The nine events of instruction are necessary ingredients for effective learning. Thus, the purpose of "gaining attention" is to focus learners on the tasks to be learned. Providing learners with instructional objectives help them to know the criteria to be mastered and when they have been achieved. Recall of relevant prerequisite information into active memory is crucial to the acquisition of complex or integrative skills. The presentation of the stimulus material is the heart of instruction. The stimulus material presented depends on the goal of the instruction. However, as Driscoll (1994, p. 353) aptly remarked, "For all types of outcomes, the stimulus presentation should emphasize distinctive features or essential elements of the desired outcome in order to facilitate the processes of pattern recognition and selective perception." To that end, "techniques such as simplifying a display, voice inflection, underlying, encircling, pointing at, or enlarging might be used to be sure that learners attend to relevant instructional features." (Okey, 1991). In terms of providing learning guidance, the purpose is to help and ensure that learners acquire the particular capabilities specified in the objectives. The instructional event involves modeling or showing learners what appropriate actions constitute correct performance (Okey, 1991). Eliciting performance is the instructional event that requires the learner to demonstrate mastery of the newly learned stimulus material. Its purpose is to show whether or not the learned capability has been stored in long-term memory. The response required from the learner must match that required in the objective as a way of providing practice that is relevant to the desired outcome. Informative feedback is provided to apprise learners of the correctness or accuracy of their performance.

Feedback functions to correct learners' misconceptions or provide extended elaboration on the knowledge or skill to be learned. The next event of instruction is assessing performance. Performance assessment is concerned with exhibiting complete demonstration of the learning outcomes at the close of the instruction. The purpose is to establish the degree of retention of the new learning as well as to provide additional practice. Retention of all learned capabilities is further enhanced by providing additional practice in a wide variety of instances. Learning in a variety of contexts enhances the ability to transfer or apply knowledge learned in settings and situations different from the initial learning contexts.

For effective application of the events of instruction, the events must be designed and implemented in ways that meet the specific requirements of each type of learning outcome. The need for differential implementation of instructional events stems from different functions served by the events. Aronson and Briggs (1983) classified the nine events of instruction into two main categories according to their functions. One category consists of events that "function in essentially the same way regardless of the type of learning" (p. 93). The events in this category include gaining attention, informing the learner of the objective, eliciting performance, and providing feedback. The essential function of this group of events is to facilitate an expectancy of the results of learning. The second category consists of events that "function entirely differently depending on the type of learning" (Aronson and Briggs, 1983, p. 83). Included in this category of events are stimulating recall of prerequisite learnings and providing learning guidance. Two factors account for the differential effects of the events of instruction. First, "The nature of the essential prerequisites for stimulating recall of prerequisite learnings is different for each type of outcome because the internal conditions are different." (Aronson and Briggs, 1983, p. 93). The second factor is that "the function of learning guidance will be different for each type of learning because the external conditions are different. Thus, the instructional prescription is often determined by the kind of learning guidance that is required." (Aronson and Briggs, 1983, p. 93). Ultimately, practical applications of the events of instruction depend on the characteristics of the learner and the nature of the learning situation.

As Driscoll (1994, p. 351) pointed out, "the manner in which the events are implemented may vary greatly depending upon the instructional delivery system that is chosen." As such, the process of applying the events of instruction often involves making prescriptions for the use of various media. Instructional media refers to "all means by which stimuli are presented to provide the events of instruction. In this sense, media include the full range of audiovisual materials, print, and the voices of the teacher and learners." (Aronson and Briggs, 1983, p. 93). The use of media must be matched with learner characteristics and task variables. As a rule of thumb, prescriptions for media use should be sequel to and determined by specification of the requirements for providing the instructional events for a given instructional sequence.

Summary

The cognitive information processing theory, out of which grew Gagné's theory of instruction, was presented as a basic framework for conceptualizing instructional and learning processes. Information processing theory specifies or describes conditions and processes that control how humans acquire and use information. In a similar fashion, Gagné's theory of instruction stipulates a variety of ways in which learning outcomes, conditions of learning, and events of instruction can be orchestrated to facilitate encoding of information or enhance meaningful learning. Whereas "the conditions of learning include both internal events (such as previously encoded information) and external events (such as methods of elaboration to facilitate encoding) ... the events of instruction refer to methods or procedures designed to facilitate the specific processes (such as encoding, retention, retrieval, etc.) thought to occur during learning." (Driscoll, 1994, p. 333).

Gagné's theory of instruction has practical use for instructional design and evaluation of learning systems and processes. As Aronson and Briggs (1983) stated: "Understanding how instructional events function in different learning situations and for different types of learning provides direction to the designer in making appropriate instructional prescriptions." And, as Travers et al. (1993, p. 371) pointed out, Gagné's events of instruction serve as a model that "provides an instructional basis for analyzing the interaction of internal events with external events, which makes the model applicable to instruction of many forms in a wide variety of settings." Lessons designed based on Gagné's instructional design theory will manifest specified learning outcomes, well organized instructional events that are appropriate for each kind of learning outcome, and how instructional events are exemplified for different kinds of outcomes. The key elements of the learning outcomes, the conditions of learning, and the events of instruction formed the substance of the characteristics or variable categories for content analysis of the computer courseware programs under study.

Evaluation

This section of the literature review focuses on evaluation. The section is organized into the following parts: Definition of Evaluation, Function of Evaluation, Evaluation Models and Approaches, and Evaluation of Computer Courseware.

Definition of Evaluation

Evaluation has been defined differently by different people relative to its purpose and function (Wolf, 1984, p. 2). One of the earliest and highly influential definitions of evaluation was proposed by Ralph Tyler. Tyler (1950, p. 69) defined evaluation as "the process of determining to what extent educational objectives are being realized." Basic to the Tylerian view of evaluation is the principle that "evaluation should judge that a program is good if, and only if, its objectives are achieved." (Alkin and Ellett Jr., 1994).

Stemming from Tyler's conception of evaluation is Provus' Discrepancy Evaluation. Provus (1971) defined evaluation as the comparison of performance to some standards to determine whether discrepancies existed. Any observed "discrepancy information" is utilized for program improvements.

A widely accepted definition of evaluation has been that of the systematic investigation or assessment of the worth or merit of some educational objects (Scriven, 1967; Joint Committee, 1981; Brinkerhoff, et al., 1983). For instance, Smith and Glass

(1987, p. 30) defined evaluation as "the process of establishing value judgments based on evidence about a program or product." Borg and Gall (1983, p. 733) defined educational evaluation as "the process of making judgments about the merit, value, or worth of educational programs, projects, materials, and techniques."

Evaluation has also been defined in terms of providing information for decision-making. One of the best representations of this decision-oriented definition is provided by the Phi Delta Kappa (PDK) National Study Committee on Evaluation. The PDK defined evaluation as "the process of delineating, obtaining, and providing useful information for judging decision alternatives (Stufflebeam, et al., 1971, p. 40). Similarly, Beeby (1977) defined evaluation as "the systematic collection and interpretation of evidence, leading, as part of the process, to a judgment of value with a view to action."

The definition of evaluation considered most appropriate for this study is that given by Dick and Carey. According to Dick and Carey (1991, p. 227), evaluation involves "gathering information in support of making prudent decisions.' The process encompasses "clarifying the decisions to be made, deciding what information will be useful in aiding the decisions, and then gathering, synthesizing, and interpreting the information. Interpretation requires making judgments about the quality of the object evaluated that are based on defined criteria." (p. 227).

For the purpose of this study, therefore, evaluation is defined as a systematic process of gathering, synthesizing, and interpreting information in support of making prudent decisions about the quality of the object evaluated based on defined criteria. The primary goal of evaluation is improvement of quality and determination of success of programs, projects, materials, and techniques.

Function of Evaluation

Evaluation serves formative and summative functions (Scriven, 1967; Brinkerhoff, et al., 1983). Formative evaluation is concerned with providing data to assist in improving on-going program or project development. In contrast, summative evaluation is concerned with providing data for determining the worth, value, or overall effectiveness of programs, products, or procedures. Stufflebeam (1971) referred to formative evaluation as proactive evaluation intended to serve decision-making, and to summative evaluation as retroactive evaluation meant to serve accountability.

Formative evaluation is often conducted by internal evaluators, that is, individuals or teams who are directly involved in the development of the program. The individuals or team members may perform a dual role by being both developers and evaluators. In contrast, summative evaluation is often conducted by external evaluators, or a team comprised of internal and external evaluators. External evaluators are individuals not directly involved in the development of the program and may be from outside the organization.

Evaluation Models and Approaches

Evaluation models can either be descriptive or prescriptive in nature. As Alkin and Ellett Jr. (1994), succinctly stated, "Evaluation models either describe what evaluators do or prescribe what they should do." Alkin and Ellett Jr. (1994) described prescriptive and descriptive models as follow:

> (a) A prescriptive model ... is a set of rules, prescriptions, prohibitions, and guiding frameworks, which specify what a good or proper evaluation is and how evaluation should be carried out. Such models serve as exemplars.
> (b) A descriptive model is a set of statements and generalizations which describes, predicts, or explains evaluation activities. Such models are designed to offer an empirical theory.

The focus of this study is concerned primarily with the prescriptive models of evaluation. Therefore the review of literature on evaluation models focused essentially on evaluation procedures and approaches.

A variety of prescriptive models and approaches have been developed as guidelines or strategies for conducting evaluation studies (Kemp et al., 1994; Dick and Carey, 1991; Alkin and Ellett, 1994; Flagg, B. N. 1990). Attempts to describe and explain various evaluation procedures and approaches have led to a number of classification schemes. Alkin and Ellett Jr. (1994) pointed out that the basis for determining a category system for an evaluation model is the relative emphasis or importance placed on each of the three component parts of the evaluation model. The three aspects of an evaluation model are: methodology, values, and uses.

In relation to program evaluation, Worthen (1990) classified evaluation models into five categories of approaches:

1. Performance-Objectives Congruence Approaches, which conceive of evaluation as the process of determining the extent to which specified educational objectives are actually attained. Discrepancies between the learner's performance

and stated objectives provide information for revising the educational program or instruction. Originally formulated by Tyler, this evaluation approach had great influence on the formulation of Hammond's EPIC evaluation model, Provus discrepancy model of evaluation , and Popham's instructional objectives approach.

2. Decision-Management Approaches, which describe appropriate evaluation activities throughout the life-cycle of an educational program. This evaluation approach is best represented by Stufflebeam's Context, Input, Process, and Product (CIPP) evaluation model (Stufflebeam, 1971) and Alkin's UCLA Evaluation Model (Alkin, 1969).

3. Judgment-oriented Approaches, which require experts to render a professional opinion about the quality of an instructional program, procedure, or product. This approach is represented by Scriven (1967), Stake's Countenance Model (1967), and Eisner's "connoisseurship model" (1979).

4. Adversarial Approaches, which refer to all evaluations in which there is planned opposition in the points of view of different evaluators or evaluation teams. As Worthen (1990, p. 45) stated:

> One evaluator (or team) would serve as the program's advocate, presenting the most positive view of the program possible from the data, while another evaluator (or team) would play an adversarial role, highlighting any extant deficiencies in the program. Incorporation of these opposing views within a single evaluation reflects a conscious effort to assume fairness and balance and illuminate both strengths and weaknesses of the program.

Models of adversary evaluations in education include judicial, congressional hearings, and debate models.

5. Pluralist-Intuitionist Approaches, which consider the evaluator as "a portrayer of different values and needs of all the individuals and groups served by the program, weighing and balancing this plurality of judgments and criteria in a largely intuitive fashion." (Worthen, 1990, p. 45).

In addition to the classification schemes described in the foregoing discussion, other category systems have been used as frameworks for conceptualizing evaluation models and approaches. As stated earlier, evaluation models are often categorized by the functions and needs they serve. For instance, evaluation models and procedures have been categorized depending on whether they serve formative and summative functions.

Four types of formative evaluation have been identified in the literature on evaluation models (Tessmer, 1993; Dick and Carey, 1991). These include one-to-one trials, small-group trials, field trials, and expert review.

Computer Courseware Evaluation

Several models of computer courseware evaluation can be deciphered from the literature on computer courseware. The traditional or classical model of computer courseware evaluation involves comparison of computer courseware (CAI, CBE, CAL, IVI, etc.) to another method of instruction, such as a different form of instructional technology, or traditional classroom instruction. The general thrust of the comparative experimental studies model has centered on finding statistically significant effectiveness differences between computer courseware and another method of instruction. For the most part, the results of the comparative studies model of courseware evaluation, like those from the forebear media studies, have been "no significant differences" in effectiveness among technologies under comparison (Clark, 1983; DeBloois, 1988; Reeves, 1991). The classical approach has revealed little or no information concerning factors or features that influence the success of computer courseware. Information about how to improve or develop better courseware is not engendered as well (Reeves, 1991, p. 90).

A second model of computer courseware evaluation is the courseware checklist approach. Typically, a courseware evaluation checklist consists of items concerned with "how well the courseware fits within the context of the total course, the appropriateness of text and graphics presentations, test provisions, and to lesser extent, how well user characteristics have been considered." Criswell and Swezey (1984, p. 43). Courseware evaluation checklists are often constructed as design evaluation criteria to guide formative evaluation of the courseware development process. Typically, courseware checklists are used in evaluating computer courseware for purposes of selecting educational software for curriculum adoption. As Criswell and Swezey (1984, p. 43) pointed out, courseware evaluation checklists are particularly useful "where experimental data are not available." A fundamental shortcoming of many courseware checklists is their lack of grounding in theory of instruction.

Another model of computer courseware evaluation is the computer modeling approach. Reeves (1991, pp. 93-95) delineated two forms of computer modeling approaches to understanding the impact of computer courseware. The first approach is program modeling which involves structured decomposition. Reeves (1991, p. 94)) defined structured decomposition as "the breaking of an instructional program into its component parts from the broadest level of global conceptualization to the lowest level of generality at which meaningful decisions can be made." Once an instructional program is structurally decomposed, the "program components as well as input and output measures relevant to the educational context can be analyzed using statistical procedures such as commonality analysis..." (p. 94).

The second approach to computer modeling "involves adapting existing theories of instruction into a model" for analyzing technology-based interactive instruction. According to Reeves (1991, p. 94), "Extensive measurements of each element in the model will be subsequently analyzed using a variety of path analysis and 'soft modeling' approaches ... The goals of this analysis are to test the overall predictability of the model and to estimate the relative instructional effectiveness of each of the model's elements." One way to operationalize the computational modeling approach is "to construct models of the effective dimensions of IMM (interactive multimedia) such as interactive video, collect relevant data, analyze the data with computer modeling methods, and thus improve our understanding of effective instructional dimensions "bit by bit." Reeves was deeply convinced in the promise that the computational modeling approach holds to "provide us with the new 'tongues' we need to preserve complexity and advance the science and art of IMM." (1991, p. 95).

Like other forms of courseware evaluation, however, the computational modeling approach presents difficulty in estimating the impact of computer courseware. As Reeves (1991, p. 94) eloquently stated the problem, "direct measurement is elusive."

Human learning is a complex phenomenon. The complexity is further compounded when the context and means of pedagogy involves computer courseware. No one methodology can provide unequivocal support for the worth or usefulness of computer courseware. As such, a meta-analytic or multidimensional methodological model of courseware evaluation is required to obtain authentic and sufficient data to establish what works, or does not, with regards to academic uses of computer courseware. The present study coalesces salient features of different forms of courseware evaluation into a framework model tailored for evaluating characteristics of computer courseware in promoting effective learning.

Multidimensional Scaling (MDS) Procedure

Wilkinson, et al. (1992, p. 124) defined multidimensional scaling (MDS) as "a procedure for fitting a set of points in a space such that the distances between points correspond as closely as possible to a given set of dissimilarities between a set of objects." The set of objects may be "stimuli, individuals, or the relationships between stimuli and individuals" (Jones and Koehly, 1993, p. 95).

The input for the MDS procedure can be either proximities data or preference data (Donthu and Rust, 1989; Kruskal and Wish, 1978). While proximities data represent how similar or dissimilar pairs of objects are, or are perceived to be, preference data represent how objects are ranked. The greater the similarity between objects or variables, the closer the data points in a spatial or geometric configuration that constitutes the MDS results.

The utility of the MDS procedure lies in its power to reveal the latent structure of data points or relationships among variables (Kruskal and Wish, 1978). Jones and Koehly (1993, p. 95) assert that multidimensional scaling "can be used to reveal and quantify the structure of complex stimulus domains, isolate and identify individual differences in perception, cognition, and preference, and measure changes in perceived structure over time, across subject populations, and experimental interventions." As a data reduction technique, the MDS procedure "provides a visual representation of a reduced set of data which is often easier to interpret than the data itself." (Donthu and Rust, 1989). It can be used to transform a series of unidimensional relationships into multidimensional expressions, thereby allowing relationships to be shown in both visual and numerical formats (Kress and Synder, 1994; Donthu and Rust, 1989). The MDS procedure is thus especially robust in providing greater insight into patterns of relationships between or among variables.

There are two major multidimensional scaling models. An MDS model can be either metric or nonmetric (Donthu and Rust, 1989; Jones and Koehly, 1993). According to Donthu and Rust (1989, p. 48), "Fully metric methods require ratio-scaled distances as input. MDS uses ratio-scaled distances to find a configuration whose interpoint distances are proportional to the input data." The nonmetric MDS models may be "fully nonmetric" or simply "nonmetric". The fully nonmetric MDS models assume only rank order of input distances. As Donthu and Rust (1989, p. 48) asserted, the objective of the fully nonmetric MDS models "is to find a space of minimum dimensionality and determine the rank order of each point on each dimension in turn." One shortcoming of the fully nonmetric MDS models is that they do not provide a configuration of points in space. In short, the fully nonmetric output provides hardly any useful insight into new information. In contrast, the simply nonmetric methods combine the best aspects of fully metric and fully nonmetric approaches. According to Donthu and Rust (1989, p. 49), "Nonmetric methods accept rank ordered (ordinal) input data and find a configuration whose rank order of ratio-scaled distances best produces the original input ranks." In essence, nonmetric MDS models allow monotonic transformations of nonmetric data into ratio-scaled output.

Jones and Koehly (1993, p. 104) listed four types of data that can be collected for the MDS procedure: (1) any type of proximity measure for all pairs of stimuli; (2) objective measures of the stimuli; (3) ratings of the stimuli along unidimensional attribute scales; and (4) personal information about the respondents. As they pointed out, "Information of the last three types is used as an aid to interpretation of the dimensions and configuration derived via MDS of the dissimilarities data, and to explore or identify individual and group differences in perception or construal of the stimuli." (p. 104).

The MDS procedure has been used in many fields for a variety of different purposes (Donthu and Rust, 1989; Kress and Snyder, 1994; Kruskal and Wish, 1978). The following list, from the editor's introduction to the text by Kruskal and Wish (1978, p. 6), describe some of the more common uses of the MDS techniques:

- Psychologists ... have used them to understand the perception and evaluation of auditory stimuli (such as speech and musical tones), visual stimuli (such as colors and faces), and social entities (such as personality traits and social situations).

- Sociologists have used these methods to determine the structure of groups and organizations, based on members' perceptions of one another and their interaction patterns.

- Anthropologists have used these methods for comparing different cultural groups, based on their beliefs, language, and artifacts.

- Economists and marketing researchers have used these methods for investigating consumer reactions to a wide variety of product classes.

- Educational researchers have used these methods to study the structure of intelligence, of different test batteries, and of classroom environments.

In the present study, the multidimensional scaling procedure is employed to determine specific patterns of relationships that may exist in the perceptions of the experts regarding the level of importance of the characteristics of computer courseware in promoting effective learning.

CHAPTER III

RESEARCH DESIGN AND METHODOLOGY

Introduction

This study was conducted to investigate factors and assess characteristics that determine the success, or efficacy, of computer courseware designed to support students' learning of concepts in college-level physiology. There were four purposes for conducting the study. The first purpose was to determine the effects of using computer courseware programs designed to teach physiology concepts on students' learning achievement. The second purpose was to assess the level of importance of computer courseware characteristics in promoting effective learning as perceived by experts. The third purpose was to assess the impact of the quality of the characteristics of the computer courseware programs used in this study in promoting effective learning as perceived by both students and experts. The fourth purpose was to construct an evaluation framework that courseware developers, instructional designers, researchers, project managers, curriculum designers, educators, administrators, program evaluators, and manufacturers of software programs can use to analyze and assess computer courseware programs for the characteristics of instructional quality, or efficacy.

The research design for this study utilized an achievement test to collect data on students' performance based on the use of computer courseware in the academic curriculum under study. Three evaluation checklists, in the form of survey questionnaires, were developed by the researcher and employed to collect data about perceptions regarding the characteristics of computer courseware in promoting effective learning from both the students who used the courseware programs in the Physiology 431 class and some selected experts. Statements describing those characteristics were rated by one group of experts in terms of the level of importance of each characteristic and by a second group of experts in terms of the quality of the characteristics as manifested in the courseware programs under study.

Subjects

Three groups of subjects participated in this study. The first group consisted of the students who used the three computer courseware programs under study. This group of students took the Physiology 431 class taught by Dr. Thomas Adams, in the Physiology Department at Michigan State University, during the Fall Semester of 1995. The letter that requested the permission of the faculty to use the class and courseware programs for the study is presented in Appendix D.

The students represented three categories of academic disciplines or career paths which were: pre-medicine, natural science, and humanities. Random assignment of student subjects to treatment groups was not possible due to ethical considerations. It would have been unethical to allow some students to use all the courseware programs while denying other students access to some or all of the courseware programs. However, all the students in the Physiology 431 class were encouraged to use the courseware programs under study on a voluntary basis. Dr. Adams had indicated that in the past, while a vast majority of students in the class used the programs, a few students did not. It was assumed, therefore, that the self selection process would operate in a similar way in this study.

The second group of subjects consisted of experts selected mostly from Michigan State University. A few other experts were selected from other institutions of higher learning, but only one of them returned the survey questionnaires on time and with sufficient or complete response. The experts were comprised of faculty with experience in courseware development and integration into academic curriculum, staff with professional careers in courseware development, instructional designers, educational researchers or psychometricians, and educational psychologists. The experts rated the level of importance of the characteristics of computer courseware programs in promoting effective learning.

The third group of subjects consisted of experts with professional experiences similar to those of the experts in the second group. They were drawn also mostly from Michigan State University. These experts assessed the extent to which the quality of computer courseware characteristics helped in promoting effective learning.

Instrumentation

Four instruments were used for the research data collection. The first instrument was a set of achievement tests that were developed and administered by the faculty who taught the course in which the courseware programs were used. The achievement tests were administered to measure students' learning achievement in Physiology 431 class where the courseware programs under study were used. The other instruments were constructed based on literature review (Good and Brophy, 1995; Driscoll, 1994; Kemp, 1994; Okey, 1991; Carey and Dick, 1991; Gagné et al., 1991; and Lillie and Stuck, 1989).

The second instrument, developed by the researcher, was the Computer Courseware Evaluation Form (Appendix A) that students filled out in conjunction with using the different computer courseware programs under study. The instrument had two parts. Part A centered on the characteristics of courseware content and the characteristics of instructional procedures used in the courseware programs. Measurement of Part A was based on a six-point, Likert-type response that allowed the respondents to rate their opinion or perception about the quality of the characteristics of the courseware programs used in the study in promoting effective learning.

The rating scale ranged from "not applicable" to "superior" as follows:

1 - Not applicable (or absent)	4 - Average
2 - Inferior	5 - Above average
3 - Below average	6 - Superior

Part B of the Computer Courseware Evaluation Form requested students who used the courseware programs in the Physiology 431 class and also volunteered to participate in the study to complete the following demographic information: gender, age range in years, GPA, academic discipline, class level, total credits earned at Michigan State University, previous experience in using computer productivity tools, and computer ownership. The student respondents also supplied information regarding the average number of times per week courseware programs were used, average amount of time per week courseware programs were used, their opinion on the helpfulness of the courseware programs in learning the lesson materials presented, whether they would recommend the courseware programs to other students, and whether they would like to use similar courseware programs in other college courses. Due to the composition of the student group and the nature of their responses concerning a number of demographic variables, some of the personal demographic characteristics were recoded after data collection in order to have meaningful data analysis and interpretation.

Also, the students were requested, in open-ended questions, to write any comments about the courseware programs used in the study. The comments were requested as a way to uncover any features of the programs that may not be indicated as courseware characteristics in Part A of the evaluation instrument but, nonetheless, were perceived by the students as unique and helpful in effectively learning Physiology 431 lesson materials.

In order to establish the validity of the Computer Courseware Evaluation Form instrument, the four doctoral committee members at Michigan State University initially critiqued the instrument for internal consistency, appropriateness, and clarity of questions. Similar information was obtained by pre-testing the instrument with a group of students in the Physiology 431 class, the population from which the sample for this study was drawn. The subjects who participated in the pilot study indicated that the instrument was clear and meaningful. Comments provided both by the doctoral committee members and students in the pilot study group were used in revising the evaluation instrument.

The Cronbach's alpha reliability coefficient was used to estimate the internal consistency measure of the reliability of the evaluation instrument in measuring the students' perceptions regarding the quality of the characteristics of computer courseware programs in promoting effective learning. Table 3-1 presents the alpha values obtained.

In general, 0.6 is the minimum acceptable alpha level of internal consistency (Ary, Jacobs, and Razavieh, 1990, pp. 281-282). In this study, all of the items examined relating to the Computer Courseware Evaluation Form had a reliability coefficient of greater than 0.6.

Table 3-1: Cronbach's alpha reliability coefficient of the items on the Computer Courseware Evaluation Form

	Description	Number of Items	Reliability Index
a	The quality of representation of courseware 1 lesson content	18	.9733
b	The quality of representation of instructional procedures used in courseware 1	12	.9386
c	The quality of representation of all courseware 1 characteristics	30	.9813
d	The quality of representation of courseware 2 lesson content	18	.9696
e	The quality of representation of instructional procedures used in courseware 2	12	.9554
f	The quality of representation of all courseware 2 characteristics	30	.9809
g	The quality of representation of courseware 3 lesson content	18	.9763
h	The quality of representation of instructional procedures used in courseware 3	12	.9362
i	The quality of representation of all courseware 3 characteristics	30	.9824
j	The quality of representation of all characteristics in all 3 courseware programs	115	.9362

In order to enhance the credibility of the study, the researcher requested the three professors who team-taught the Physiology 431 class to explain the importance of the study and encouraged the students to participate. The professors cooperated and explained the significance of the study and the students' participation in several class sessions. In addition, a cover letter accompanied each questionnaire to explain the purpose of the study and request the participation of the students in the study (see Appendix E).

The third instrument was the Computer Courseware Evaluation Checklist Rating Form (see Appendix B). The researcher designed the instrument to allow experts to rate their perceptions regarding the level of importance of characteristics of computer courseware in promoting effective learning. There were three parts to the instrument. Part A was related to the courseware structure and contained three sub-parts, program structure, screen layout and design, and media use. Part B was concerned about lesson content. It contained nine sub-parts delineating Gagné's Events of Instruction and Learning Outcomes. Part C requested experts responding to the questionnaire instrument to provide the following general information: gender, age range in years, professional discipline, range of teaching experience in years, approximate number of courseware programs developed, experience with computers, and computer ownership. The instrument was designed to collect information from experts to establish weights for characteristics of instruction and learning perceived to be critical to the success or efficacy of computer courseware.

The rating scale used was as follows:

0 - Not applicable
1 - Low
2 - Medium
3 - High

The fourth instrument, Computer Courseware Evaluation Checklist Form, was constructed to allow experts to evaluate the quality of the characteristics of computer courseware programs used in this study in promoting effective learning (see Appendix C). Experts were asked to interact with the three courseware programs under study —Action Potential, Control Systems, and Synaptic Mechanisms (Parts I and II) — and then used the evaluation framework to evaluate the programs. There were three parts to the evaluation instrument. Part A dealt with evaluating computer courseware structure. Structure referred to how the courseware programs were structurally and functionally organized. Part B dealt with analyzing and evaluating courseware lesson content (i.e., instructional content and strategies). This part required experts to assess the learning outcomes and instructional events manifested in the courseware programs under study. Essentially, the experts assessed how facts, concepts, principles, procedures, and attitudes were presented in the courseware programs and if they were orchestrated to facilitate effective learning. One aim of this study was to determine whether courseware types had any differential effects on students' learning or performance achievement. To that end, the evaluation instrument was constructed with three column matrices. Each of the column matrices contained the same rating scales and was associated with one particular courseware among the three computer courseware programs under study.

Measurement of both Part A and Part B was based on a six-point, Likert-type response that allowed the respondents to rate their opinion or perception about the quality of the courseware characteristics. Quality referred to the extent to which, or how well, a particular characteristic was presented or represented. The rating scale ranged from "not applicable" to "very good" as follows:

1 - Not applicable (or absent)	4 - Fair
2 - Very poor	5 - Good
3 - Poor	6 - Very Good

The "not applicable" rating meant that the particular characteristic did not apply to the objectives of the courseware, or it was absent even though applicable, or that the expert was not able to evaluate it. Blank spaces were provided within each section of both Part A and Part B for the experts to include other characteristics or features of computer courseware that they thought should be assessed and to then rate the features using the same scale used for other features. Information thus collected along with other comments and suggestions were used in constructing the final instrument, "A Framework for Analyzing and Evaluating Computer-Based Multimedia Courseware" in Chapter VI, Conclusions and Implications.

Part C of the Computer Courseware Evaluation Checklist Form focused on general information about the courseware evaluator. This part requested the experts responding to the questionnaire instrument to provide information about their gender, age range in years, professional discipline, range of teaching experience in years, approximate number of courseware programs developed, experience with computers, and computer ownership.

Also, the experts were requested, in open-ended questions, to write any comments about the courseware programs used in the study. The comments were requested as a way to uncover any features of the programs that may not be indicated as courseware characteristics in Parts A and B of the evaluation instrument but, nonetheless, were perceived by the experts as unique and helpful in effectively learning the lesson materials that the courseware programs present. Such unique features, possibly latent in the courseware programs, may provide additional information that leads to a better understanding of the factors that influence the success or efficacy of computer courseware.

Like the evaluation form used with the student respondents, several steps were taken to ensure the validity of the data collection instrument used with the experts. First, the instrument was developed based on the review of literature on academic uses of computer courseware and on educational psychology principles of effective instruction and effective learning. Researchers, faculty members who have developed and used computer courseware in academic curriculum, as well as educational researchers were also consulted in constructing the questions on the questionnaires or instruments. Second, the instrument was initially critiqued for clarity and appropriateness of questions by the four doctoral committee members at Michigan State University. The doctoral committee's comments and suggestions were used in revising the evaluation instrument. Third, the revised questionnaire instrument was pre-tested to determine whether the questions on the evaluation instrument were clear and meaningful from the respondents' point of view and whether the questions were able to elicit and measure the information desired.

Another reason for pre-testing the revised questionnaire was to determine the average time it would take respondents to complete the instrument. The pilot study involved a focus group comprising of ten experts (including one Physiology 431 graduate assistant) drawn from various departments at Michigan State University and three regular students from the Physiology 431 class. The focus group members were given the instrument a week prior to the discussion meeting so that it could be reviewed and responded to ahead of time in preparation for the discussion meeting. In the discussion meeting, the focus group members shared and discussed their views and perceptions regarding the evaluation instrument in terms of the following topics:

1. Clarity and adequacy of instructions or directions for using the instrument
2. Clarity of the questionnaire items
3. Adequacy of the instrument to elicit and measure the desired information or whether the instrument missed any characteristics that should be included as a way to measure the efficacy of computer courseware
4. Whether the instrument contained any redundant items
5. Whether any questionnaire item was confusing and should be stated differently

The focus group discussion meeting was videotaped and audiotaped. The tapes as well as notes of important comments and suggestions written during the meeting were later analyzed for any information that might be necessary for further modification and to better enhance the clarity and understanding of the instrument.

The instrument was checked for reliability. The Cronbach's alpha reliability coefficient was used to estimate the internal consistency measure of the reliability of the evaluation instrument in measuring the experts' perceptions regarding the quality of the characteristics of computer courseware programs in promoting effective learning. Table 3-2 presents the alpha values obtained from the reliability analysis.

Table 3-2: Cronbach's alpha reliability coefficient of the items on the Computer Courseware Evaluation Checklist Rating Form

	Description	Number of Items	Reliability Index
a	The level of importance of the characteristics of "program structure" in promoting effective learning	19	0.7786
b	The level of importance of the characteristics of "screen layout and design" in promoting effective learning	14	0.8622
c	The level of importance of the characteristics of "media use" in promoting effective learning	5	0.8797
d	The level of importance of the characteristics of "prerequisite skills" in promoting effective learning	12	0.9203
e	The level of importance of the characteristics of "presenting new lesson content" in promoting effective learning	30	0.9137
f	The level of importance of the over all characteristics in promoting effective learning via computer courseware	80	0.9592

Questionnaire Distribution and Data Collection

As explained earlier, each of the three subject groups that participated in this study responded to a particular instrument designed to collect a set of specific data from the group. Accordingly, separate steps were taken in distributing the questionnaire instruments to the groups.

Three main steps were taken in handling the evaluation instrument with the student group. The first step was to obtain the permission of the professor who developed the courseware programs under study and also taught the Physiology 431 class in which the programs were used (see Appendix D). In addition to getting Dr. Adams' permission to use his courseware programs and the Physiology 431 class for the study, I sought and obtained his consent and support to introduce me and to explain the purpose and nature of the study to the class, as well as to request that the students participate in the study on a voluntary basis. The cooperation of both the faculty and students continued throughout the semester. For instance, before the beginning of several class lectures, Dr. Adams or one of the other two professors who team-taught the class reminded the students to complete and return the evaluation questionnaire to me. The introduction, announcements, and reminders were done verbally, accompanied by projection of overhead transparency notes. The second step in distributing the questionnaire instruments involved the researcher going to the classroom and handing out copies of the instrument to the students who volunteered. A cover letter explaining the purpose and nature of the study, as well as obtaining the students' voluntary consent to participate in the study accompanied the evaluation instruments (see Appendix E). The third step with the student group involved the researcher visiting ten class lecture sessions, usually 15 minutes before and after the lectures, to collect completed questionnaires. Ten class visits were made to ensure a high questionnaire return rate.

In the case of the expert groups, four main steps were taken in distributing the evaluation instruments. First, the researcher sent introductory letters, email messages, or made phone calls to various experts primarily at Michigan State University (see Appendix F). A few other experts were contacted at other institutions of higher learning in the mid-Michigan area to seek their voluntary consent to participate in the study. Most of the experts gave their consent verbally over the phone. A few experts agreed to participate through email. The second step taken was to hand-distribute the evaluation instruments to the experts who volunteered to participate in the study. In most cases, the researcher delivered the instruments to the experts in their offices. In one instance, however, the instrument was delivered to an expert at home who, in turn, distributed copies of the instrument to two other experts. A cover letter explaining the purpose and urgency of the study accompanied the evaluation instruments (see Appendix G). The third step in handling the evaluation questionnaires with the experts involved follow-up phone calls or email messages to the experts to ensure a high return rate. With the exception of the experts who had returned their questionnaires with their names written on them before the follow up messages were sent, the experts were sent a generic message to avoid the feeling of being singled out and thereby offended (see Appendix H).

The fourth step involving the experts was concerned with the collection or returns of the evaluation questionnaires. Although all the evaluation instruments were accompanied by self-addressed stamped envelopes, most of the experts returned their questionnaires along with the envelopes to the researcher by hand. Since most of the experts were from Michigan State University, some of them returned the questionnaires and envelope via campus mail. Both means of returning the instruments and envelopes saved the researcher a lot of time and money in data collection. A few of the experts returned the questionnaires using the self-addressed stamped envelopes.

Data Analysis

Analyses of data for this study were conducted under three major parts. Part one examined data collected from the students in the Physiology 431 class. Part two examined data collected from the group of experts who responded to the Computer Courseware Evaluation Checklist Rating Form. Part three focused on data collected from the group of experts who used the courseware programs and responded to the Computer Courseware Evaluation Checklist Form.

Analyzing Data Collected from the Student Group

Part one of the data analyses quantitatively addressed research questions A and B, along with their subsidiary questions, using data obtained from survey of students and from course grades. The aim of data analyses in part one was to determine the effects of courseware usage and the factors that predict students' learning achievement in Physiology 431 course. As a precursor, simple descriptive statistics using the Statistical Package for the Social Sciences (SPSS) were obtained in terms of frequencies, percentages, means and standard deviations. Frequency and percentage distributions were utilized to represent the demographic characteristics of the subjects. In order to determine the effects of courseware usage on the students' learning achievements, one way analysis of variance (ANOVA) was used to test for statistical significance of mean differences in adjusted course grades among students who used all the courseware programs, those who used one or two programs, and those who did not use any of the programs. The .05 alpha-level, which is conventional for behavioral social science research (Cohen, 1977), was used for all tests of statistical significance in this study. Once differences in adjusted grade scores were established among the groups of students, the Tukey post-hoc test analysis was conducted to determine which group of students performed better. Further analysis on the effect of courseware usage on the students' learning achievement was undertaken using stepwise regression analysis. The purpose of the regression analysis was to determine the extent to which the amount of courseware usage predicted students' learning achievement while controlling for the students personal demographic characteristics.

The next phase of part one of the data analyses centered on the students' perceptions regarding the quality of the computer courseware programs in promoting effective learning. The aim of this phase of the analyses was two-fold. One aim was to determine whether the students' perceptions regarding the quality of the courseware programs in promoting effective learning were related to and/or predicted their learning achievements. The second aim was to determine whether the students' perceptions were related to and/or predicted by their demographic characteristics. For parsimony and economy in managing and conducting the data analyses, related characteristics on the courseware evaluation questionnaire were constituted into sets or groups of composite variables. Following the categories used for the items on the computer courseware evaluation questionnaire responded to by the students (see Appendix B), three sets of composite variables were formed for each courseware as: courseware structure, media use, and instructional procedures. A total of nine sets of composite variables were thus formed for the three courseware programs used in the study. Correlation procedure was employed to determine relationships between students' learning achievements and their perceptions regarding the quality of the courseware programs in promoting effective learning. One way analysis of variance (ANOVA) was then used to determine whether the students' perceptions of the courseware characteristics varied by their demographic characteristics such as gender, academic discipline, class level, and computer ownership. The mean, standard deviations, F-values, and P-values were obtained and analyzed for composite sections of each computer courseware program. Further analyses, using stepwise regression procedures, were conducted to determine whether learning achievement was predicted by perceptions and also whether perception was predicted by the students demographic characteristics.

An analysis was also conducted on the comments that the students provided to open-ended questions concerning other features of the courseware programs that they perceived as helpful in promoting effective learning. The responses were compiled and categorized under concepts or themes that emerged from the contents of the comments.

Analyzing Data of Respondents in the Expert Rating Form Group

Part two of the data analyses quantitatively addressed research question C and its subsidiaries. Simple descriptive statistics in terms of frequencies and percentages were employed to represent the distribution of the respondents in the Expert Rating Form Group. Other descriptive statistical measures were computed in the form of means, standard deviations, and ranks on the experts' perceptions regarding the level of importance of computer courseware characteristics in promoting effective learning. The aggregate mean ratings of the perceptions were computed based on the three-point Likert-type response which ranged from "low" to "high" as follows:

1 - Low
2 - Medium
3 - High

The mean ratings were interpreted as follow:

1.00 - 1.99 — Low
2.00 - 2.50 — Medium
2.51 - 3.00 — High

As in part one, related characteristics on the Courseware Evaluation Checklist Rating Form were constituted into a set of composite variables. Following the categories used for the items on the computer courseware evaluation questionnaire responded to by the experts (Appendix C), five sets of composite variables were formed for each courseware as: courseware structure, screen layout and design, media use, prerequisite skills, and new lesson content. One way analysis of variance (ANOVA) was used to examine the relationships among the experts' perceptions regarding the level of importance of courseware characteristics and their demographic characteristics such as: gender, academic discipline, class level, and computer ownership. The mean, standard deviations, F-values, and P-values were obtained and analyzed for composite sections of each computer courseware. Further analysis, using stepwise regression procedure, was conducted to determine whether the experts' perceptions were predicted by their demographic characteristics.

A more detailed and intensive analysis was conducted to identify differences and similarities in the way that characteristics that can promote effective learning via computer courseware were perceived. The experts' demographic characteristics were not pertinent to the analysis and therefore not included. Multidimensional scaling technique (MDS) was used to examine the data to determine whether patterns of structure or relationships existed among the characteristics as perceived by the experts. The MDS procedure was used only in this phase of the data analyses where there were enough cases or variables to compute proximity measures for the data collected.

In order to obtain the clusters or patterns of relationships, distances among all the characteristics that can promote effective learning via computer courseware were calculated from the raw data using SPSS. A three dimensional Euclidean distance matrix was used as the scaling model. The MDS procedure produced three dimensional coordinates of all the variables. The results were imported into Systat to generate a three-dimensional plot of the relationships matrix.

An analysis was also conducted on the comments that the experts provided to an open-ended question concerning other features or characteristics not listed on the questionnaire that they thought were important in promoting effective learning via computer courseware. The responses were compiled and categorized under concepts or themes that emerged from the contents of the comments.

Analyzing Data of Respondents in the Expert Courseware Evaluation Group

Part three of the data analyses quantitatively addressed Research Question D and its subsidiaries. The aim of the data analyses was to determine what the experts' perceptions regarding the quality of the courseware programs used in the study were as a measure of the potential of the programs to engender effective or successful learning.

Simple descriptive statistics in terms of frequencies and percentages were employed to represent the composition of the respondents in the Expert Courseware Evaluation Group who used the courseware programs and responded to the Computer Courseware Evaluation Checklist Form. Both descriptive and inferential statistics were used to obtain a profile of the experts' perceptions.

The first step in profiling the experts' perceptions was to form composite variables from a set of related characteristics on the courseware evaluation questionnaire. Five sets of composite variables were formed for each courseware, making a total of 15 sets of composite variables for the three courseware programs used in the study. One way analysis of variance (ANOVA) was used to determine whether there were significant differences among the experts in their perceptions regarding the quality of the courseware characteristics by their demographic characteristics such as gender, age, professional discipline, teaching experience, number of courseware programs developed, previous experience with using computers as productivity tools, and computer ownership. The mean, standard deviations, F-values, and P-values were obtained and analyzed for composite sections of each computer courseware. Further analyses, using stepwise regression procedures, were conducted to determine whether the experts' perceptions vary by their demographic characteristics.

The last data analysis conducted centered on the responses to open-ended questions concerning other features of the courseware programs that the experts perceived as helpful in promoting effective learning. The responses were compiled and categorized under concepts or themes that emerged from the contents of the experts' comments.

Summary

This chapter contains the design and methodology used in this study. It describes the composition of subjects involved in the study. Four instruments used for the study were described. The first instrument was simply the exams administered to the students in the Physiology 431 class. The other three were evaluation survey questionnaires which were tested with samples of the target population to establish their content validity. The process of questionnaire distribution and data collection was discussed.

Next, data analyses procedures were presented. The analyses were conducted in three parts. Part one addressed the research questions concerned with the Student Group. Part two addressed the questions concerned with experts who responded to the Computer Courseware Evaluation Checklist Rating Form. Part three addressed the questions concerned with experts who responded to the Computer Courseware Evaluation Checklist Form. Regression analysis was used to determine the extent to which courseware usage predicted the students learning achievement. Both simple descriptive and inferential statistical procedures were used to determine relationships and differences in the experts' perceptions regarding the characteristics of computer courseware programs in promoting effective learning. In the case of the experts' perceptions regarding the level of importance of characteristics that promote effective learning via computer courseware, a more in-depth and intensive analysis was conducted using multidimensional scaling technique. The MDS procedure was explained.

Comments to open-ended questions were compiled and categorized under concepts or themes that emerged from the contents of the comments. The comments were analyzed.

CHAPTER IV

PRESENTATION AND ANALYSIS OF DATA FROM STUDENTS

Introduction

The data presented in this chapter was gathered from the students in Physiology 431 at Michigan Sate University. The data was gathered during the Fall semester of 1995.

Over 400 students registered for the Physiology 431 class during that semester, however, only 55 students volunteered and participated in the study. Nonetheless, data on exam grades for most of the students, as well as data on which students used and which did not use the programs were available and, therefore, collected. The only exceptions were a few students who had incomplete grade records or those who did not provide sufficient information on the data collection instruments used in the study. For instance, students who skipped multiple sections of the evaluation questionnaire or those who did not correctly indicate their student identification numbers on the form that asked them to indicate courseware programs used were not included in the data analyses. The student identification number was a necessary identifier in coding students' demographic variables to match exam grades.

The report in this chapter is presented in three sections. Section one presents the demographic descriptions of the students in the Physiology 431 class. It presents information on the students' participation and/or use of the courseware programs under study. Section two addresses the questions relating to the effects of computer courseware on students' learning achievement. Section three contains information about the students' perception regarding the quality of the characteristics of the computer courseware used in this study.

Section One — Description of Students' Demographics

There were three major groups of students involved in this study. The first group consisted of 76 (19.2%) students who neither used the courseware programs nor responded to the evaluation questionnaire that accompanied the programs. The second group consisted of 265 (66.9%) students who used the programs, but did not respond to the evaluation questionnaire. The third group consisted of 55 (13.9%) students who used the programs and responded to the questionnaire. Nearly all of the students in this third group, 53 (96.4%), used all the three courseware programs under study. Of the two exceptions, one student used only courseware 1 (Action Potential) and the other student used only courseware 2 (Control Systems). None of the 55 students in the third group self-selected to use courseware 3 (Synaptic Mechanisms I and II) alone or to use a combination of courseware 1 and 2, courseware 1 and 3, or courseware 2 and 3. The self-selection nature of the study made it difficult to have an even distribution of the research participants to different study groups. The frequency distribution of the students' use of courseware and their participation in the research questionnaire is presented in Table 4-1.

Table 4-1

The distribution of the student respondents by
use of courseware and participation in research questionnaire
(n=396)

	No.	%
No courseware use and no participation	76	19.2
Used courseware but no participation	265	66.9
Used courseware and participated	55	13.9
Total	396	100

Of the 265 students who used the courseware programs, but did not participate in responding to the evaluation questionnaire, a frequency distribution of the programs they used is presented in Table 4-2.

Table 4-2

The distribution of students who used courseware programs
but did not participate in research questionnaire
by courseware programs used.
(n=265)

Courseware Used	YES		NO		Total	
	No.	%	No.	%	No.	%
Courseware 1 — Action Potential	262	98.9	3	1.1	265	100
Courseware 2 — Control Systems	240	90.6	25	9.4	265	100
Courseware 3 — Synaptic Mechanisms	243	91.7	22	8.3	265	100

Of the 55 students who used the courseware programs and participated in responding to the research questionnaire, a frequency distribution of their responses regarding the programs they used is presented in Table 4-3.

Table 4-3

The distribution of the student respondents by
use of courseware and participation in responding to research questionnaire
(n=55)

Courseware Used	YES		NO		Total	
	No.	%	No.	%	No.	%
Courseware 1 — Action Potential	54	98.2	1	1.8	55	100
Courseware 2 — Control Systems	54	98.2	1	1.8	55	100
Courseware 3 — Synaptic Mechanisms	53	96.4	2	3.6	55	100

A total of 150 questionnaires were distributed to the students in the Physiology 431 class. Out of that number, 55 questionnaires were adequately completed and returned. The data analyzed and presented in this chapter were derived primarily from those sources. The total return rate was 36.7%. The distribution of the respondents by academic discipline and gender is presented in Table 4-4.

Table 4-4

The distribution of the student respondents by academic discipline and gender

Gender	Pre-Medicine		Natural Science		Humanities		Other		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Male	19	34.5	6	10.9					25	46.3
Female	21	38.2	5	9.1	1	1.8	2	3.6	29	53.7
Total	40	72.7	11	20	1	1.8	2	3.6	54*	100

* One missing value observed

Of the 55 valid respondents, 40 (72.7%) were pre-medical students, 11 (20%) were majoring in natural science disciplines, one (1.8%) was in humanities, and two (3.6%)

were in the "other" category. The "other" category consisted of one graduate student and one Life Long Education student. Of these 55 student respondents, 25 (46.3%) were males, 29 (53.7%) were females, with one missing value observed.

In terms of distribution by age, the student respondents consisted of four (7.3%) who were below 20 years, 41 (74.5%) between 20 and 25 years, six (10.9%) between 26 and 30 years, and three (5.5%) over 30 years.

The students' GPAs, before taking the Physiology 431 class and, therefore, prior to using the courseware under study, ranged between 2.5 and 4.0. Table 4-5 presents the GPA distribution.

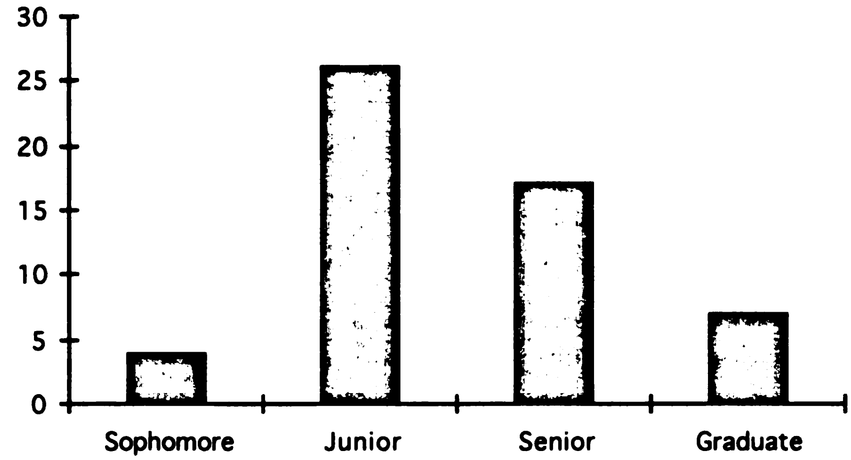
Table 4-5

The distribution of the student respondents by GPA

GPA	No.	%
under 3.0	7	12.7
3.0 - 3.5	20	36.4
3.51 - 4.0	21	38.2
Missing values	7	12.7
Total	55	100

Several other classification schemes were used in studying the nature of the student respondents. By class level, the student respondents consisted of four (7.4%) sophomores, 26 (48.1%) juniors, 17 (31.5%) seniors, seven (13%) graduates, with one missing value observed. A barchart of the class level distribution in presented in Figure 4-1.

Figure 4-1
The distribution of the student respondents by class level



The type of previous experience with computers is another classification scheme used. The distribution of the student respondents according to previous experience in using computer productivity tools is presented in Table 4-6.

Table 4-6

Number and percentage of the student respondents with previous experience using computer productivity tools

Type of Computer Experience	With previous experience		With no previous experience		Missing Values		Total	
	No.	%	No.	%	No.	%	No.	%
Wordprocessing	50	90.9	4	7.3	1	1.8	55	100
Spreadsheet	38	69.1	16	29.1	1	1.8	55	100
Database	29	52.7	25	45.5	1	1.8	55	100
Communication	46	83.6	8	14.5	1	1.8	55	100
Programming	26	47.3	28	50.9	1	1.8	55	100
Multimedia	14	25.2	40	72.7	1	1.8	55	100
Games	41	74.5	13	23.6	1	1.8	55	100
Courseware	32	58.2	22	40	1	1.8	55	100
Assembling Computers	6	10.9	48	87.3	1	1.8	55	100

The respondents were asked to indicate whether or not they owned computers. 29 (52.7%) of the students responded yes, 24 (43.6%) responded no, with two (3.6%) missing values observed. Also the respondents were examined as to the total credits earned at Michigan State University prior to taking the Physiology 431 class and using the courseware programs under study. The distribution of the responses ranged from zero to 140 credits. This distribution is presented in Table 4-7.

Table 4-7

The distribution of the student respondents by total credits earned at MSU

MSU Credits	No.	%
0 - 35	8	14.5
36 - 70	22	40.0
71 - 105	11	20.0
106+	5	9.1
Missing values	9	16.4
Total	55	100

The student respondents were asked whether or not the courseware programs helped them to better learn the concepts presented in Physiology 431 class. Nearly all the students, 53 (96.4%), responded positively. The only exceptions were 2 (3.6%) missing observation values.

Finally, the students were asked as to whether or not they would like to have similar courseware programs in other college courses. 53 (96.2%) respondents said yes; only two (3.6%) respondents said no.

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Section Two — The Effects of Computer Courseware on Students' Learning Achievement.

This section examined the effects of computer courseware usage on students' learning achievement. Data analyses for the section were guided by research question A and the subsidiary questions under it.

Research Question A1

Does courseware usage predict students' level of learning achievements?

The final grade in Physiology 431 class, as measured by the adjusted raw score, was used as the outcome in this analysis. The adjusted raw score was a linear combination of grades for all three exams written in the Physiology 431 class during the semester in which the use of the courseware programs in the class was studied. One way analysis of variance (ANOVA) was used to compare differences among students who used all the courseware programs, those who used one or two programs, and those who did not use any of the programs in terms of the adjusted raw score. This information was available for all 395 students who attended the Physiology 431 course. The ANOVA results presented in Table 4-8 indicate a statistically significant difference among the three groups of students ($F=24.75$, $P<0.05$). Tukey's post-hoc results revealed that students who used all three programs significantly performed better than those who used just one or two programs, who in turn, performed significantly better than those who did not use any program.

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Table 4-8

One way analysis of variance (ANOVA) results of differences in learning achievements (as measured by adjusted raw scores) among students who used and those who did not use the courseware programs

Groups	N	Mean	SD	F-value	P-value
Group1 (No Courseware Used)	77	80.2857	20.0150	24.7460	.0000
Group2 (Courseware 1 and 2, Courseware 1 and 3 or Courseware 2 and 3)	44	82.4091	15.7721		
Group 3 (Courseware 1, 2 and 3)	275	94.3818	14.9448		
Total	396	90.7551	17.0797		

In sum, the students who used the courseware programs significantly performed better than those who did not. In addition, the more courseware programs used, the better the students' performance.

Research Question A2

> **To what extent is the students' level of learning achievement dependent on factors other than the use of the computer courseware, for instance, demographic characteristics (gender, age, GPA, academic discipline, class level, previous experience with computers, and computer ownership)?**

The final grades in the Physiology 431 class, as measured by the adjusted raw scores, was further examined to determine if students' learning achievements were due mainly to the use of the computer courseware or whether other factors account for the observed significant differences in the adjusted raw scores. Unlike Research Question A1, information for Research Question A2 was available for only those 55 students who responded to the questionnaire. Two stepwise regression models were constructed to fit the data.

The first regression model was designed to determine whether the amount of courseware usage alone predicted learning achievement as measured by adjusted raw scores. The amount of usage of courseware 1, courseware 2, and courseware 3 were used as predictors. The amount of courseware usage was computed as the product of the average number of sessions a program was used per week by the average amount of time (in minutes) spent on the program per session. As Table 4-9 indicates, the amount of usage of courseware 2 alone was a significant predictor of the adjusted raw score (β= 0.331, $P<0.05$). For this predictor, one unit increase in the use of courseware 2 improves the adjusted raw score by 0.33 standard deviations. Usage of courseware 2 alone a

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accounts for 10.9% of the variance in learning achievement as measured by adjusted raw scores.

The second stepwise regression model was designed to determine the extent to which the amount of courseware usage predicted students' level of learning achievement while controlling for other personal demographic characteristics of the respondents. Adjusted raw score was used as the outcome. Factors used as control variables were gender, GPA, academic discipline, class level, previous experience using computer courseware or multimedia programs, previous experience in computer programming, previous experience using databases, previous experience using spreadsheet, and computer ownership. The selection of these control variables was a function of the availability of sufficient data for any particular variable. Table 4-9 presents the results of the analysis. The results revealed that the main predictors of adjusted raw scores were the students' GPA and gender. Students with better GPAs performed significantly better than students with lower GPAs (β= 0.472, $P<0.05$). A difference of one standard deviation in GPA was predicted to cause a difference of 0.472 standard deviation in adjusted raw score. In terms of gender, male students performed significantly better than female students where, on average, achievement score for male students was about 0.338 standard deviations above that of female students.

In sum, when computer usage is the sole predictor of adjusted raw score, the amount of usage of courseware 2 (i.e., Control Systems) is the only significant predictor of learning achievement. The effect is greatly reduced, however, when the students' gender and GPA were entered into the prediction model.

Table 4-9

Regression results for the prediction of adjusted raw scores (learning achievements) by the students' demographic characteristics

Outcome	Model	Step	Predictors Entered	β	t-value	P-value	R^2
Adjusted Score	1	1	Courseware 2 (Control Systems)	0.331	2.528	0.0145*	0.109
	2	1	GPA	0.472	3.989	0.0002*	0.2684
		2	Gender	0.338	2.854	0.0065*	0.3805

* Significant at 0.05 level.
Model 1 — Using only courseware usage as predictors
Model 2 — Using courseware usage and demographic characteristics as predictors.

Section Three — Students' Perceptions Concerning Quality of Computer Courseware

This section answers the research questions relating to the student respondents' perceptions regarding the quality of the characteristics of computer courseware programs under study. The students were asked to rate their perceptions regarding the quality of the characteristics of the programs in promoting effective learning. The Computer

Courseware Evaluation Form (see Appendix A) was used in collecting data to answer the research questions relating to the students' perceptions.

The major question guiding this section of the report was

Research Question B:

What are the student respondents' perceptions regarding the quality of the characteristics of computer courseware programs used in this study?

The subsidiary questions were:

Research Question B1: What are the student respondents' perceptions regarding the quality of the characteristics of the computer courseware programs used in this study in promoting effective learning?

Research Question B2: Do the student respondents' perceptions regarding the quality of the computer courseware characteristics vary by their demographic characteristics such as: gender, class level, academic discipline, previous experience using computer productivity tools, previous experience using computer courseware, previous experience with computer programming, or computer ownership?

Research Question B3: What other features of the courseware programs do the student respondents perceive as unique and helpful in promoting effective learning?

Students' perceptions regarding the quality of the characteristics of the computer courseware programs in promoting effective learning

The student respondents were asked to rate how they perceived the quality of each courseware program under study in promoting effective learning. The mean of the quality ratings and standard deviations were computed for the characteristics of each composite section of the courseware programs. The possible mean ratings ranged from the lowest, 1.00, indicating that the set of composite characteristics was rated inferior, to the highest, 5.0, indicating that the set of composite characteristics was rated superior. Table 4-10 presents the means, standard deviations, and ranks of the students' perceptions regarding the quality of the characteristics of the courseware sections.

From the information on the table, two patterns of mean ratings of students' perceptions of quality were observed. The first pattern relates to how the courseware sections compared or were perceived across the three programs. The mean ratings of quality of instructional procedures characteristics were higher (4.34, 4.33, and 4.29) than the mean ratings of courseware structure characteristics (4.28, 4.27, and 4.26), which, in turn, were higher than the mean ratings of the characteristics of media use (4.13, 4.13, 4.06). The second pattern of perception of quality relates to how the three courseware programs compared in terms of the mean ratings of quality of each specific courseware section. The highest mean ratings in each courseware section went to courseware 3, the second highest mean ratings in each courseware section went to courseware 1, except in instructional procedures which received third place mean rating. The third and last mean ratings in each courseware section went to courseware 2, except in instructional procedures section that received second place mean rating in that section category. In all, the students perceived courseware 3 as the best in terms of the quality of courseware characteristics in promoting effective learning, followed by courseware 1, and then courseware 2.

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Table 4-10

Means, standard deviations, and ranks of the students' perceptions regarding the quality of the characteristics of sections of the courseware programs under study

Courseware Composites	Courseware Rated	N	Mean	SD	Rank
Courseware Structure	Courseware 1	55	4.27	.52	5
	Courseware 2	55	4.26	.54	6
	Courseware 3	55	4.28	.51	4
Media Use	Courseware 1	55	4.13	.88	7
	Courseware 2	55	4.06	.90	9
	Courseware 3	55	4.13	.83	7
Instructional Procedures	Courseware 1	55	4.29	.61	3
	Courseware 2	55	4.33	.59	2
	Courseware 3	55	4.34	.59	1

The results of mean ratings of the quality of each courseware component were correlated with the students' grades to determine whether there was a significant relationship between the students' perception regarding the quality of courseware programs and their learning achievement. The results of scatter plots and correlation analysis indicated no linear or even curvilinear relationship between grades and perception of courseware quality. The perception of courseware quality had no significant relationship with students' learning achievement.

A similar result was obtained in analyzing the data to determine any relationship between students' perceptions regarding the quality of courseware characteristics and amount of courseware usage. No significant relationship was observed between perceptions regarding the quality of courseware characteristics and learning achievement.

Effects of demographic characteristics on the student respondents' perceptions regarding the quality of the characteristics of the courseware programs under study

One way analysis of variance (ANOVA) was used to determine whether students' perceptions regarding the quality of computer courseware characteristics vary by their demographic characteristics such as gender, academic discipline, class level, and computer ownership. The results are presented in Tables 4-11 through 4-16.

As the tables indicate, no significant differences in the students' perceptions were observed between or among groups by gender, academic discipline, computer ownership or, surprisingly, previous experience with computer programming. However, significant differences in perceptions regarding the quality of the characteristics of certain courseware sections were observed among the students by their class level and previous experience using computer courseware.

As shown in Table 4-11, junior students differed significantly from senior students in their perceptions regarding the instructional procedures component of all three courseware programs — courseware 1 ($F=7.0$, $P=.01<.05$); courseware 2 ($F=4.9$, $P=.03<.05$); courseware 3 ($F=6.3$; $P=.02<.05$). In all three courseware programs, the junior students were more positive in their perceptions regarding the quality of instructional procedures characteristics than the senior students — courseware 1(mean for juniors = 4.41, mean for seniors = 3.95); courseware 2 (mean for juniors = 4.41, mean for seniors = 4.03); courseware 3 (mean for juniors = 4.44, mean for seniors = 4.02).

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However, both class levels did not differ in their perceptions regarding the quality of other dimensions of the programs.

As shown in Table 4-12, significant differences in perceptions regarding the quality of the characteristics of certain courseware sections were observed between student respondents with previous experience using computer courseware and those without previous experience. Students who had no previous experience using computer courseware had more positive perceptions of the quality of courseware characteristics than students who had previous experience in terms of the following:

Courseware 1: courseware structure (F=8.65, P=.005<.05)
media use (F=4.76, P=.34<.05))
instructional procedures (F=5.89, P=.02<.05)

Courseware 2: courseware structure (F=5.63, P=.02<.05)
instructional procedures (F=4.74, P=.03<.05)

Courseware 3: courseware structure (F=7.87, P=.01<.05)
instructional procedures (F=5.46, P=.02<.05)

No significant difference was observed in either group in their perceptions regarding the quality of media use in courseware 2 and courseware 3.

Table 4-11
Analysis of variance results of the student respondents' perception of the quality of characteristics of the courseware sections/composites in helping them to better learn Physiology 431 concepts by class level

Courseware Composites/Sections	Junior			Senior				
	N	Mean	SD	N	Mean	SD	F-value	P-value
Courseware 1 — Courseware Structure	26	4.328	.8479	17	4.104	.7806	2.2808	.1387
Courseware 1 — Media Use	26	4.051	.8479	17	4.250	.7806	.6003	.4429
Courseware 1 — Instructional Procedures	26	4.407	.4772	17	3.946	.6642	7.0026	.0115*
Courseware 2 — Courseware Structure	26	4.293	.4863	17	4.119	.5557	1.1676	.2862
Courseware 2 — Media Use	26	3.910	.8718	17	4.269	.7298	1.9775	.1672
Courseware 2 — Instructional Procedures	26	4.414	.4870	17	4.027	.6573	4.8928	.0326*
Courseware 3 — Courseware Structure	26	4.345	.4416	17	4.114	.5274	2.4162	.1278
Courseware 3 — Media Use	26	4.039	.7875	17	4.279	.7174	1.0307	.3159
Courseware 3 — Instructional Procedures	26	4.44	.4499	17	4.015	.6624	6.3106	.0160*

N = Number, SD = standard deviation
* Significant $p < .05$

Table 4-12
Analysis of variance results of the student respondents' perception of the quality of characteristics of the courseware sections/composites in helping them to better learn Physiology 431 concepts by previous experience with computers using courseware

Courseware Composites/Sections	Previous Experience			No Previous Experience				
	N	Mean	SD	N	Mean	SD	F-value	P-value
Courseware 1 — Courseware Structure	32	4.127	.5389	22	4.514	.3577	8.654	.0049*
Courseware 1 — Media Use	32	3.953	.9069	22	4.455	.7013	4.7572	.0337*
Courseware 1 — Instructional Procedures	32	4.137	.6470	22	4.532	.4905	5.8891	.0187*
Courseware 2 — Courseware Structure	32	4.140	.5450	22	4.475	.4529	5.6311	.0214*
Courseware 2 — Media Use	32	3.979	.8885	22	4.242	.8599	1.1746	.2835
Courseware 2 — Instructional Procedures	32	4.195	.6473	22	4.542	.4471	4.7364	.0341*
Courseware 3 — Courseware Structure	32	4.147	.5270	22	4.516	.3844	7.8737	.0070*
Courseware 3 — Media Use	32	4.018	.8545	22	4.379	.7013	2.6735	.1081
Courseware 3 — Instructional Procedures	32	4.194	.6347	22	4.561	.4454	5.4617	.0233*

N = Number, SD = standard deviation
* Significant $p < .05$

Table 4-13

Table 4-13

Analysis of variance results of the student respondents' perception of the quality of characteristics of the courseware sections/composites in helping them to better learn Physiology 431 concepts by gender.

Courseware Composites/Sections	Male			Female			F-value	P-value
	N	Mean	SD	N	Mean	SD		
Courseware 1 — Courseware Structure	25	4.279	.4878	29	4.289	.5319	.0050	.9438
Courseware 1 — Media Use	25	4.177	.9142	29	4.141	.8244	.0230	.8801
Courseware 1 — Instructional Procedures	25	4.311	.6597	29	4.286	.5860	.0217	.8835
Courseware 2 — Courseware Structure	25	4.268	.5244	29	4.284	.5469	.0123	.9120
Courseware 2 — Media Use	25	4.017	.9647	29	4.147	.8094	.2896	.5928
Courseware 2 — Instructional Procedures	25	4.319	.6414	29	4.351	.5628	.0354	.8516
Courseware 3 — Courseware Structure	25	4.297	.4829	29	4.297	.5309	.0000	.9960
Courseware 3 — Media Use	25	4.100	.8633	29	4.221	.7694	.2979	.5875
Courseware 3 — Instructional Procedures	25	4.329	.6410	29	4.356	.5520	.0262	.8720

N = Number, SD = standard deviation

Table 4-14

Analysis of variance results of the student respondents' perception of the quality of characteristics of the courseware sections/composites in helping them to better learn Physiology 431 concepts by academic discipline

Courseware Composites/Sections	Premed			Natural Science				
	N	Mean	SD	N	Mean	SD	F-value	P-value
Courseware 1 — Courseware Structure	40	4.289	.5335	11	4.232	.3248	.1156	.7353
Courseware 1 — Media Use	40	4.135	.8703	11	4.121	.9192	.0022	.9624
Courseware 1 — Instructional Procedures	40	4.269	.6700	11	4.349	.3392	.1400	.7099
Courseware 2 — Courseware Structure	40	4.287	.5499	11	4.203	.4081	.2224	.6393
Courseware 2 — Media Use	40	4.094	.8410	11	3.924	1.0836	.3089	.5809
Courseware 2 — Instructional Procedures	40	4.326	.6437	11	4.333	.3570	.0012	.9721
Courseware 3 — Courseware Structure	40	4.299	.5354	11	4.258	.2916	.0611	.8059
Courseware 3 — Media Use	40	4.150	.8038	11	4.106	.9137	.0243	.8767
Courseware 3 — Instructional Procedures	40	4.332	.6368	11	4.349	.3571	.0069	.9341

N = Number, SD = standard deviation

Table 4-15
Analysis of variance results of the student respondents' perception of the quality of characteristics of the courseware sections/composites in helping them to better learn Physiology 431 concepts by previous experience with computer programming

Courseware Composites/Sections	Previous Experience			No Previous Experience				
	N	Mean	SD	N	Mean	SD	F-value	P-value
Courseware 1 — Courseware Structure	26	4.182	.5400	28	4.379	.4642	2.0910	.1542
Courseware 1 — Media Use	26	4.000	.9402	28	4.304	.7642	1.7062	.1972
Courseware 1 — Instructional Procedures	26	4.227	.6537	28	4.363	.5816	.6596	.4204
Courseware 2 — Courseware Structure	26	4.198	.5500	28	4.349	.5131	1.0894	.3014
Courseware 2 — Media Use	26	4.032	.9378	28	4.137	.8337	.1891	.6654
Courseware 2 — Instructional Procedures	26	4.267	.6347	28	4.401	.5592	.6777	.4141
Courseware 3 — Courseware Structure	26	4.193	.5324	28	4.393	.4659	2.1761	.1462
Courseware 3 — Media Use	26	4.048	.9160	28	4.274	.6938	1.0515	.3099
Courseware 3 — Instructional Procedures	26	4.264	.6428	28	4.418	.5359	.9183	.3424

N = Number, SD = standard deviation

Table 4-16

Analysis of variance results of the student respondents' perception of the quality of characteristics of the courseware sections/composites in helping them to better learn Physiology 431 concepts by computer ownership

Courseware Composites/Sections	Own a Computer			Did not own a Computer				
	N	Mean	SD	N	Mean	SD	F-value	P-value
Courseware 1 — Courseware Structure	29	4.294	.5910	24	4.263	.4055	.0482	.8271
Courseware 1 — Media Use	29	4.239	.9602	24	4.066	.7482	.5153	.4761
Courseware 1 — Instructional Procedures	29	4.221	.6984	24	4.362	.4955	.6883	.4106
Courseware 2 — Courseware Structure	29	4.307	.5915	24	4.229	.4681	.2695	.6059
Courseware 2 — Media Use	29	4.221	.9121	24	3.927	.8460	1.4578	.2328
Courseware 2 — Instructional Procedures	29	4.265	.6853	24	4.395	.4632	.6201	.4347
Courseware 3 — Courseware Structure	29	4.316	.5801	24	4.264	.4157	.1322	.7177
Courseware 3 — Media Use	29	4.213	.9081	24	4.115	.7045	.1866	.6675
Courseware 3 — Instructional Procedures	29	4.275	.6774	24	4.399	.4623	.5747	.4519

N = Number, SD = standard deviation

Further analysis was conducted on the data using the stepwise regression procedure to determine demographic factors that might be significant predictors of the students' perceptions regarding the quality of the characteristics of courseware programs under study. The results are presented in Table 4-17. As the table shows, only GPA and the students' class level were significant predictors of the students' perceptions regarding the quality of computer courseware characteristics.

In terms of GPA, the range 3.51 to 4.0 was observed as a significant predictor of the quality of the characteristics of both courseware 1 structure (β=.313, P=.022) and courseware 2 structure (β=.310, P=.024). As a predictor, GPA in the range 3.51-4.0 accounted for approximately 9.8 percent of the variance in the students' perceptions regarding the quality of the characteristics of courseware 1 structure and 9.6 percent of the variance in the perceptions regarding the quality of the characteristics of courseware 2 structure (see Table 4-17). In general, the results revealed that students with GPAs in the range 3.51-4.0 were more likely than others to have a more positive perception of the quality of the characteristics of courseware structures.

Class level was a significant predictor of the students' perceptions regarding the quality of the characteristics of instructional procedures of all three courseware programs: courseware 1 instructional procedures (β=-.382, P=.005), courseware 2 instructional procedures (β=-.347, P=.011), and courseware 3 instructional procedures (β=-.373, P=.005). As a predictor, being a senior student explained about 15 percent, 12 percent, and 14 percent of the variances in the perceptions regarding the quality of instructional procedures of courseware 1, courseware 2, and courseware 3, respectively (see Table 4-17). The results revealed that senior students were more likely than other groups to be more negative in their perceptions regarding the quality of the characteristics of instructional procedures of the courseware programs under study.

Table 4-17

Regression results of the perceptions of student respondents regarding the quality of the characteristics of the courseware programs under study in promoting effective learning

Courseware Sections	Predictors Entered	β	T-value	Sig T	F-value	P-value	R^2
Courseware 1 - Structure	GPA						
	3.0-3.50	.071	.421	.675			
	3.51-4.0	.313	2.35	.022	5.53	.022*	.098
Courseware 1 - Instructional Procedures	Class Level						
	Juniors	-.164	-.964	.339			
	Seniors	-.382	-2.95	.005	8.73	.005*	.146
Courseware 2 - Instructional Procedures	Class Level						
	Juniors	-.205	-1.19	.239			
	Seniors	-.347	-2.64	.011	6.97	.011*	.120
Courseware 3 - Structure	GPA						
	3.0-3.50	.110	.654	.516			
	3.51-4.0	.310	2.33	.024	5.44	.024*	.096
Courseware 3 - Instructional Procedures	Class Level						
	Juniors	-.175	-1.03	.309			
	Seniors	-.373	-2.87	.005	8.25	.005*	.139

* **Significant at 0.05 level.**

Other features of the courseware programs the student respondents perceived as unique and helpful in effectively learning Physiology 431 course materials

The students were asked to comment on their experiences using the courseware programs, particularly on any features of the programs not indicated as characteristics on the evaluation instrument, that they perceived to be helpful in effectively learning Physiology 431 course materials. The students' responses were compiled and grouped according to the respective courseware programs in cases where a specific comment applied to a particular program, or according to themes in cases where comments applied to all three programs. Comments under courseware sections and themes were further categorized under positive or negative perception. Sections and themes with comments that are either all positive or all negative were categorized as such. The themes under which the comments were classified were derived from instructional and learning principles expressed in the comments themselves. When a comment contained more than one idea, and so could fit under several themes, a subjective decision was made as to the best theme under which it should be classified. Nebulous comments or statements that, although sounded interesting, but did not indicate how specific courseware features promoted or could facilitate effective learning, were not included in this report. For instance, statements like "the programs are excellent", or "the programs are very helpful," were not reported since such statements did not explain specific ways in which the programs were excellent or helpful. The classifications, comments, and discussion of the data are presented next.

Comments common to all three courseware programs

Overall usefulness and utility of the courseware programs

Positive views or perceptions:

The courseware programs were favorably appraised as offering complete tutorial instructions and serving well as a useful synthesis of the Physiology 431 course lecture and reading materials. As such, the programs were considered to be a useful supplement to classroom instruction. One student commented: "I liked the way the computer program paralleled the study guide. This really reinforced the lectures and made it easy to take notes." Another student remarked: "I thought these were so helpful! I read the book and went to all the lectures, but the CAI programs put it all together in my head and really prepared me for the test questions." Another student stated, "The courseware directly reinforced everything we had been taught in lecture and in the readings. It was very complete, and therefore could be used to answer questions from both the lecture and readings." Yet another student remarked: "The programs clarified a lot of points that were confusing in the book. They are a good supplement to class lectures." In the words of another student:

> The programs helped me tremendously. I used them as a reference and was able to increase my understanding with them. I feel I truly learned the material from that part of the class (in which the programs were used), particularly because the material was presented and reinforced in three different ways - lecture, book and computer.

Virtually all the student respondents described the programs as a useful tool for enabling a "thorough review" of the extensive lesson concepts and principles covered in the course. As one student remarked:

> I believe these computer programs really helped. There was a lot of information that Dr. Adams presented where we had to take rapid notes and even though he would go over everything several times, the computer programs really helped tie everything together and clearly showed how the different systems worked. It is very valuable because you can go through it at your own pace and can read as much or as little as you want.

Another feature of the courseware programs perceived to be helpful in promoting effective learning of the Physiology 431 lessons was the use of examples and the application of abstract concepts to real life situations. According to one student: "The application of theory to real life situations was educational."

The systematic, clarity, and completeness of lesson content presentation was another salient feature of the courseware programs identified as helpful in promoting effective learning. In the words of one student: "The courseware is the most helpful aid to any class I have ever taken in a course with so much information. I liked how it tied it all together in a systematic manner." Another student remarked: "I loved them. They were about the only thing I studied. I liked how clearly all pieces fit right in the program. The less I have to do to get the information the more time I have to learn it."

Negative views or perceptions:

Some of the comments that the students provided to the open-ended questions revealed negative perceptions about certain features of the courseware programs as well as negative views concerning the way in which the programs were used in the Physiology 431 course. The documentation and analysis of such negative comments are crucial to a meaningful and fruitful formative evaluation of any product development.

One major criticism of the courseware programs under study was the wordiness of the presentation of information. According to one student: "Some of the screens had too much reading information (text)."

Some students criticized the prominence that the programs had in the course. In the words of one student:

> It seemed as though we were tested on the courseware programs rather than the material covered in the book and lecture. I heard from students who had taken the class earlier that the courseware was all that was needed. It seems as though it became the center of the material to be tested rather than merely a learning supplement.

Another student critiqued:

> It should be used (both by professor and students) only as supplementary to lecture. It was stressed too much. Having the book, lecture, computer was too much redundant material to wade through when a student has other classes that they must attend to. I think in a class such as physiology, such programs should cover material completely separate from that covered in class and the book (i.e., clinical situations). Then it would be more interesting and successful.

One student even declared: "After the time spent in lecture, reviewing notes, reading text, I put the computer programs at a low priority. The text was often too similar to the text book."

Also, some students argued that the programs presented essentially the same information covered by other course materials and, as such, were redundant. For instance, one student remarked: "The material on the courseware should not be too repetitive of information found in course readings and lectures. Sometimes I found the courseware a bit too repetitive of what we had already learned."

Individualized Instruction

Positive views or perceptions

Another major theme that emerged from the students' comments was the usefulness of the courseware programs in providing individualized instruction. According to one student: "The programs allow you to work at your own pace to ensure understanding." Another student claimed: "I think that the software was excellent. It accented the points from lecture with Dr. Adams and I could work at my own speed." In the words of another student: "Definitely, without it, material cannot be learned as well for students like myself. It opens up options and is more fair for certain people."

Stimulating and sustaining learner interest

Positive views or perceptions

A number of students remarked that the computer courseware programs helped to stimulate and sustain their interests in learning the lesson content. For instance, one student commented: "I found the computer to keep my interest longer than reading a textbook."

Several characteristics were identified as factors that made the courseware programs stimulating and interesting. First, some students claimed that the courseware programs helped them to "visualize concepts more clearly." In the words of one student: "It helped you stay motivated, visualize what you are doing, and check yourself afterward. I loved it." Second, some students claimed that the programs were "fun" to interact with. According to one student: "It's hard to discipline oneself to sit down to read a book. These programs accomplished the same task in a different way. A way that is fun and less of a chore." Third, the programs were considered to be interesting because of the nature of humor used. In the words of one student:

> I would really recommend these programs because they hold so much information. They allow you to work on them when you want. The humor and little pictures are great! They are hilarious! Its kind of like a little kids game - makes learning fun and with harder concepts.

Fourth, the programs were perceived to use instructional strategies that promoted positive attitude toward learning. For instance, one student noted:

> Dr. Adams programs were exceptional because he explained why answers were correct and more importantly why the others were wrong. And psychologically, even when I did get answers wrong, phrases like "I can see why you chose this

> answer but..." and "good try but..." didn't leave me feeling defeated. It helped me to keep a good attitude and lower stress level while studying.

Relevance of the programs to learner needs

Positive views or perceptions:

The relevance of the courseware programs to the students' needs to perform well in exams was cited as one characteristic that some students perceived made the programs to be helpful in promoting effective learning. According to one student: "The programs were more useful for me in studying for the test than the textbook. They cleared up any confusion I had." Another student even claimed:

> The programs were extremely helpful, informative and fun. I plan on using these and the others to study for the MCAT. It helped very much to go through them before and after the material was presented in lecture.

According to another student, the programs offer an "excellent way of reviewing and bringing together material before exams." In the words of one student: "The courseware programs helped much during preparation for exams. They clarified many concepts and organized numerous materials for an easier understanding." Another student claimed: "The programs better prepared me for the exam. I could get a feel for the kind of questions that would be asked and see my weak areas." In the words of another student: "The material was clear, focused and relevant to the class. It helped out in that it simplified things. It made it much easier to understand a concept."

Facilitated the use of students' learning styles

Positive views or perceptions:

The courseware programs were perceived to enable some students to use their learning styles. According to one student: "I learn better by trial and error. So this optional technique for learning was exceptional." Another student stated:

> Everyone can't learn by reading and lecture only. The multimedia software uses sight, sound and active learning in the form of review questions to enhance the student's unique learning abilities.

In the words of one student: "The programs provided clarification to concepts discussed in class. They helped me to visualize key concepts, something that is very important in my learning process." A similar sentiment was expressed by another student who noted: "Visual learning at my own space made it easier to grasp concepts." One student was simply impressed by the use of computer courseware in academic curriculum. According to the student: "It was helpful to see course information via a third media in addition to lectures and assigned readings."

Promoted meaningful learning

Positive views or perceptions:

Another important feature of the courseware programs that the students perceived was their potential to promote meaningful learning. One student claimed: "Quiz questions at the end and throughout the programs enabled me to apply concepts rather than just grasp or memorize the material." Another student asserted that the programs "provide excellent review and related material to the way exam questions were to be asked. Question why's and help with explanations clarified lesson material very well." In a similar vein, one student noted: "The programs were very helpful in stressing main ideas. They were also helpful in developing problem solving skills and thinking." Another student asserted: "This is a very good way to be involved actively in the learning process." One student claimed: "The courseware enhanced my understanding of the main topics and also further explained the more obscure topics." The same sentiment was expressed by another student who noted: "The courseware was extremely helpful in aiding my understanding of the various topics." In the words of one student: "I believe the computer aided program for Physiology was extremely helpful and informative. It clarifies things that were unclear in class. This program should continue to be used in this course."

Interactivity, learner and navigational control

Positive views or perceptions:

Interactivity, learner and navigational controls were perceived as essential features of the courseware programs that helped in promoting effective learning. According to one student: "The courseware is unique in that it allows the subject to complete the lesson on his/her own time and at an appropriate pace as determined by the learner." Another student noted: "I think this courseware is an extremely effective learning aid. It forces the student to interact with the material instead of trying to passively absorb it through review of notes or reading. This interactions enhances learning. The courseware also provides a constant reference that can be accessed at an individualized pace."

Negative views or perceptions:

The students noted a shortcoming in terms of navigational restrictions in certain parts of the courseware programs. In the words of one student: "I wish that there was a means of going backwards to refer to things I realized later in the tutorials that I was still working on. Also, I wish I could have printed some of the material."

User-friendliness

Positive views or perceptions:

Ease of use and user-friendliness are crucial to the success of any computer courseware in promoting effective learning. With regards to the courseware programs under study, one student claimed: "I like how they were user-friendly and the student using it could determine how fast or slow to go through the material, or could go back over a difficult concept."

Feedback

Positive views or perceptions:

The feedback features of the courseware programs were appraised favorably for their usefulness in promoting effective learning. According to one student: "The review questions were very helpful. It allowed me to not only see what I was supposed to learn, it gave me the reasons why my answer was wrong. Telling students why they got a question wrong is the most helpful thing to me. I learn from making mistakes." Another student remarked: "I think the big thing it did was when I punched in a wrong answer, it told me why I was wrong." One student claimed: "I thought some of the feedback statements were humorous!" In the words of one student: "Very good features (of the programs) include the use of examples and feedback."

Aesthetics and visual appeals

Negative views or perceptions:

In general, the aesthetics and visual appeals of the courseware programs were rated poorly. Such a perception could negatively influence the acceptance and usage of courseware programs. In the words of one student, for instance, "The multiple colors on the screen strain the eyes."

One related issue was the quality and accuracy of the textual materials of the programs. In general, the students felt that the programs presented too much textual information. Some spelling mistakes were also detected. According to one student: "The text and explanations on this program were a bit extensive, too much like text book. Hurts eyes to read screen full of text. But informative indeed!" Another student remarked: "The programs need to be proofread carefully!!! I was thrown off by misspelled and wrong words." Another student suggested: "... cut down (text). Use the computer to convey information in non-traditional ways, using graphics and case histories." Yet another student prescribed: "Cut text in half. Key words and phrases only. I found myself rushed for time trying to read full screen text. Narrate instead."

Courseware availability and accessibility

Positive views or perceptions:

Comments provided about courseware availability centered primarily on the need to develop similar programs on other topics in physiology 431 course, topics in other physiology courses, and topics in other sciences, particularly the physical sciences. In the words of one student: "I believe that the CAI was tremendously helpful. I really wish that it was available for the rest of 431 and I hope it is available for 432 (i.e., Physiology 431 and 432 courses)." The same sentiment was echoed by another student who wrote, "The computer-aided instruction was extremely beneficial. I only wish they had one for each test, such as one on the GI (Gastrointestinal) tract and ANS (Autonomic Nervous System)." In the same vein, another student wrote, "These programs are great and should definitely be continued. The lack of computer assistance on the

Gastrointestinal tract topic is reflected in the lesson grade I received on that recent test as compared to my first test with which computer aided instruction was available."

Negative views or perceptions:

An issue closely related to availability is the view that courseware programs should be delivered across multiple platforms. The programs under study are strictly Windows-based. However, a comment by one student argued for cross-platform compatibility of courseware programs. In the words of the student: "The programs were useful. But need to accommodate both PC and Mac users." Expressing the same sentiment, one student remarked:

> Having to go to a computer lab is a detriment. Although disks are available to check out, there weren't enough copies to go around when needed. Could something be put on the internet (e.g., a home page on WWW)? Or, if a disk (Mac or IBM) was available for purchase with the study guide, this would help.

According to another student: "The material was very useful and well written. I enjoyed learning the material this way. I just wish that the software was available for people with Macintosh computers."

On the issue of accessibility, the students' comments centered primarily on the need to make the procedure for successfully using the courseware programs in the microcomputer labs on campus foolproof, especially for students who do not personally own computers. According to one student:

> I feel that the students should have access to the program without the use of the login name/password. I didn't get mine for awhile and everytime I would try to study for physiology using the computer programs I was locked out. I had

> problems getting a password. And many, even the computer techies, were unsure what the glitch was. All the while, I was left out in the cold having to study with others when they used the computer.

In the words of another student: "I think the computer-aided instructional programs are a great asset to this course. The only drawback is that for working students who live off campus (and do not own a computer for home use), it's difficult to get adequate time on campus computers."

A protest by one student is noteworthy for linking accessibility to computer courseware with computer literacy as a prerequisite for the use of courseware in academic curriculum. According to the student:

> I live off campus and have limited time to come here (i.e., the computer labs on campus) for use of computers. I thought the directions were not specific enough. The one attempt I made to use the computer, I was unable to access the programs. I'm probably as close to computer illiterate as you can get.

The same sentiment was echoed by another student who wrote:

> These programs are useful in that they strengthen a students understanding of course materials. However, what is not fair and not right is that MSU's book of classes available never indicates if computers are used in the class; and for those who do not know much about how to use computers, it's not a good thing at all not to notify students before signing up for the class.

<u>Time to complete courseware usage</u>

Positive views or perceptions:

The students' comments revealed a mixed view on the time required to complete the courseware programs. While some students felt that a considerable amount of time could and should be devoted to the programs, others held a contrary point of view. According to one student, for instance, "I did all of the programs in a short amount of time, maybe a week. If I would have done them over the course of a few weeks, or even several, and also more than once I think I would have learned more efficiently. That was my own fault. The courseware was very helpful though."

Negative views or perceptions:

On the contrary, another student complained, "The problem with them is that they take much time to finish and look at such that you end up spending more hours studying them. You might not spend that much time studying the book."

Appropriateness of using computer courseware

Positive views or perceptions:

The student respondents also provided comments on academic uses of computer courseware programs in general. An examination of the comments revealed mixed feelings on the part of the students. Some students liked and recommended wider applications as well as broader integration of computer courseware. Others deplored and protested against the use of computer courseware in academic courses in which computers is not the subject matter of discipline.

As an example of the camp that supported full integration of computer courseware into academic curriculum, one student claimed the applicability of computer courseware in all subject areas. In the words of the student: "Every class can use these type of programs." Another student remarked: "I would like to see more of these programs for biochemistry and physics classes." Also, one student recommended:

> Courses such as the General Inorganic Chemistry, Organic Chemistry, and most of all Biochemistry should have courseware programs similar to the one in Physiology. All of these sciences require the learner to know large amounts of information from nomenclature to real life applications. These programs could ease the learning process and can virtually minimize it.

A less enthusiastic student, but nonetheless supportive of academic uses of computer courseware, commented: "I don't think they (i.e., courseware programs) should serve to replace lecture or readings but as a compliment to the usual learning methods." Another student argued: "In some classes that (i.e., courseware programs) would be good, but not all classes." According to another student: "Hard sciences are the only courses in which I believe that the additional material may be helpful."

Negative views or perceptions:

Some students outrightly opposed academic uses of computer courseware. For instance, one student protested: "I think computer material in a non-computer class being required reading is wrong. I managed a 3.5 without the programs and without much studying and thus I think they were a waste of time."

The same instructor effects

Positive views or perceptions:

The students' comments revealed that the use of the courseware programs by the same instructor who developed them influenced the students' acceptance and usage of the programs. In the words of one student:

> I feel one reason this was so helpful in learning the class material is because the professor put the programs together. Because of this, there was no doubt that the material presented was important and relevant to the class itself. I used courseware programs in other courses and I had the same experience. I felt they were a wonderful tool for learning and I very much respect the professor for taking the time to put such a tool together for us.

For some students, the programs capsulized the topics, concepts, and principles that were important to the instructor. The programs, therefore, served as a tool for focusing the students' attention on lesson materials. One student responded: "Overall, I thought that the CAI programs enhanced my understanding of the materials in a way that indicated how the professor wanted me to learn and understand the materials, not just how the textbook authors thought about the material." One student noted: "I really wish more classes would put these (kinds of programs) together because you can really know what your professor is focusing on and what the most important material is!"

Specific comments about Courseware 1 (i.e., Action Potential)

Positive views or perceptions:

The courseware program on Action Potential was appraised to serve well as a useful synthesis of classroom lecture on the topic. In the words of one student: "This program was very helpful to tie the whole thing together. Graphics in this program were very helpful." According to another student: "Action Potential reinforced what we learned in class and the practice questions really helped me in terms of comprehension and picking up main points to be learned."

The clarity of the courseware was also identified as another feature that made the program to be a useful learning tool. According to one student: "The CAI program on Action Potential was relatively straight forward." Another student remarked that the program was a "Good set up and easy to understand."

One student noted that the program helped to promote thinking skills. The student asserted: "This was very detailed view of the Action Potential and quite thought provoking. Many of the questions were worthy of extra attention."

Negative views or perceptions:

A few of the comments about the courseware on Action Potential indicated negative views or needed improvement. In the words of one student: "In a few of the screens I could not go back to a specific of the courseware without starting over. Use animation and audio (sound of an Action Potential)." Another student remarked: "More extensive difficult review questions would be helpful." According to another student: "The threshold-frequency stuff was weird. I didn't like the Previous or Next page stuff. I like to click on what I need to see."

Comments about Courseware 2 (i.e., Control Systems)

Positive views or perceptions:

The comments provided concerning the courseware on Control Systems indicate that some students liked how the program used graphics illustrations, examples, and analogies to clarify and simplify lesson concepts. In the view of one student: "It (the program on Control System) was the best one! It showed many examples and excellent diagrams concerning Control Systems in physiology." In the words of another student: "This program was very useful and helpful. The graphics and examples made it easier to understand concepts of Control Systems." According to one student: "This was a difficult subject for me but the courseware made things easier to understand. The examples and test questions were also helpful." Another student remarked: "Assumes that students have never seen Control Systems before. I hadn't."

The program was well received especially as an important supplement to classroom lecture on Control Systems. In the words of one student: "This was probably the most helpful (of the courseware programs) because there was no information in the book. I had to rely strictly on lecture and study guide." According to another student: "As I had missed the presentation of this material in lecture format, I felt that the tutorial itself prepared me very well for the upcoming subject examination." Also, one student stated:

"The program almost directly paralleled the study guide (used in the class) and was very helpful."

Negative views or perceptions:

Mixed views were expressed concerning the use of examples in the courseware program on Control Systems. According to one student, for instance, "I feel that more examples should have been given. More problems to work through would have helped more." A similar view was expressed by another student in the statement: "Physiological examples are really helpful here. I think you could include more." One student even claimed: "It was short, and didn't go over the material in enough detail so you can understand completely." However, a different point of view was expressed by another student who complained:

> The Control Systems explained the basic lesson, but in giving examples went a little beyond my knowledge of the body's systems. Because of this, I simply skipped over that example - but was left wondering if I was to know that much material. Even though I understood Control Systems, I felt rather disillusioned after such a difficult example. This negative aspect is what sticks in my mind about the courseware.

Comments about Courseware 3 (i.e., Synaptic Mechanisms I and II)

Positive views or perceptions:

One feature that some students identified as an important strength of the courseware on Synaptic Mechanisms was application of concepts to real life situations. In the words of a student: "This tutorial served as a good review of the information, and allowed me to develop enough knowledge of the application of the material to other situations."

Some students praised the program for simplifying and clarifying what would otherwise have been a difficult subject matter. According to one student: "The program was very good at explaining how to tell whether or not it is a peripheral nerve or a (neural/dorsal) root that is damaged when doing a neurological examination. Even though I missed the question on the exam #1, I know the answer and how to determine it. I missed it due to time restriction and had to just fill in an answer." Another student said, "What was most helpful were the hints and the explanation that follow the selections."

Other features that some students identified as useful in promoting effective learning were the use of examples, review questions, and graphics animation. According to one student: "Synaptic Mechanisms I and II were useful - the examples and questions helped me quite a bit. Great program." Another student wrote: "The actual moving animations meant the most to aid in understanding the mechanisms... Keep the programs, they're great!"

Negative views or perceptions:

Some comments were made concerning drawbacks in the program as well as aspects in which the program needs improvement. According to one student: "Just like Control Systems and Action Potential, I could not go back during certain parts, almost got lost in the program. Animation would be very useful." Another student wrote: "Synaptic Mechanisms was fine but a little bit harder (compared to other programs) to keep focused on the program. It was good but missing maybe some details." One student remarked: "I wished there was more here. I still felt a little lost after completing the courseware and reading. Perhaps more check your work questions here would help." According to one student: "The only problem I noticed was that (endplate) potentials were not explained clearly enough in either the programs or the book, or class." Also, one student commented: "Some of the screens contained too much text. This caused fatigue." Another student noted: "Some explanations were wordy."

Summary

Findings related to the effects of computer courseware on students' learning achievement were presented in this chapter. Comments made by students regarding features of the computer courseware programs that aided effective learning of the lesson concepts were complied and classified under four major sections:

1. Comments common to all the three courseware programs
2. Comments specific to courseware 1
3. Comments specific to courseware 2
4. Comments specific to courseware 3

Section one, comments common to all three courseware programs, was further divided into themes to make the numerous and diverse comments provided about the programs more comprehensible and meaningful. The themes that emerged from the comments were:

- Overall usefulness and utility of the courseware programs
- Individualized Instruction

- Stimulating and sustaining learner interest
- Relevance of the programs to learner needs
- Facilitated the use of students' learning styles
- Promoted meaningful learning
- Interactivity, learner and navigational control
- User-friendliness
- Feedback
- Aesthetics and visual appeals
- Courseware availability and accessibility
- Time to complete courseware usage
- Appropriateness of using computer courseware
- The same instructor effects

A summary of the findings, conclusions, discussions, and recommendations regarding the effects of computer courseware on learning achievement is presented in Chapter VI.

CHAPTER V

PRESENTATION AND ANALYSIS OF DATA FROM EXPERTS

Introduction

The data presented in this chapter were gathered from experts drawn mostly from Michigan Sate University. The only exception was data collected from an expert from a community college because of the respondent's academic background in educational systems development and previous extensive professional experience in courseware development at Michigan State University. The data from the experts were collected during the Fall 1995 and Spring 1996 semesters.

The report in this chapter is presented in three sections. Section one describes the demographic characteristics of the experts involved in the study. Section two addresses the questions relating to the experts' perceptions regarding the level of importance of computer courseware characteristics in promoting effective learning. Section three presents information about the experts' perceptions regarding the quality of the characteristics of computer courseware programs in promoting effectively learning.

Section One — Description of the Experts' Demographics

Two groups of experts participated in the study. The first group consisted of 32 experts who responded to the survey questionnaire on the level of importance of the characteristics of computer courseware in promoting effective learning. This group of experts is referred to as the Expert Rating Form Group (ERFG). The second group consisted of 34 experts who used and evaluated the same computer courseware programs that the students in Physiology 431 class used and evaluated. This group of experts is referred to as the Expert Courseware Evaluation Group (ECEG).

Several demographic characteristics were collected about the experts in an attempt to understand factors that influenced their perceptions. Such an understanding will, in turn, shed some light on factors that exert influence on the evaluation of educational software. The demographic characteristics of the Expert Rating Form Group will be described first, followed by a description of the Expert Courseware Evaluation Group demographic characteristics.

The Expert Rating Form Group was comprised of an equal number of male (50%) and female (50%) respondents. By age distribution, 13 (40.6%) of the respondents in the Expert Rating Form Group were below 35 years old, 11 (34.4%) of them were between 36 and 45 years old, and those at least 46 years old constituted 25 % of the group. In terms of teaching experience, five (15.6%) of the respondents in the Expert Rating Form Group had between one and ten years of experience. Another five (15.6%) respondents had between 11 and 20 years of experience. Eight (25%) of the respondents had at least 21 years of teaching experience. 14 (43.8%) respondents either had no teaching experience or did not provide that information.

Table 5-1

The distribution of respondents in the Expert Rating Form Group
by range of teaching experience in years
(n=32)

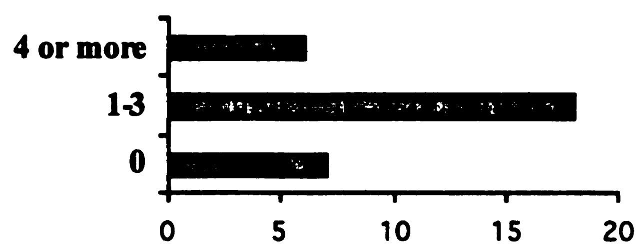
Teaching Experience in Years	No.	%
None (or missing values)	14	43.8
1-10	5	15.6
11-20	5	15.6
21 and above	8	25
Total	32	100

23 (71.9%) of the respondents in the Expert Rating Form Group indicated having expertise in courseware development. Nine (28.1%) respondents indicated having no courseware development expertise.

Data was also collected on the approximate number of courseware programs the experts had developed. As Figure 5-1 shows, 18 (56.3%) of the respondents had developed between one and three programs. Six (18.8%) respondents had developed at least four programs. Seven (21.9%) respondents indicated that they had not developed any programs.

Figure 5-1

The distribution of respondents in the Expert Rating Form Group
by approximate number of courseware programs developed



The respondents were asked to indicate whether or not they had previous experience using computer productivity tools. As Table 5-2 shows, all the respondents indicated having experience using word processing and communication tools. 75% of the respondents had experience using spreadsheet programs, 72% had database experience, 63% had computer programming experience, 91% had multimedia experience, 66% had experience in computer games, 72% had experience using courseware programs, and 25% had experience in assembling computers.

Table 5-2

The distribution of respondents in the Expert Rating Form Group by previous experience using computers as productivity tools

Type of Computer Experience	Had previous experience		No previous experience		Total	
	No.	%	No.	%	No.	%
Wordprocessing	32	100			32	100
Spreadsheet	24	75	8	25	32	100
Databases	23	71.9	9	28.1	32	100
Communication	32	100			32	100
Programming	20	62.5	12	37.5	32	100
Multimedia	29	90.6	3	9.4	32	100
Games	21	65.6	11	34.4	32	100
Courseware	23	71.9	9	28.1	32	100
Assembling Computers	8	25	24	75	32	100

In a related, but separate question from experience with computer productivity tools, this group of respondents was asked to indicate whether or not they owned computers. The distribution of computer ownership consisted of 30 (94%) respondents in the Expert Rating Form Group who owned a computer, only two (6.3%) did not.

Similar data presented for the Expert Rating Form Group were also collected for respondents in the Expert Courseware Evaluation Group. The analysis of the data is presented separately since this group consisted mostly of different respondents and responded to a different survey questionnaire.

The Expert Courseware Evaluation Group was composed of 22 (64.7%) males and 12 (35.3%) females. By age distribution, eight (23.5%) of the Expert Courseware Evaluation Group were under 25 years old, 11 (32.4%) were between 26 and 35 years old, and 14 (41.2%) were over 36 years old. The Expert Courseware Evaluation Group consisted of five (14.7%) respondents with expertise in the content area covered by the courseware under study, and 29 (85.3%) respondents with no expertise in the content area. Nearly three-quarters (73.5%) of the respondents in the Expert Courseware Evaluation Group indicated that they had expertise in courseware development. Nine (26.5%) of the respondents in this group had no previous experience in computer courseware development.

In terms of teaching experience, six (17.6%) of the respondents in the Expert Courseware Evaluation Group had not more than 10 years experience, three (8.8%) had between 11 and 20 years experience, nine (26.5%) had at least 21 years of experience. As Table 5-3 indicates, 16 (47.1%) respondents either had no teaching experience or did not provide that information.

Table 5-3

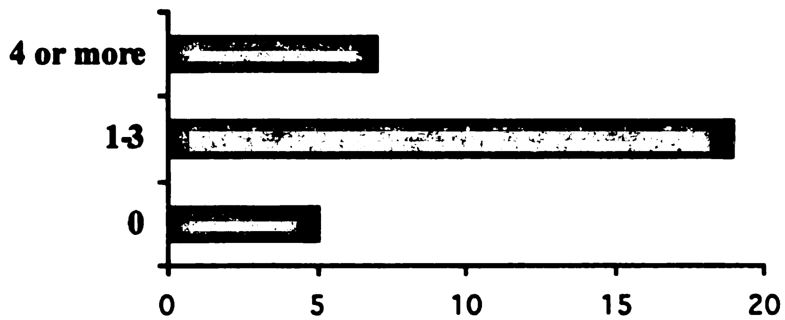
The distribution of respondents in the Expert Courseware Evaluation Group
by range of teaching experience in years
(n=34)

Teaching Experience in Years	No.	%
None (or missing values)	16	47.1
1-10	6	17.6
11-20	3	8.8
21 and above	9	26.5
Total	34	100

Data was also collected on the approximate number of courseware programs developed by the respondents in the Expert Courseware Evaluation Group. As Figure 5-2 shows, 19 (55.9%) of the respondents had developed between one and three courseware programs, seven (20.6%) had developed more than three courseware, and five (14.7%) of the respondents indicated that they had no experience in developing computer courseware. Three (8.8%) of the respondents did not answer this question.

Figure 5-2

The distribution of respondents in the Expert Courseware Evaluation Group
by approximate number of courseware programs developed



Another demographic characteristic examined for the respondents in the Expert Courseware Evaluation Group was previous experience using computer productivity tools. As table 5-4 shows, all the respondents indicated having experience using word processing and communication tools. 88.2% of the respondents had experience using spreadsheet programs, about 80% had database experience, about 65% had computer programming experience, about 91% had multimedia experience, over 60% had experience in computer games, about 82% had experience using courseware programs, and over 44% had experience in assembling computers.

Table 5-4

The distribution of respondents in the Expert Courseware Evaluation Group by previous experience using computers as productivity tools

Type of Computer Experience	Had previous experience		No previous experience		Total	
	No.	%	No.	%	No.	%
Wordprocessing	34	100			34	100
Spreadsheet	30	88.2	4	11.8	34	100
Databases	27	79.4	7	20.6	34	100
Communication	34	100			34	100
Programming	22	64.7	12	35.3	34	100
Multimedia	31	91.2	3	8.8	34	100
Games	24	70.6	10	29.4	34	100
Courseware	28	82.4	6	17.6	34	100
Assembling Computers	15	44.1	19	55.9	34	100

This group of respondents was also asked to indicate whether or not they owned a computer. 30 (88.2%) respondents owned a computer, only four (11.8%) did not.

Section Two — Perceptions of Respondents in the Expert Rating Form Group Regarding the Level of Importance of the Characteristics of Computer Courseware in Promoting Effective Learning

This section answers the research questions relating to the perceptions of the respondents in the Expert Rating Form Group regarding the level of importance of the characteristics of computer courseware in promoting effective learning. The purpose was to distill, from experts, knowledge of factors and characteristics considered to be important in promoting effective instruction and effective learning via computer courseware.

Data collected to answer the research question utilized the Computer Courseware Evaluation Checklist Rating Form (see Appendix B). The questionnaire was based on Gagné's Events of Instruction with additional information gleaned from current research and theories in educational psychology and academic uses of new technologies.

Two levels of analyses were applied to the data collected using the Rating questionnaire. The first level of analysis used simple descriptive statistics to describe the experts' perceptions regarding the characteristics of courseware programs in promoting effective learning. The second level of analysis, based on the results of simple descriptive statistics, focused on determining whether the experts' perceptions varied by their demographic characteristics.

The major research question guiding this section of the report was

Research Question C:

What computer courseware characteristics do experts perceive as important in promoting effective learning?

The subsidiary questions were:

Research Question C1: What are the experts' perceptions regarding the level of importance of computer courseware characteristics in promoting effective learning?

Research Question C2: Do the experts' perceptions regarding the level of importance of computer courseware characteristics in promoting effective learning vary by their demographic characteristics such as gender, age, professional discipline, teaching experience, courseware development experience, experience using computer productivity tools, and computer ownership?

Research Question C3: What other features do experts perceive as important to the success of computer courseware in promoting effective learning?

Experts' perceptions regarding the level of importance of computer courseware characteristics in promoting effective learning

Respondents in the Expert Rating Form Group were asked to rate their perceptions of the level of importance of computer courseware characteristics in promoting effective learning. The mean importance ratings and standard deviations of the perceptions were computed for each characteristic. The possible means rating ranged from the lowest, 1.00, indicating low importance to the highest, 3.00, indicating high importance. Table 5-5 shows the means, standard deviations, and ranks of the perceptions regarding the characteristics. From this information, the mean importance ratings observed ranged from the lowest rating, 2.03 for the characteristic "tests the learner on restating lesson information in his or her own words", to the highest rating 2.84 for the characteristic "presents complete, accurate, or current lesson materials." All the characteristics were rated as either high or medium in their level of importance, with each level having equal number of characteristics, 40 (50%). No characteristic was considered to be of low importance, that is, below 2.0 on the rating scale.

The mean importance ratings, standard deviations, and ranks were also computed for the characteristics of computer courseware sections. The five sections were courseware structure, screen layout and design, media use, prerequisite skills, and new lesson content. Table 5-6 presents the results of the analysis. The results indicate that the characteristics of both courseware structure and new lesson content were rated equal and at the top of the level of importance. Third in the level of importance were the characteristics of prerequisite skills, followed by the characteristics of screen layout and design. Media use characteristics ranked last, but nonetheless were considered to be of medium importance.

Table 5-5

Means, standard deviations, and ranks of the importance of characteristics of computer courseware that engender effective learning

Characteristics	N	Mean	SD	Rank
Presents complete, accurate, or current lesson materials	32	2.84	.37	1
Confirms the correctness of learner's use of application of concepts and rules	32	2.81	.47	2
Confirms the correctness of learner's response to question about statements of facts	32	2.81	.47	2
Presents information in simple and concise statements	32	2.81	.40	2
Directions on how to use the courseware	32	2.81	.40	2
Confirms the correctness of learner's solution to problems presented	32	2.81	.47	2
Presents varied examples of concepts and rules or principles	32	2.81	.40	2
Match between courseware objectives and lesson content	32	2.81	.40	2
The level or degree of interactivity the learner has with the lesson materials (opportunity for the learner to participate)	31	2.81	.79	2
Requires the learner to practice the skills learned and provides feedback on the learner's performance	32	2.78	.49	10
Learner control over the rate of information presentation	32	2.75	.76	11
The logical organization of lesson content	31	2.74	.44	12
Provides a variety of opportunities for the learner to practice or use cognitive strategies learned	32	2.72	.52	13
Consistency of the screen layout and elements (graphics, color, button, text, etc.)	32	2.72	.52	13
Introduction focuses learner attention on the learning situation or context	31	2.68	.54	15
Describes and demonstrates concepts, principles, and procedures to be learned	32	2.66	.55	16
Provides instruction to guide the learner in linking simple to more complex lesson content	32	2.66	.60	17

The use of instructional strategies (e.g., hints, examples, illustrations, analogies, flowcharts, outlines)	32	2.66	.55	17
Statement of objectives	32	2.66	.55	19
Simplicity of the screen layout and elements (graphics, color, button, etc.)	32	2.63	.49	20
Stimulates recall of prerequisite concepts and principles or rules	32	2.63	.61	20
Introduction focuses learner attention on the tasks and skills to be learned	32	2.62	.66	22
The use of graphics in enhancing learning of the course materials	32	2.62	.61	22
Identification of intended audience	31	2.61	.72	24
Tests the learner on applying concepts and rules to new situations or examples	31	2.58	.62	25
The amount (chunk) of information presented on each screen or in each lesson unit	32	2.56	.56	26
Stimulates recall of relevant facts and context that will make the learning tasks or processes meaningful	32	2.56	.62	26
Clarifies the general nature of problem solutions expected from the learner	32	2.56	.56	26
Feedback to students' responses	32	2.56	.67	26
Provides additional opportunities for the learner to practice the skills learned	31	2.55	.68	30
Tests the learner on making choice of action in a real or simulated situation	31	2.55	.62	30
Provides opportunity for the learner to practice making choices related to the attitude learned	31	2.55	.57	30
Provides prompts and hints to help the learner find novel solution to stated problem	32	2.53	.67	33
Presents novel problems for the learner to solve	32	2.53	.62	33
The use of courseware navigational tools (buttons, hotwords, etc.)	32	2.53	.51	33
Provides opportunity for the learner to practice performing all physical skills or tasks taught in the lesson	31	2.52	.51	36
The use of text styles to enhance the readability of text	32	2.50	.67	37
Provides instruction to guide the learner in following the proper sequence of steps to master the lesson content	32	2.50	.62	37
Stimulates recall of skills, situations, and actions that will be involved in the learner	32	2.50	.67	37

making personal choices or decisions				
Presents instruction on and demonstrates proper steps required for the motor skill performance desired	30	2.50	.73	37
Shows direct consequences of personal actions taken or decisions made by the learner	31	2.48	.68	41
The use of branching or hyperlinks	31	2.48	.89	41
Coherence among screen elements or components (background, foreground, pages, navigational tools, etc.)	32	2.47	.57	43
The use of HELP function to get context sensitive information	32	2.47	.67	43
General visual appeal of the overall screen design	32	2.47	.67	43
Provides feedback on the degree of accuracy and timing of the learner's performance of skills	32	2.47	.72	43
The use of MENU to access information	31	2.45	.62	47
Describes and shows the use of mental strategies or procedures to solve problems (e.g., strategy of asking proper questions; a strategy to "work the problem in steps backward from the goal")	32	2.44	.62	48
The use of text sizes to enhance the readability of text	32	2.44	.67	48
The use of video in enhancing learning of the course materials	31	2.42	.72	50
Tests the learner on solving a variety of novel or unique problems	32	2.41	.67	51
The use of spaced reviews including a variety of examples throughout the lesson	32	2.41	.76	52
Stimulates recall of skills, by modeling or illustration, that the learner can imitate in learning new behaviors or attitudes	32	2.41	.76	53
The use of audio in enhancing learning of the course materials	31	2.39	.67	54
Match between performance tests and lesson objectives	31	2.39	.72	54
Presents information to be learned about desired behaviors or attitudes by modeling or illustrating actions and consequences related to the behaviors or attitudes	31	2.39	.72	54
The complexity of lesson structure for the intended audience	29	2.38	.62	57
Provides example of the kind of behavior or attitude expected of the learner	32	2.37	.71	58

The level of difficulty of lesson materials for the intended audience	31	2.35	.66	59
States what the learner will be able to say or do after the lesson	32	2.34	.70	60
Confirms originality of learner's solution to problems presented	30	2.33	.71	61
The use of animations in enhancing learning of the course materials	31	2.32	.70	62
The ease of correcting errors (e.g., typing errors)	31	2.32	.65	62
Stimulates recall of subskills (part skills) and the process of integrating subskills (executive subroutine) necessary to learn the performance of the total motor skills desired	30	2.30	.70	64
Describes or demonstrates the desired behavior or attitude by simulating, modeling, or illustrating actions and consequences related to the behavior or attitude	32	2.28	.68	65
Balance in the screen layout and elements (graphics, color, button, text, etc.)	32	2.28	.68	65
Review questions to clarify the lesson content	32	2.28	.77	65
Review of relevant content (prerequisite skills) at the beginning of the lesson	32	2.28	.68	65
The use of icons to communicate meaning or expected action	32	2.25	.76	69
Tests the learner on using all physical skills taught in the lesson	30	2.20	.71	70
The use of INDEX or TABLE OF CONTENT to access information	31	2.19	.75	71
Review of the main concepts and principles at the end of the lesson	31	2.19	.75	71
The use of color to enhance the readability of text	32	2.19	.74	71
The use of special effects (text animation, highlighting, transition effects, etc.)	30	2.17	.79	74
Asks the learner to apply concepts and rules to instances not previously encountered in the lesson	31	2.16	.86	75
Statement or demonstration of the courseware relevance to the learner	30	2.13	.68	76
The availability of GLOSSARY to provide meaning of terms or additional information	31	2.13	.85	77
Demonstrates performance of motor (physical) skills expected of the learner	28	2.11	.79	78
Asks the learner for information in his/her own words	31	2.10	.70	79
Tests the learner on restating lesson information in his/her own words	30	2.03	.81	80

Table 5-6

Means, standard deviations, and ranks of characteristics of computer courseware sections

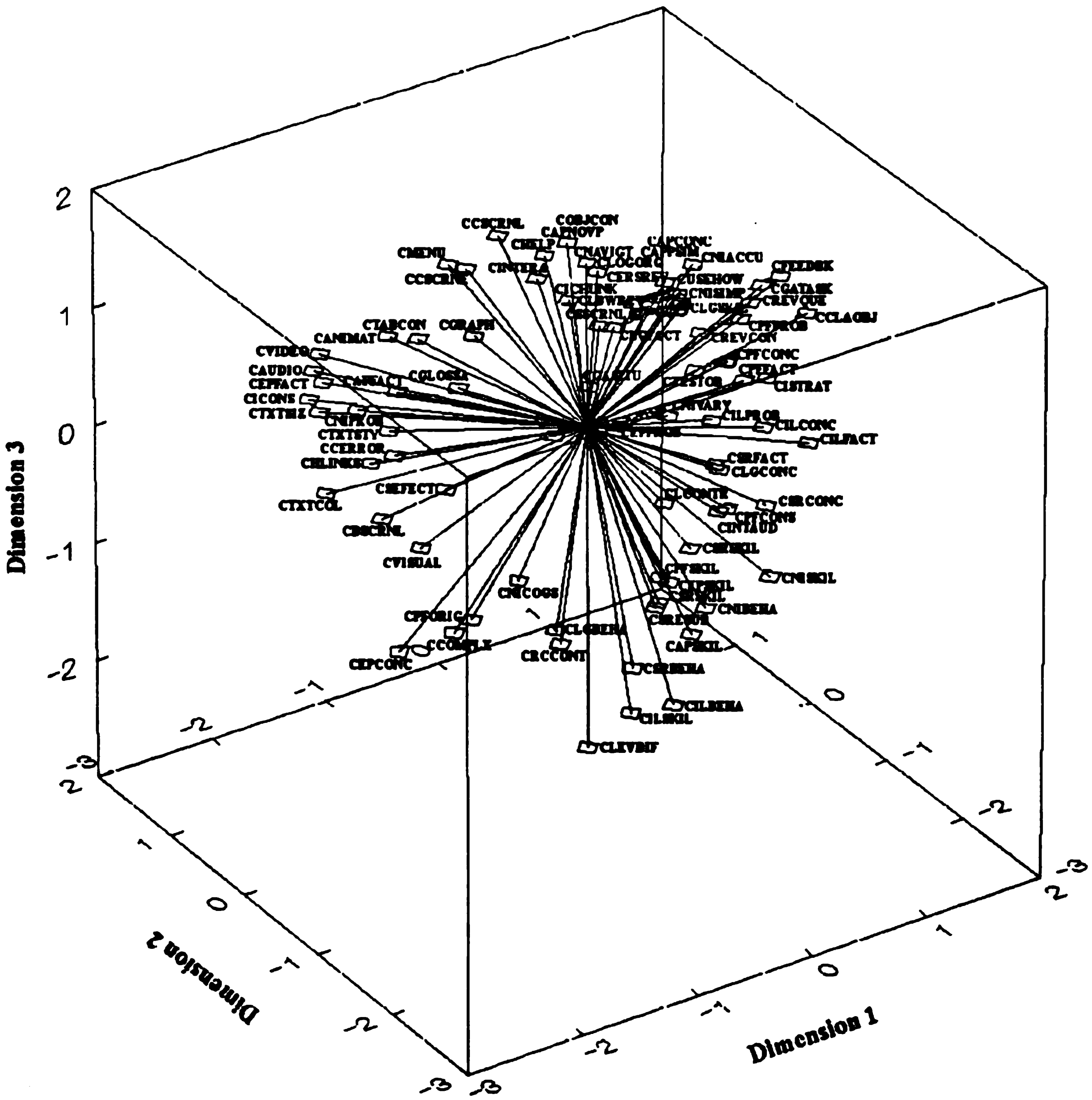
Courseware Sections	N	Mean	SD	Rank
Courseware Structure	32	2.51	.25	1
Screen Layout and Design	32	2.40	.41	4
Media Use	32	2.35	.59	5
Prerequisite Skills	32	2.48	.45	3
New Lesson Content	32	2.51	.34	1

Further intensive analysis using the multidimensional scaling procedure (MDS) was conducted on the data collected from respondents in the Expert Rating Form Group in order to determine whether any specific or systematic patterns of relationships existed in the perceptions of the experts regarding the level of importance of the characteristics of computer courseware in promoting effective learning. The patterns of relationships examined consisted of three-dimensional graphical illustrations of how the experts cluster together (i.e., similar) or spread apart (i.e., dissimilar) in their perceptions regarding the variables.

The MDS coordinates of all the variables were computed in SPSS. The MDS results were then imported into Systat to generate a three-dimensional plot of the relationships matrix. Figure 5-3 presents the three-dimensional plot of all the variables. The MDS coordinates of the variables are presented in Appendix I. The meaning of the abbreviations used to name the variables are explained on page xv.

Figure 5-3

MDS of perceptions of respondents in the Expert Rating Form Group regarding the level of importance of the characteristics of computer courseware in promoting effective learning (variable view of all the characteristics)



The plot was analyzed by visualizing it as a cube with the center of the cube as the origin of the coordinates for the variables. A close inspection of the three-dimensional plot revealed six distinct clusters of perceptions among the experts regarding the variables. The distinct clusters were located in the upper, upper right, lower right, lower, lower left, and upper left regions of the cube.

The following indicates the variables that were located in each of the regions.

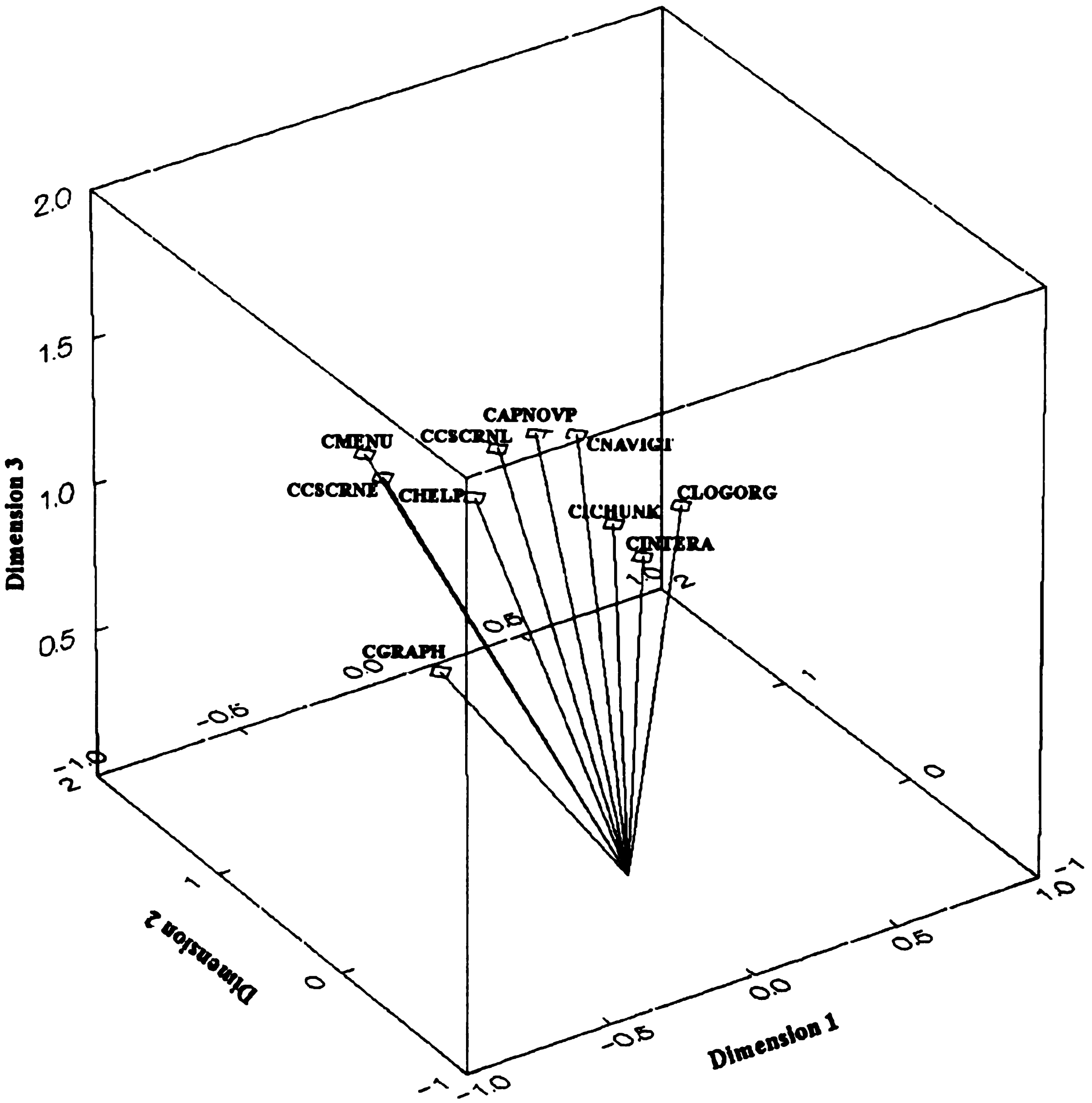
Regions of the Clusters		**Variables**	
Upper mid region	CCSCRNL	CLOGORG	CHELP
	CCSCRNE	CICHUNK	CAPNOVP
	CMENU	CINTERA	
	CGRAPH	CNAVIGT	
Upper right region	CGASITU	COBJCON	CILPROB
	CSSCRNL	CLGSKIL	CNIVARY
	CLGFACT	CUSEHOW	CEPPROB
	CERSKIL	CCLAOBJ	CPFFACT
	CNISIMP	CISTRAT	CPFCONC
	CLBWREV	CTESTOB	CPFPROB
	CAPCONC	CFEEDBK	CREVCON
	CAPPSIM	CGATASK	CREVQUE
	CERSREV	CILCONC	CEPBEHA
	CNIACCU	CILFACT	
Lower right region	CLCONTR	CSRFACT	CSRESUB
	CSRCONC	CSRSKIL	CLGPROB
	CNISKIL	CINTAUD	CAPSKIL
	CPFCONS	CPFSKIL	CNIBEHA
	CLGCONC	CEPSKIL	
Lower mid region	CRCCONT	CSRBEHA	CLEVDIF
	CLGBEHA	CILSKIL	CILBEHA
Lower left region	CNICOGS	CCOMPLX	
	CPFORIG	CEPCONC	
Upper left region	CCERROR	CTABCON	CVIDEO
	CVISUAL	CGLOSSA	CAUDIO
	CBSCRNL	CTXTSIZ	CNIPROB
	CSEFECT	CTXTSTY	CEPFACT
	CTXTCOL	CICONS	CAPFACT
	CHLINKS	CANIMAT	

Two major spheres were identified from the three-dimensional plot. One sphere included a cluster of variables in the upper right region and another cluster of variables in the upper left region of the cube. This sphere of cluster of variables consisted of characteristics mostly related to principles of courseware structure, human interface design (screen layout and design), learner control, and the use of media (such as video, audio, and graphics). The second sphere included clusters of variables in the upper right, lower right, lower, and lower left regions of the cube. This sphere of cluster of variables were mostly concerned with components of instructional theories emerging from current research in educational psychology triggered by the phenomenal incursion of new computer technologies in education and training. The variables located in the regions within the second sphere of the three-dimensional plot were related primarily to lesson content characteristics as defined in Gagné's events of instruction. A comparison among the variables displayed within the two spheres and the results of the mean ratings of the variables presented earlier in Table 5-5 revealed some close relationships. Most of the variables within the first sphere of the three-dimensional plot were also the variables that received high mean ratings. Similarly, variables that were located in the second sphere of the three-dimensional plot constituted the majority of the characteristics that received mean ratings of medium level of importance. As explained earlier, no variable received a low mean rating.

The upper mid region contained variables that were primarily related to characteristics of learner control over the pace, order, type, and amount of courseware lesson materials to interact with (see Figure 5-3a). The characteristics in this region included the use of menu, screen design balance and coherence, navigational tools, amount of information presented on each screen, help function, logical organization of lessons, and interactivity. The use of graphics was perceived by the experts as at the same level of importance as the characteristics relating to learner control. This perception may be due to the fact that human interface design, which defines the nature of learner control, involves the use of a lot of graphics. One other characteristic that was located in the upper region, although it is seemingly unrelated in attributes and functions to human interface design or learner control, was how well a courseware tests the learner on solving a variety of novel problems. It was not clear from the pattern of perception represented in this region why the experts perceived the latter characteristic as having the same level of importance as the other characteristics displayed in the region.

Figure 5-3a

Enlarged view of the upper mid region of the three-dimensional plot of the variables



Both the upper right region (Figure 5-3b) and lower right region (Figures 5-3c) contained the vast majority of the variables displayed in the three-dimensional plot. Almost all the variables located in these two regions were related to lesson content characteristics as defined by Gagné's events of instruction. However, there were no discernible patterns in the way the variables were displayed within the two regions. The variables seemed organized as assortments of different components of the Events of Instruction. The only variable that seemed different in nature from other variables located within the two regions was identifying the audience of computer courseware. While the characteristics may be somewhat related to lesson content, it was more closely akin to the characteristics associated with courseware structure in this study. It was not clear from the patterns of perception why the experts perceived audience identification as at the same level of importance as other variables displayed in these two regions.

Figure 5-3b

Enlarged view of the upper right region of the three-dimensional plot of the variables

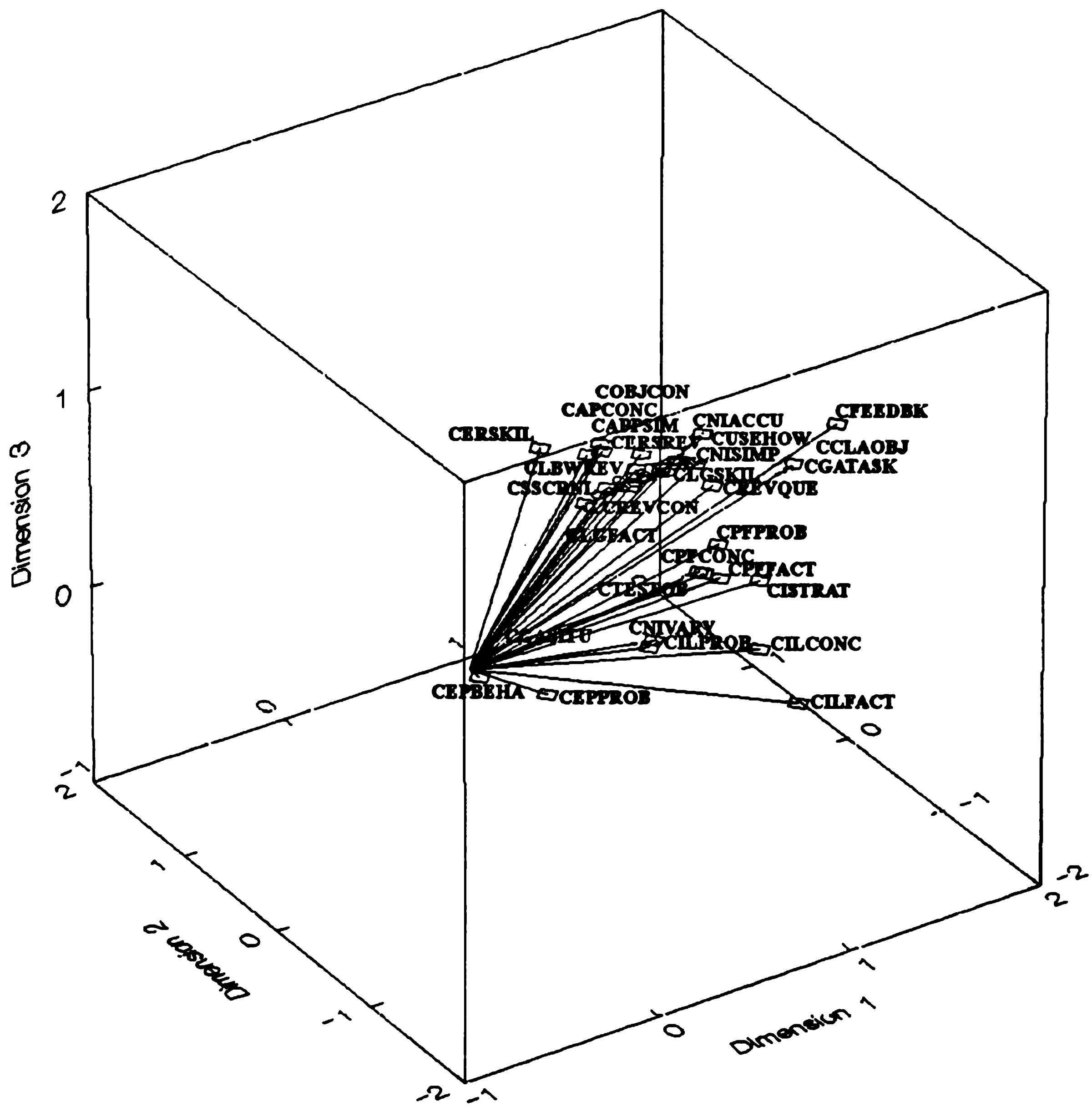
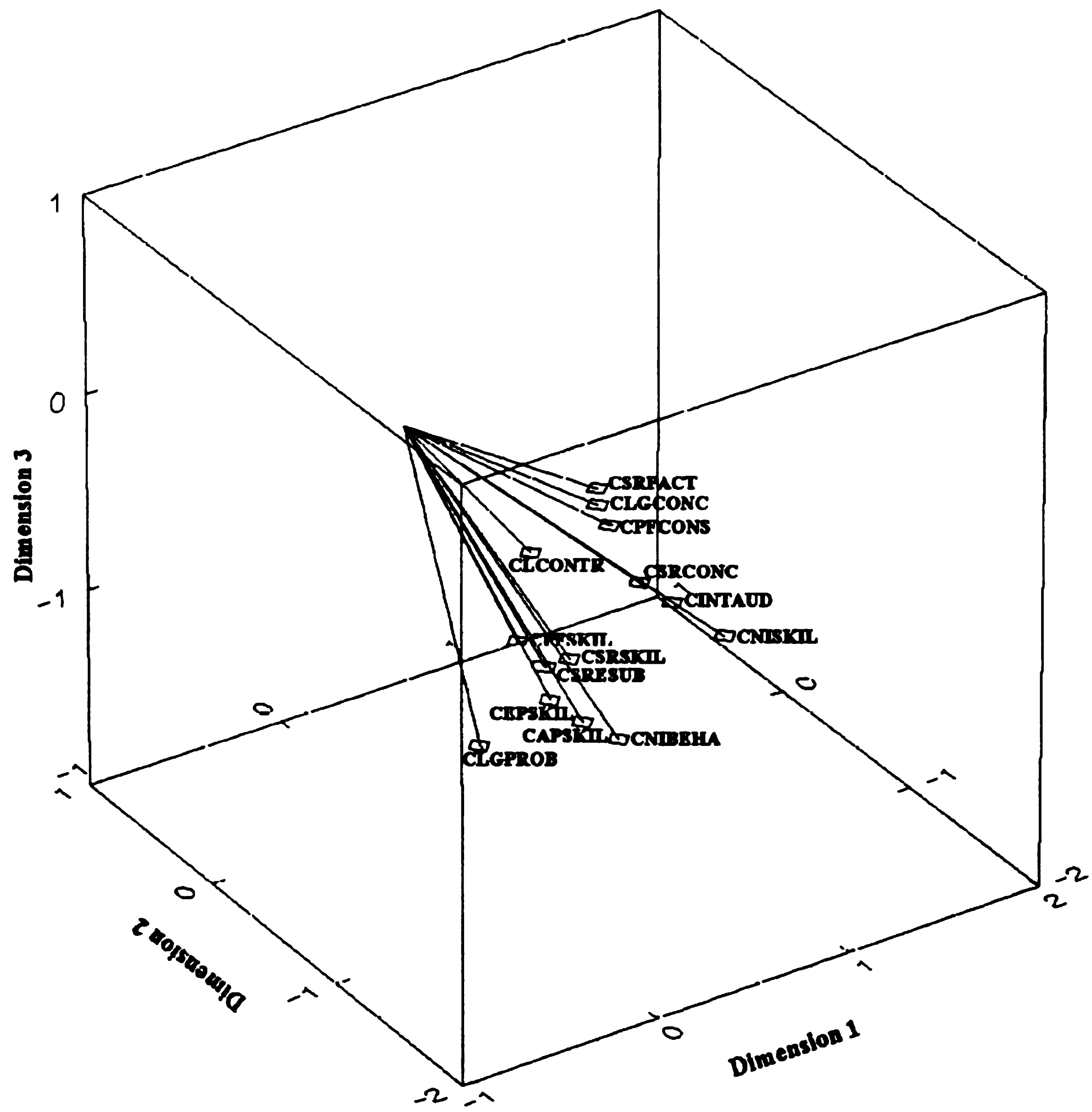


Figure 5-3c

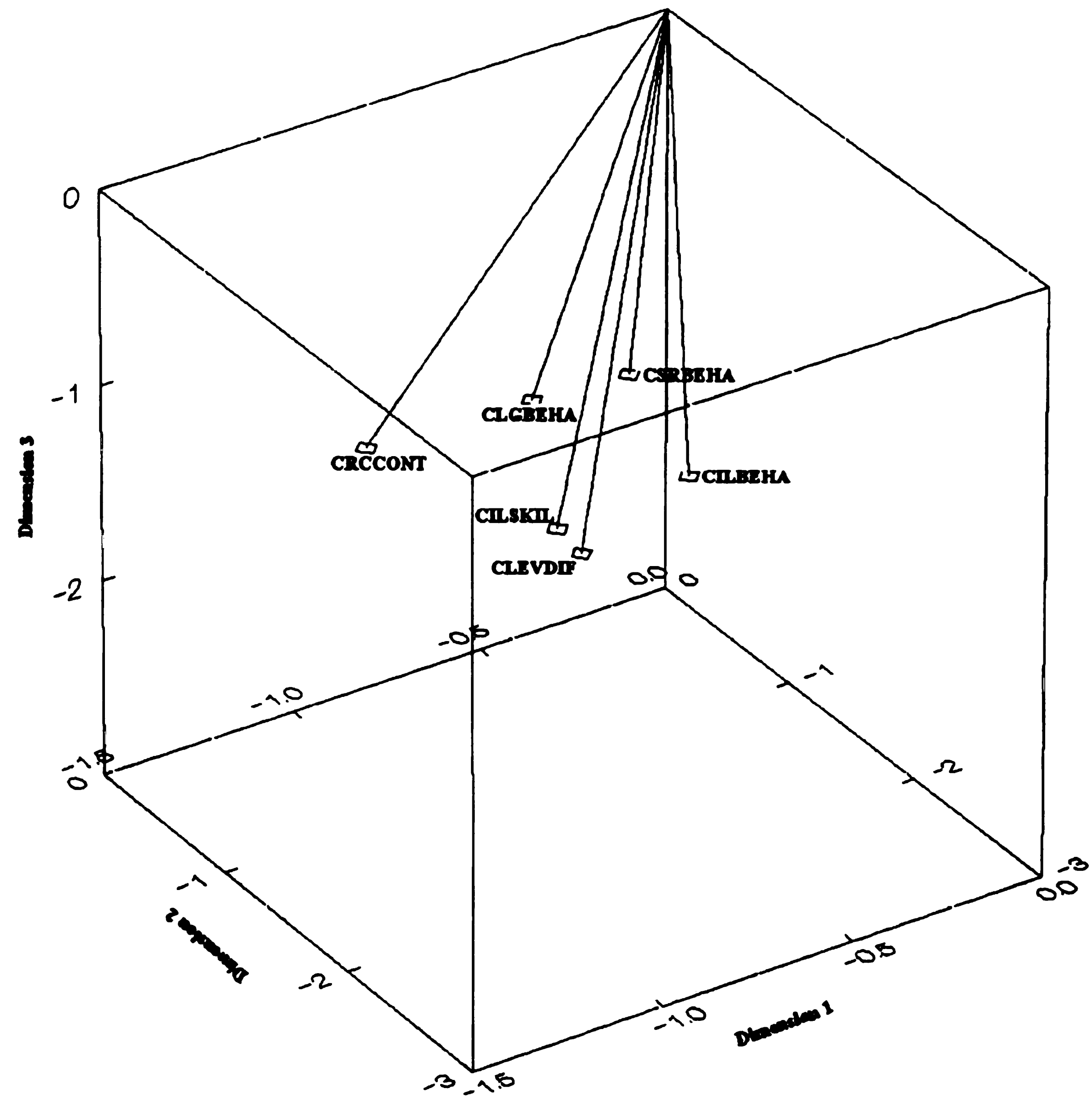
Enlarged view of the lower right region of the three-dimensional plot of the variables



The lower mid region contained a cluster of variables that was mostly related to characteristics of attitude and motor skills (see Figure 5-3d). An interesting observation was the experts' perception that the level of difficulty of lesson materials for the intended audience was at the same level of importance as variables or characteristics of lesson content on attitude and motor skills to be learned. It may be that the level of difficulty is somehow related to the ease of learning achievement more especially in attitude and motor skills domains than in other knowledge domains.

Figure 5-3d

Enlarged view of the lower mid region of the three-dimensional plot of the variables



The variables that were located in the lower left region all seemed related to higher cognitive processes (see Figure 5-3e). The variables were:

- describing or showing the use of mental strategies or procedures to solve problems
- complexity of lesson structure for the intended audience
- confirming originality of learner's solution to problems presented
- eliciting performance by asking the learner to apply concepts and rules to instances not previously encountered in the lesson

From the results of the mean ratings for these variables (as shown earlier in Table 5-5) it appeared that the experts perceived the characteristics to be of only medium importance in promoting effective learning via computer courseware. The mean ratings, ranging from lowest, 1.0, to highest, 3.0, for the variables in the order listed above were 2.44, 2.38, 2.33, and 1.16.

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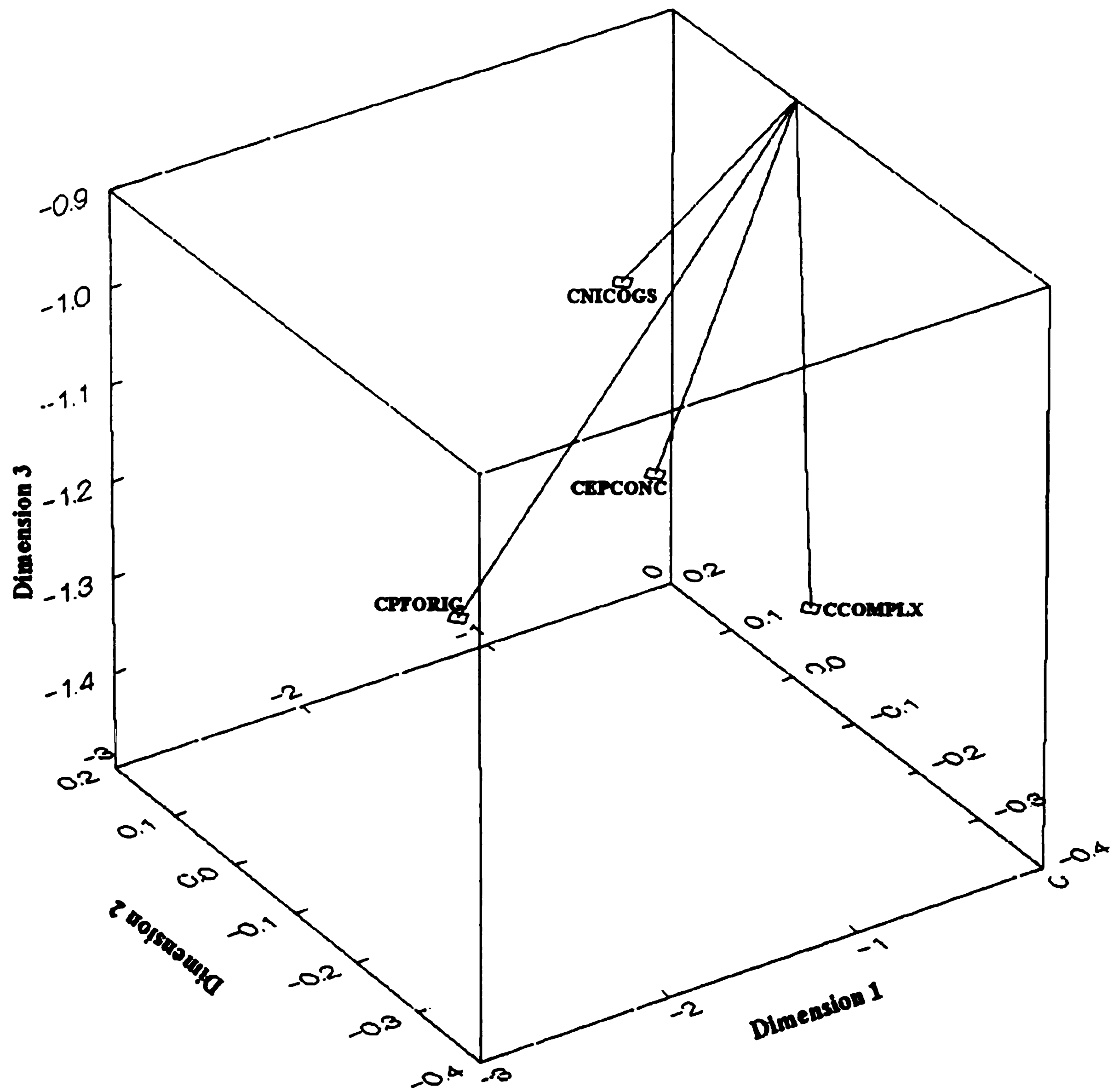
Figure 5-3e

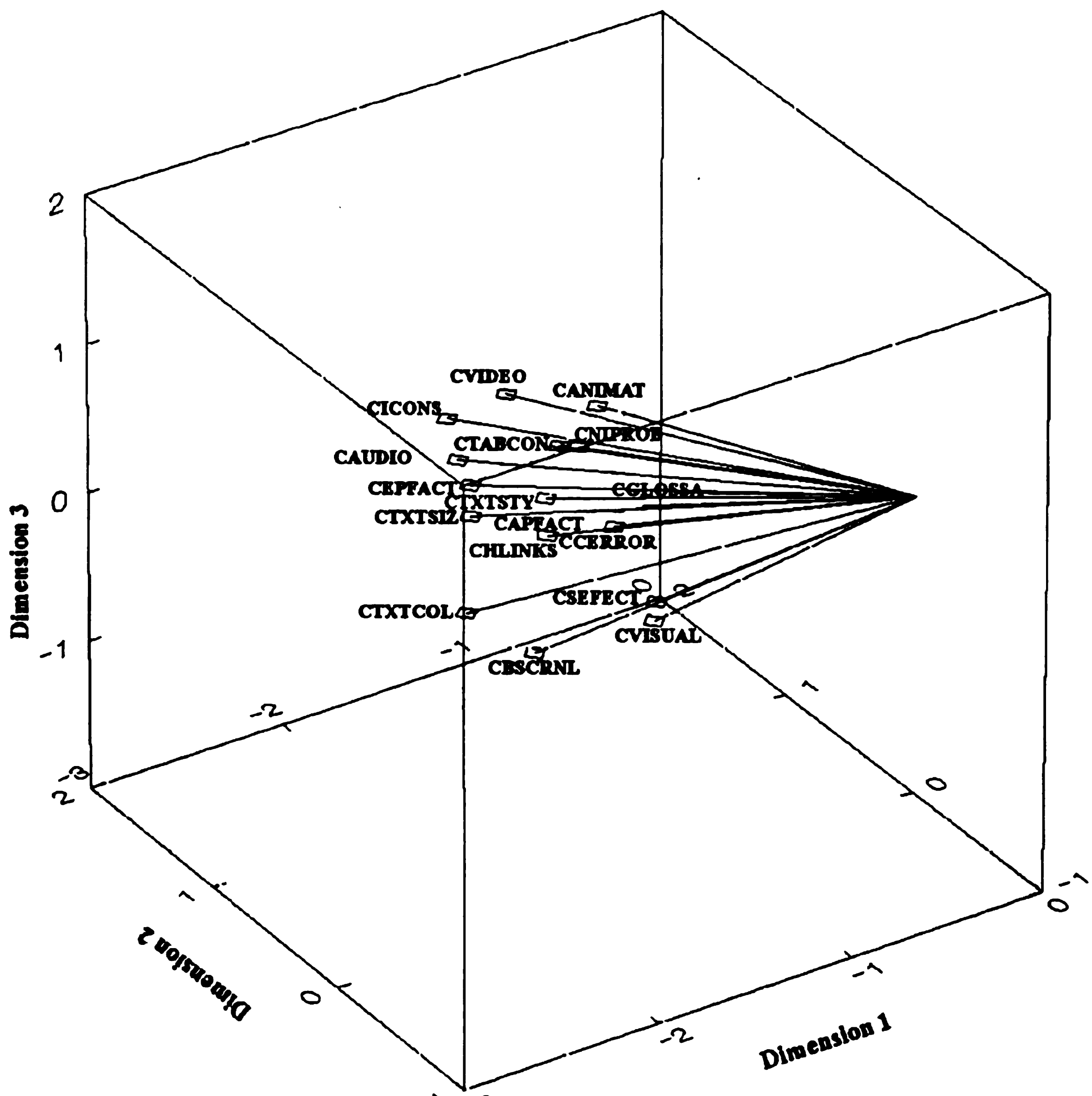
Enlarged view of the lower left region of the three-dimensional plot of the variables



The remaining region examined was the cluster of variables in the upper left region (see Figure 5-3f). As explained earlier, virtually all the variables located in this region were related to characteristics of the use of media and human interface design. Overall, the variables were perceived by experts to be of medium importance when cross examined with the results of their mean ratings as presented earlier in Table 5-5.

Figure 5-3f

Enlarged view of the upper left region of the three-dimensional plot of the variables



In sum, each region was examined closely for specific patterns of the perceptions of the experts. It was observed that each region contained variables that were closely related in attributes and/or functions. The variables located in each region were mostly linked to some closely related events of instruction as specified by Gagné or sections of the characteristics of computer courseware as specified for the purpose of this study. However, each region also contained a minority of variables from other components or sections of computer courseware characteristics as defined for the purpose of this study. The results for each region indicated that the experts were fairly close in their opinion or perception regarding the relative level of importance of the variables in each cluster. Each variable in a cluster region was perceived as having fairly the same level of importance as the other variables in the cluster.

Effects of demographic characteristics on experts' perceptions regarding the level of importance of computer courseware characteristics in promoting effective learning

One way analysis of variance (ANOVA) was used to determine whether the perceptions of respondents in the Expert Rating Form Group regarding the level of importance of computer courseware characteristics to the success of the programs varied according to their demographic characteristics such as: gender, age, professional discipline, teaching experience, courseware development experience, experience with computers as productivity tools, and computer ownership. The results are presented in Tables 5-7 and 5-8. As the results revealed, there were only significant differences in perceptions regarding the characteristics of courseware structure among the experts by their gender (F-value = 4.3) and age (P-value = .047). The result of a post hoc Tukey's test (see Table 5-8) indicates a significant difference in the perception of experts 36-45 years old compared to those over 46 years old at the level .05.

Further analysis was conducted on the data using the stepwise regression procedure to determine whether gender, age, or any other demographic characteristics, are significant predictors of the experts' perceptions regarding the level of importance of characteristics of courseware programs in promoting effective learning. The results are presented in Table 5-9. Age was the only factor observed to be a significant predictor of the experts' perceptions at the .05 level. Compared to experts over 46 years old, those between 36 and 45 years of age are predicted to have higher perceptions regarding the level of importance of the characteristics of the following sections of computer courseware:

courseware structure (β= 0.43, F=.01), prerequisite skills (β= 0.35, F=.05), and new lesson content (β= 0.41, F=.03). In the case of screen layout and design, experts over 46 years old are predicted to have significantly lower perceptions regarding the level of importance of that set of characteristics (β= -0.36, F=.04). In general, it appears that the older an expert is, the less likely he or she would consider the computer courseware characteristics under study as important in promoting effective learning. The converse of such a perception would be true for younger experts.

Although gender was a significant factor in explaining differences among experts in their perceptions of the level of importance of the courseware characteristics, the regression results indicate that it was not a significant predictor. Teaching experience, previous experience using computer courseware and multimedia, and even professional expertise in courseware development, all appeared not to be significant predictors of the experts' perceptions regarding the level of importance of the computer courseware characteristics under study in promoting effective learning.

Table 5-7

Analysis of variance results of perception of respondents in the Expert Rating Form Group regarding the level of importance of the characteristics of composite sections of computer courseware that can produce effective learning by gender.

Courseware Composites/Sections	Male			Female			F-value	P-value
	N	Mean	SD	N	Mean	SD		
Courseware Structure	16	2.43	.239	16	2.60	.245	4.3049	.0467*
Screen Layout and Design	16	2.34	.419	16	2.47	.395	.7875	.3819
Media Use	16	2.31	.551	16	2.39	.639	.1485	.7027
Learning Prerequisite Skills	16	2.34	.465	16	2.61	.405	3.0247	.0923
New Lesson Content	16	2.42	.366	16	2.61	.279	2.9169	.0980

N = Number, SD = standard deviation
*** Significant $p < .05$**

Table 5-8

Analysis of variance results of perception of respondents in the Expert Rating Form Group regarding the level of importance of the characteristics of composite sections of computer courseware that can produce effective learning by age in years

Courseware Composites/ Sections	35 and under			36-45			46 and above				
	N	Mean	SD	N	Mean	SD	N	Mean	SD	F-value	P-value
Courseware Structure	13	2.47	.257	11	2.67	.264	8	2.39	.132	3.6368	.0390*
Screen Layout and Design	13	2.45	.342	11	2.53	.479	8	2.15	.316	2.3466	.1136
Media Use	13	2.36	.528	11	2.45	.669	8	2.18	.599	.5135	.6037
Learning Prerequisite Skills	13	2.37	.493	11	2.69	.392	8	2.36	.386	2.0553	.1463
New Lesson Content	13	2.41	.328	11	2.70	.319	8	2.42	.292	2.8984	.0712

N = Number, SD = standard deviation
*** Significant $p < .05$**

Table 5-9

Regression results of the perceptions of respondents in Expert Rating form Group regarding the level of importance of the characteristics of courseware in promoting effective learning

Courseware sections	Age in years (the only predictor entered)								
	36-45			46 and over			F-value	P-value	R^2
	β	T-value	Sig T	β	T-value	Sig T	F-value	P-value	R^2
Courseware Structure	0.43	2.61	.014	-.14	-.76	.457	6.80	.014*	0.18
Screen Layout and Design	.095	.499	.622	-.36	-2.1	.04	4.56	.04*	.132
Prerequisite Skills	.352	2.06	.048	-.002	-.01	.99	4.25	.048*	.124
New Lesson Content	.408	2.45	.021	.013	.072	.94	5.99	.02*	.166

*** Significant at 0.05 level.**

Other features experts perceived as important to the success of computer courseware in promoting effective learning

Only a few comments were provided. The comments were related essentially to the type and scope of learning that can be mediated via computer courseware. The comments are documented and analyzed below.

One factor an expert thought might be crucial to the success of computer courseware in promoting effective learning is designing computer courseware in ways that augment the classroom needs of a teacher and also facilitate learning processes that promote the learner's cognitive processes. In the words of the expert:

> I think a good computer courseware is not only (in your evaluation cases) dependent on the software itself, but also how the instructor uses it in the classroom. I feel that in your evaluation form, it seems that the software will do everything the instructor (teacher) will do. For example, it seems to me that it will be difficult to implement "eliciting the performance" in the "normal" computer courseware, except the so called "intelligent tutoring system." I am also not sure that using the computer to give precise and quick feedback is really good for the learner's cognitive thinking and learning.

Another expert expressed the same concern slightly differently. The expert remarked that while some characteristics may be important in some type of educational software it may not be so important in others. As the expert noted:

> Generalization is difficult if a courseware is just a tutorial. Some parts are not crucial, while if it is at simulation level or problem-solving, those not-so-important parts will become a necessity. So depending on the level of courseware, different items gain importance.

The same concern was expressed by another expert who thought that a "one-size fits all" assessment instrument for computer courseware might be difficult to construct, if not impossible. The expert noted that:

> Without knowing the purpose of a specific courseware module, it is impossible to rate the characteristics as to their importance for the module's effectiveness. Some modules teach by repetitive practice (e.g. typing); others present complex ... and expect collaborative discussion. What makes them effective examples of this group will differ.

The utility of the computer courseware is a factor that an expert considered paramount to the success of courseware programs. According to the expert:

> The most important (consideration with courseware) is ease of use for both students and instructors. No long introduction. Each step should supply concise context of learning.

The way computer courseware reacts to a user response is thought to be crucial to the success of educational software by an expert. For instance, computer courseware should offer more than just stimulus-response learning modality. In the words of the expert:

> 'Correctness' implies only one possible solution or answer to problem; in many cases this is true, however, regardless of the range of possible 'correct' answers, developers should not discourage participants who may not be grasping the materials. Instead of returning an error, the courseware should take the student through a review of the material they did not grasp. 'Grasping' is not black and white and the developers must anticipate numerous 'correct' answers in many situations.

Section Three — Perceptions of Respondents in the Expert Courseware Evaluation Group Regarding the Quality of Computer Courseware in Promoting Effective Learning.

This section answers the research questions relating to the perceptions of the respondents in the Expert Courseware Evaluation Group regarding the quality of the characteristics of computer courseware programs used in this study. The experts were asked to rate the quality of the characteristics of the courseware programs in promoting effective learning. The research questions for this section were constructed to fulfill a two-fold purpose. First, data collected from experts in response to the questions will help in determining the characteristics of the computer courseware programs that experts consider salient to engendering effective learning of the lesson materials. Second, the data will provide information useful in constructing an evaluation framework for an authentic evaluation of computer courseware.

Data collected to answer the research questions about the experts' perception regarding the quality of the courseware under study utilized the Computer Courseware Evaluation Checklist Form (see Appendix C). The questionnaire was a variant of the other two questionnaire instruments used in this study.

Like the analyses conducted in section two, two levels of analyses were applied to the data collected using the Computer Courseware Evaluation Checklist Form. The first level involved simple data analysis to determine relationships among variables. The second level was based on the results of the simple data analysis and was more intensive. The intensive data analysis focused on the differences and similarities among experts who participated in the study in terms of their perception about the degree to which the quality of the computer courseware programs influenced effective learning of the lesson material.

The major question guiding this section of the report was

Research Question D:

> **What are the experts' perceptions regarding the quality of the characteristics of computer courseware programs used in this study?**

The subsidiary questions were:

> Research Question D1: What are the experts' perceptions regarding the quality of the characteristics of the computer courseware programs used in this study in promoting effective learning?

Research Question D2: Do the experts' perceptions regarding the quality of the computer courseware characteristics vary by their demographic characteristics such as gender, age, professional discipline, teaching experience, courseware development experience, experience using computer productivity tools, and computer ownership?

Research Question D3: What other features of the courseware programs used in this study do experts perceive as unique and helpful in promoting effective learning?

Experts' perceptions regarding the quality of computer courseware characteristics in promoting effective learning

The respondents in the Expert Courseware Evaluation Group were asked to rate how they perceived the quality of each courseware program under study as helpful in promoting effective learning. The mean of the quality ratings (importance ratings) and standard deviations were computed for the characteristics of each composite section of the courseware programs. The possible mean ratings ranged from the lowest, 1.00, indicating that the set of composite characteristics is rated very poor, to the highest, 5.0, indicating that the set of composite characteristics is rated very good. Table 5-10 presents the means, standard deviations, and ranks of the experts' perceptions regarding the quality of the characteristics of the courseware sections.

From the information on the table, two sections of courseware 2 top the list of rank of mean ratings. First in rank was courseware 2 structure (mean = 3.83). The prerequisite skills section of courseware 2 ranked second (mean =3.75). Third in rank was the characteristics of courseware 3 structure. Four of the five sections of courseware 1 were in the last four ranks on the list of mean ratings. Overall, courseware 2 had the best mean ratings, followed by courseware 3, with courseware 1 having the lowest mean ratings. In general, the experts had a more positive perception of the quality of courseware 2 characteristics than courseware 3 characteristics which in turn were perceived better than the characteristics of courseware 1.

Almost all of the courseware sections were rated as fair in quality as measured by the mean ratings which ranged from the lowest, 3.28, to the highest, 3.83. The only exception was the prerequisite section of courseware 1 which was rated as poor (mean = 2.97).

Table 5-10

Means, standard deviations, and ranks of experts' perceptions regarding the quality of the characteristics of sections of the courseware programs under study

Courseware Composites	Courseware Rated	N	Mean	SD	Rank
Courseware Structure	Courseware 1	34	3.37	.61	12
	Courseware 2	34	3.83	.53	1
	Courseware 3	34	3.67	.67	3
Screen Layout and Design	Courseware 1	34	3.34	.74	13
	Courseware 2	34	3.54	.72	9
	Courseware 3	34	3.57	.70	8
Media Use	Courseware 1	34	3.50	.81	10
	Courseware 2	34	3.65	1.94	4
	Courseware 3	34	3.43	.96	11
Prerequisite Skills	Courseware 1	34	2.97	.73	15
	Courseware 2	34	3.75	.82	2
	Courseware 3	34	3.62	.68	5
New Lesson Content	Courseware 1	34	3.28	.60	14
	Courseware 2	34	3.62	.59	5
	Courseware 3	34	3.58	.90	7

Effects of demographic characteristics on experts' perceptions regarding the quality of computer courseware characteristics

One way analysis of variance (ANOVA) was used to determine the extent to which the perceptions of the respondents in the Expert Courseware Evaluation Group regarding the quality of computer courseware characteristics varied by their demographic characteristics such as gender, age, professional discipline, teaching experience, courseware development experience, experience with computers as productivity tools, and computer ownership. The results are presented in Tables 5-11 through 5-20.

As Table 5-17 indicates, a significant difference in perception regarding the quality of courseware 1 new lesson content characteristics was observed among experts who had developed some courseware programs and those who had not. Experts who had not developed any programs had a more positive perception about the quality of the characteristics than others who had developed some programs (F=3.35, P=.049). However, no significant difference in the perception was observed between experts who had developed between one and three programs (mean = 3.16) and those who had developed at least four courseware programs (mean = 3.19).

As shown in Table 5-15, a significant difference was observed in the perceptions regarding the quality of courseware 2 structure between experts without content expertise and those with expertise in the content area covered by the courseware programs under study (F=4.22, P=.048). The experts without content expertise had a more positive perception (mean = 3.89) of the quality of the characteristics of courseware structure in courseware 2 than experts with content expertise (mean = 3.35). Table 5-17 indicates that there was also a significant difference in the perception regarding the quality of courseware 3 prerequisite skills characteristics between experts without content expertise and those with content expertise (F=6.5, P=.02). The former had a more positive perception (mean = 3.72) of the quality of courseware 3 prerequisite skills characteristics than experts with content expertise (mean = 2.87).

No significant differences were observed in the experts' perceptions by gender, age, teaching experience, experience using computers as productivity tools, or computer ownership. Also, no significant differences in perceptions regarding the quality of the following characteristics of the courseware programs were observed among experts by any demographic characteristics:

Courseware 1: courseware structure, screen layout and design, media use, and prerequisite skills

Courseware 2: screen layout and design, media use, prerequisite skills, and new lesson content

Courseware 3: courseware structure, screen layout and design, media use, and new lesson content

Table 5-11
Analysis of variance results of the perceptions of respondents in the Expert Courseware Evaluation Group regarding the quality of the characteristics of the courseware sections/composites in helping them to effectively learn the lesson material (Physiology 431 concepts) by gender

Courseware Composites/Sections	Male			Female			F-value	P-value
	N	Mean	SD	N	Mean	SD		
Courseware 1 — Courseware Structure	22	3.31	.65	12	3.47	.55	.4678	.4989
Courseware 1 — Screen Layout/Design	22	3.25	.76	12	3.51	.74	.9333	.3413
Courseware 1 — Media Use	22	3.49	.83	12	3.53	.81	.0235	.8792
Courseware 1 — Prerequisite Skills	22	3.02	.78	12	2.87	.67	.3350	.5668
Courseware 1 — New Lesson Content	22	3.29	.60	12	4.79	5.24	1.8309	.1855
Courseware 2 — Courseware Structure	22	3.79	.52	12	3.90	.55	.2965	.5898
Courseware 2 — Screen Layout/Design	22	3.52	.69	12	3.57	.81	.0353	.8522
Courseware 2 — Media Use	22	3.67	.90	12	3.61	1.29	.0266	.8714
Courseware 2 — Prerequisite Skills	22	3.82	.89	12	3.63	.69	.3816	.5411
Courseware 2 — New Lesson Content	22	3.63	.56	12	3.61	.65	.0127	.9109
Courseware 3 — Courseware Structure	22	3.55	.71	12	3.91	.54	2.3343	.1364
Courseware 3 — Screen Layout/Design	22	3.53	.68	12	3.64	.77	.1846	.6704
Courseware 3 — Media Use	22	3.49	.96	12	3.29	.99	.3353	.5666
Courseware 3 — Prerequisite Skills	22	3.59	.71	12	3.69	.65	.1672	.6853
Courseware 3 — New Lesson Content	22	65.0	32.92	12	75.75	17.84	1.0936	.3035

N = Number, SD = standard deviation

Table 5-12

Analysis of variance results of the perceptions of respondents in the Expert Courseware Evaluation Group regarding the quality of the characteristics of the courseware sections/composites in helping them to effectively learn the lesson material (Physiology 431 concepts) by age

Courseware Composites/ Sections	35 years and under			36-45 years old			46 or more years old				
	N	Mean	SD	N	Mean	SD	N	Mean	SD	F-value	P-value
Courseware 1 - Courseware Structure	9	3.31	.57	11	3.49	.56	14	3.30	.69	.3556	.7036
Courseware 1 - Screen Layout/ Design	9	3.09	.64	11	3.56	.34	14	3.34	.98	1.0134	.3747
Courseware 1 - Media Use	9	3.30	.967	11	3.48	.61	14	3.65	.88	.4860	.6197
Courseware 1 - Prerequisite skills	9	2.94	.673	11	2.92	.56	14	3.03	.91	.0705	.9321
Courseware 1 - New Lesson Content	9	5.35	6.03	11	3.22	.51	14	3.30	.62	1.4898	.2411
Courseware 2 - Courseware Structure	9	3.89	.61	11	3.84	.55	14	3.79	.49	.0995	.9056
Courseware 2 - Screen Layout/ Design	9	3.26	.81	11	3.74	.54	14	3.57	.77	1.1283	.3365
Courseware 2 - Media Use	9	3.61	1.17	11	3.30	1.19	14	3.96	.76	1.2640	.2967
Courseware 2 - Prerequisite skills	9	3.79	.69	11	3.95	1.08	14	3.57	.68	.6604	.5238
Courseware 2 - New Lesson Content	9	3.63	.76	11	3.67	.53	14	3.58	.54	.0627	.9393
Courseware 3 - Courseware Structure	9	3.79	.61	11	3.63	.94	14	3.64	.47	.1778	.8380
Courseware 3 - Screen Layout/Design	9	3.35	.86	11	3.73	.62	14	3.58	.67	.7214	.4941
Courseware 3 - Media Use	9	3.19	.93	11	3.51	1.15	14	3.51	.85	.3660	.6964
Courseware 3 - Prerequisite skills	9	3.68	.68	11	3.69	.78	14	3.54	.64	.1734	.8416
Courseware 3 - New Lesson Content	9	79.2	29.2	11	69.0	22.2	14	61.9	32.5	.9957	.3810

N = Number, SD = standard deviation

Table 5-13

Analysis of variance results of the perceptions of respondents in the Expert Courseware Evaluation Group regarding the quality of the characteristics of the courseware sections/composites in helping them to effectively learn the lesson material (Physiology 431 concepts) by faculty with expertise in courseware development

Courseware Composites/Sections	Yes			No				
	N	Mean	SD	N	Mean	SD	F-value	P-value
Courseware 1 — Courseware Structure	10	3.49	.72	24	3.32	.57	.5437	.4663
Courseware 1 — Screen Layout/Design	10	3.49	.68	24	3.28	.76	.5190	.4765
Courseware 1 — Media Use	10	3.55	.83	24	3.48	.82	.0441	.8351
Courseware 1 — Prerequisite Skills	10	2.96	.51	24	2.97	.82	.0017	.9671
Courseware 1 — New Lesson Content	10	3.38	.41	24	4.0	3.75	.2732	.6048
Courseware 2 — Courseware Structure	10	3.98	.63	24	3.77	.48	1.1519	.2912
Courseware 2 — Screen Layout/Design	10	3.86	.64	24	3.41	.72	2.9690	.0945
Courseware 2 — Media Use	10	3.86	1.08	24	3.57	1.03	.5584	.4604
Courseware 2 — Prerequisite Skills	10	4.17	1.05	24	3.58	.6575	4.06	.0523
Courseware 2 — New Lesson Content	10	3.76	.54	24	3.56	.60	.8313	.3687
Courseware 3 — Courseware Structure	10	3.51	.87	24	3.74	.58	.8905	.3524
Courseware 3 — Screen Layout/Design	10	3.71	.59	24	3.51	.75	.5469	.4650
Courseware 3 — Media Use	10	3.60	1.05	24	3.35	.93	.4596	.5027
Courseware 3 — Prerequisite Skills	10	3.57	.64	24	3.64	.71	.0710	.7916
Courseware 3 — New Lesson Content	10	69.30	17.83	24	68.58	32.49	.0043	.9483

N = Number, SD = standard deviation

Table 5-14

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Table 5-14

Analysis of variance results of the perceptions of respondents in the Expert Courseware Evaluation Group regarding the quality of the characteristics of the courseware sections/composites in helping them to effectively learn the lesson material (Physiology 431 concepts) by staff with expertise in courseware development

Courseware Composites/Sections	Yes			No				
	N	Mean	SD	N	Mean	SD	F-value	P-value
Courseware 1 — Courseware Structure	15	3.22	.55	19	3.48	.65	1.5977	.2154
Courseware 1 — Screen Layout/Design	15	3.29	.79	19	3.38	.72	.0970	.7574
Courseware 1 — Media Use	15	3.49	.83	19	3.52	.82	.0117	.9145
Courseware 1 — Prerequisite Skills	15	2.85	.72	19	3.07	.75	.7363	.3972
Courseware 1 — New Lesson Content	15	4.42	4.72	19	3.34	.59	.9782	.3301
Courseware 2 — Courseware Structure	15	3.73	.50	19	3.92	.54	1.1258	.2966
Courseware 2 — Screen Layout/Design	15	3.39	.67	19	3.65	.75	1.0661	.3096
Courseware 2 — Media Use	15	3.45	1.08	19	3.81	1.0	1.0209	.3199
Courseware 2 — Prerequisite Skills	15	3.46	.66	19	3.98	.88	3.6035	.0667
Courseware 2 — New Lesson Content	15	3.47	.65	19	3.74	.59	1.7391	.1966
Courseware 3 — Courseware Structure	15	3.78	.62	19	3.59	.71	.6530	.4250
Courseware 3 — Screen Layout/Design	15	3.59	.72	19	3.55	.70	.0377	.8472
Courseware 3 — Media Use	15	3.28	.77	19	3.54	1.09	.6448	.4279
Courseware 3 — Prerequisite Skills	15	3.59	.66	19	3.65	.71	.0766	.7837
Courseware 3 — New Lesson Content	15	69.87	30.2	19	67.95	28.18	.0364	.8498

N = Number, SD = standard deviation

Table 5-15

Analysis of variance results of the perceptions of respondents in the Expert Courseware Evaluation Group regarding the quality of the characteristics of the courseware sections/composites in helping them to effectively learn the lesson material (Physiology 431 concepts) by expertise in content area

Courseware Composites/Sections	Yes			No				
	N	Mean	SD	N	Mean	SD	F-value	P-value
Courseware 1 — Courseware Structure	4	2.99	.59	30	3.42	.61	1.7042	.2010
Courseware 1 — Screen Layout/Design	4	3.37	.65	30	3.34	.76	.0040	.9497
Courseware 1 — Media Use	4	3.63	1.11	30	3.49	.79	.0975	.7568
Courseware 1 — Prerequisite Skills	4	2.57	.51	30	3.02	.75	1.3509	.2537
Courseware 1 — New Lesson Content	4	3.02	.2651	30	3.93	3.35	.2874	.5956
Courseware 2 — Courseware Structure	4	3.35	.44	30	3.89	.51	4.2184	.0482*
Courseware 2 — Screen Layout/Design	4	3.55	.63	30	3.54	.74	.0004	.9837
Courseware 2 — Media Use	4	3.38	.75	30	3.69	1.08	.3169	.5774
Courseware 2 — Prerequisite Skills	4	4.06	1.78	30	3.71	.65	.6441	.4281
Courseware 2 — New Lesson Content	4	3.24	.37	30	3.67	.59	1.9653	.1706
Courseware 3 — Courseware Structure	4	3.39	.44	30	3.71	.69	.8302	.3690
Courseware 3 — Screen Layout/Design	4	3.49	.62	30	3.58	.72	.0555	.8152
Courseware 3 — Media Use	4	2.75	.50	30	3.52	.97	2.3485	.1352
Courseware 3 — Prerequisite Skills	4	2.87	.61	30	3.72	.63	6.4710	.0160*
Courseware 3 — New Lesson Content	4	71.75	27.66	30	68.40	29.25	.0467	.8302

N = Number, SD = standard deviation
*** Significant p < .05**

Table 5-16

Analysis of variance results of the perceptions of respondents in the Expert Courseware Evaluation Group regarding the quality of the characteristics of the courseware sections/composites in helping them to effectively learn the lesson material (Physiology 431 concepts) by teaching experience in years

Courseware Composites/ Sections	10 and under			11-20			21 and above			F-value	P-value
	N	Mean	SD	N	Mean	SD	N	Mean	SD		
Courseware 1 — Courseware Structure	6	3.79	.41	3	2.93	.43	9	3.31	.77	2.0988	.1572
Courseware 1 — Screen Layout/ Design	6	3.55	.26	3	3.43	.44	9	3.31	1.04	.1699	.8454
Courseware 1 — Media Use	6	3.50	.55	3	3.50	.87	9	3.62	1.01	.0451	.9560
Courseware 1 — Prerequisite skills	6	2.93	.61	3	2.81	.68	9	3.05	.90	.1150	.8921
Courseware 1 — New Lesson Content	6	3.27	.33	3	3.24	.44	9	3.31	.71	.0196	.9807
Courseware 2 — Courseware Structure	6	3.98	.53	3	3.64	.92	9	3.84	.52	.3345	.7209
Courseware 2 — Screen Layout/ Design	6	3.79	.59	3	3.37	.48	9	3.67	.93	.2936	.7498
Courseware 2 — Media Use	6	3.43	1.17	3	3.83	1.26	9	4.04	.90	.6108	.5559
Courseware 2 — Prerequisite skills	6	4.29	1.35	3	3.55	1.06	9	3.68	.70	.8226	.4582
Courseware 2 — New Lesson Content	6	3.88	.51	3	3.39	.71	9	3.59	.57	.8020	.4668
Courseware 3 — Courseware Structure	6	3.33	.96	3	3.58	.80	9	3.69	.56	.4410	.6515
Courseware 3 — Screen Layout/Design	6	3.58	.66	3	3.46	.39	9	3.66	.78	.0983	.9069
Courseware 3 — Media Use	6	3.58	1.28	3	3.50	1.50	9	3.52	1.03	.0067	.9933
Courseware 3 — Prerequisite skills	6	3.63	.61	3	3.53	1.11	9	3.60	.69	.0186	.9816
Courseware 3 — New Lesson Content	6	69.5	13.9	3	73.0	34.9	9	69.2	32.8	.0320	.9686

N = Number, SD = standard deviation

Table 5-17

Analysis of variance results of the perceptions of respondents in the Expert Courseware Evaluation Group regarding the quality of the characteristics of the courseware sections/composites in helping them to effectively learn the lesson material (Physiology 431 concepts) by approximate number of courseware programs developed

Courseware Composites/ Sections	0			1-3			4 or more				
	N	Mean	SD	N	Mean	SD	N	Mean	SD	F-value	P-value
Courseware 1 — Courseware Structure	5	3.68	.47	19	3.29	.52	7	3.08	.80	1.5446	.2310
Courseware 1 — Screen Layout/ Design	5	3.44	.58	19	3.47	.63	7	2.87	.87	2.0502	.1476
Courseware 1 — Media Use	5	3.50	.50	19	3.57	.93	7	3.29	.64	.3038	.7404
Courseware 1 — Prerequisite skills	5	3.29	.72	19	2.82	.72	7	2.74	.62	1.1041	.3455
Courseware 1 — New Lesson Content	5	7.05	8.02	19	3.16	.49	7	3.19	.64	3.3543	.0494*
Courseware 2 — Courseware Structure	5	4.05	.25	19	3.76	.58	7	3.73	.58	.6049	.5531
Courseware 2 — Screen Layout/ Design	5	3.68	.82	19	3.66	.63	7	3.25	.86	.8868	.4232
Courseware 2 — Media Use	5	4.20	.84	19	3.71	1.04	7	3.54	.97	.6764	.5165
Courseware 2 — Prerequisite skills	5	3.83	.54	19	3.78	.99	7	3.52	.67	.2515	.7794
Courseware 2 — New Lesson Content	5	3.74	.54	19	3.57	.61	7	3.49	.65	.2492	.7811
Courseware 3 — Courseware Structure	5	3.74	.54	19	3.56	.74	7	3.76	.69	.2546	.7770
Courseware 3 — Screen Layout/Design	5	3.43	.79	19	3.69	.64	7	3.42	.82	.5571	.5791
Courseware 3 — Media Use	5	3.5	1.12	19	3.52	1.04	7	3.26	.79	.1790	.8372
Courseware 3 — Prerequisite skills	5	3.65	.89	19	3.58	.76	7	3.61	.47	.0198	.9804
Courseware 3 — New Lesson Content	5	74.4	37.8	19	64.4	24.3	7	70.7	37.9	.2792	.7585

N = Number, SD = standard deviation

*** Significant $p < .05$**

Table 5-18

Analysis of variance results of the perceptions of respondents in the Expert Courseware Evaluation Group regarding the quality of the characteristics of the courseware sections/composites in helping them to effectively learn the lesson material (Physiology 431 concepts) by previous experience using computer courseware and multimedia programs

Courseware Composites/Sections	Yes			No			F-value	P-value
	N	Mean	SD	N	Mean	SD		
Courseware 1 — Courseware Structure	26	3.24	.59	8	3.79	.49	5.7171	.0229
Courseware 1 — Screen Layout/Design	26	3.28	.79	8	3.56	.47	.8616	.3603
Courseware 1 — Media Use	26	3.49	.89	8	3.56	.49	.0526	.8200
Courseware 1 — Prerequisite Skills	26	2.88	.77	8	3.26	.55	1.6385	.2097
Courseware 1 — New Lesson Content	26	3.26	.59	8	5.65	6.37	3.8332	.0590
Courseware 2 — Courseware Structure	26	3.79	.57	8	3.99	.36	.8980	.3504
Courseware 2 — Screen Layout/Design	26	3.47	.72	8	3.79	.71	1.2211	.2774
Courseware 2 — Media Use	26	3.59	.99	8	3.83	1.23	.2826	.5987
Courseware 2 — Prerequisite Skills	26	3.64	.69	8	4.12	1.13	2.1977	.1480
Courseware 2 — New Lesson Content	26	3.59	.62	8	3.73	.4938	.3799	.5420
Courseware 3 — Courseware Structure	26	3.72	.58	8	3.51	.94	.6162	.4382
Courseware 3 — Screen Layout/Design	26	3.55	.71	8	3.63	.72	.0699	.7932
Courseware 3 — Media Use	26	3.31	.89	8	3.81	1.13	1.7405	.1964
Courseware 3 — Prerequisite Skills	26	3.60	.65	8	3.69	.81	.0936	.7617
Courseware 3 — New Lesson Content	26	67.31	29.12	8	73.63	28.57	.2903	.5937

N = Number, SD = standard deviation

Table 5-19

Analysis of variance results of the perceptions of respondents in the Expert Courseware Evaluation Group regarding the quality of the characteristics of the courseware sections/composites in helping them to effectively learn the lesson material (Physiology 431 concepts) by previous experience with computer programming

Courseware Composites/Sections	Yes			No				
	N	Mean	SD	N	Mean	SD	F-value	P-value
Courseware 1 — Courseware Structure	22	3.34	.64	12	3.42	.58	.1210	.7302
Courseware 1 — Screen Layout/Design	22	3.26	.76	12	3.50	.69	.8618	.3602
Courseware 1 — Media Use	22	3.35	.78	12	3.78	.83	2.2686	.1418
Courseware 1 — Prerequisite Skills	22	3.02	.82	12	2.88	.55	.2423	.6259
Courseware 1 — New Lesson Content	22	4.06	3.91	12	3.37	.47	.3616	.5518
Courseware 2 — Courseware Structure	22	3.73	.56	12	4.02	.42	2.5219	.1221
Courseware 2 — Screen Layout/Design	22	3.43	.80	12	3.74	.50	1.3785	.2490
Courseware 2 — Media Use	22	3.59	1.09	12	3.75	.98	.1595	.6923
Courseware 2 — Prerequisite Skills	22	3.74	.97	12	3.76	.51	.0046	.9463
Courseware 2 — New Lesson Content	22	3.49	.65	12	3.86	.36	3.3911	.0748
Courseware 3 — Courseware Structure	22	3.69	.65	12	3.63	.73	.0853	.7722
Courseware 3 — Screen Layout/Design	22	3.49	.74	12	3.71	.63	.7556	.3912
Courseware 3 — Media Use	22	3.38	.97	12	3.51	.97	.1334	.7173
Courseware 3 — Prerequisite Skills	22	3.57	.76	12	3.73	.52	.4129	.5251
Courseware 3 — New Lesson Content	22	68.5	31.5	12	69.3	23.9	.0064	.9370

N = Number, SD = standard deviation

Table 5-20

Analysis of variance results of the perceptions of respondents in the Expert Courseware Evaluation Group regarding the quality of the characteristics of the courseware sections/composites in helping them to effectively learn the lesson material (Physiology 431 concepts) by previous experience assembling computers

Courseware Composites/Sections	Yes			No			F-value	P-value
	N	Mean	SD	N	Mean	SD		
Courseware 1 — Courseware Structure	15	3.49	.65	19	3.26	.57	1.2626	.2695
Courseware 1 — Screen Layout/Design	15	3.32	.85	19	3.36	.66	.0175	.8956
Courseware 1 — Media Use	15	3.48	.75	19	3.52	.88	.0185	.8927
Courseware 1 — Prerequisite Skills	15	3.13	.76	19	2.85	.71	1.2525	.2714
Courseware 1 — New Lesson Content	15	3.40	.63	19	4.15	4.19	.4628	.5012
Courseware 2 — Courseware Structure	15	3.96	.56	19	3.74	.49	1.4255	.2413
Courseware 2 — Screen Layout/Design	15	3.48	.79	19	3.59	.72	.2080	.6514
Courseware 2 — Media Use	15	3.59	.98	19	3.69	1.10	.0783	.7814
Courseware 2 — Prerequisite Skills	15	3.92	1.06	19	3.62	.58	1.1875	.2840
Courseware 2 — New Lesson Content	15	3.65	.68	19	3.59	.52	.0811	.7777
Courseware 3 — Courseware Structure	15	3.83	.64	19	3.55	.68	1.4644	.2351
Courseware 3 — Screen Layout/Design	15	3.51	.79	19	3.61	.64	.1632	.6890
Courseware 3 — Media Use	15	3.31	.74	19	3.52	1.11	.3935	.5349
Courseware 3 — Prerequisite Skills	15	3.67	.63	19	3.59	.73	.1019	.7517
Courseware 3 — New Lesson Content	15	66.0	26.71	19	71.00	30.69	.2489	.6213

N = Number, SD = standard deviation

Further analysis was conducted on the data using the stepwise regression procedure to determine demographic factors that might be significant predictors of the experts' perceptions regarding the quality of the characteristics of courseware programs under study. The results are presented in Table 5-21. As the table shows, only expertise in content area and expertise in courseware development were significant predictors of perception regarding the quality of computer courseware characteristics. Expertise in content area was a significant predictor of the quality of the characteristics of the programs under study: Courseware 1 new lesson content (β=-.979, P=.004), Courseware 2 structure (β=-.879, P=.049), and Courseware 2 new lesson content (β=-.926, P=.024). As a predictor, content expertise accounted for approximately 90% of the variance in perceptions regarding the quality of the characteristics of new lesson content in both courseware 1 and courseware 2 (see Table 5-21). This predictor also accounted for approximately 80% of the variance in perceptions regarding the quality of the characteristics of courseware 2 structure (see Table 5-21). In general, the results revealed that expertise in content area was more likely to predict a negative perception of the quality of the characteristics of the computer courseware programs.

Another significant predictor of the quality of the courseware characteristics was expertise in courseware development. The factor significantly predicted the quality of courseware 1 screen layout and design (β=.964, P=.008), and courseware 1 prerequisite skills characteristics (β=.957, P=.011). As a predictor, courseware development expertise explained over 90% of the variance in the experts' perceptions regarding the quality of the characteristics of both screen design and prerequisite skills (see Table 5-21). The results revealed that experts in courseware development are more likely than other groups to have more positive perceptions regarding the quality of the characteristics of the screen design and prerequisite skills sections of the courseware programs under study.

Table 5-21

Regression results of the perceptions of respondents in the Expert Courseware Evaluation Group regarding the quality of the characteristics of the courseware programs under study in promoting effective learning

Courseware Sections	Predictors Entered	β	T-value	Sig T	F-value	P-value	R^2
Courseware 1 - Screen Layout and Design	Expertise in courseware development	.964	6.25	.008	38.99	.008	.929
Courseware 1 - Prerequisite Skills	Expertise in courseware development	.957	5.75	.011	33.01	.011	.917
Courseware 1 - New Lesson Content	Expertise in content area	-.979	-8.46	.004	71.574	.004	.959
Courseware 2 - Structure	Expertise in content area	-.879	-3.20	.049	10.263	.049	.774
Courseware 2- New Lesson Content	Expertise in content area	-.926	-4.26	.024	18.119	.024	.857

*** Significant at 0.05 level.**

Other features of the courseware programs used in this study that the experts perceived as unique and helpful in promoting effective learning

The respondents in the Expert Courseware Evaluation Group were solicited for general comments on other features or characteristics not listed on the evaluation questionnaire, which they perceived as helpful in or inhibiting to promoting effective learning via computer courseware. The experts' responses were compiled and grouped together according to the respective courseware programs in cases where a specific comment applied to a particular program, or according to themes in cases where comments applied to all three programs. The themes under which the comments are classified were derived from the instructional and learning principles expressed in the comments themselves.

Comments that were nebulous or did not provide enough information about how a mentioned feature helped or did not help learning processes were not included in the report. For instance, a statement like "the programs did not present objectives" was not included since a statement concerning objectives was already on the evaluation questionnaire. Also, the statement would not be included in the reporting since it lacked specificity in terms of how the absence of the feature from a program affects learning processes. The following were the categories or classification schemes used:

1. Overall quality of the courseware programs
2. Chunk of information presented
3. Language style
4. Interactivity and learner control
5. Questions and feedback
6. Lesson review
7. User interface design

8. Visual appeal
9. Media use
10. Environmental factors
11. Evaluating programs and quality improvement
12. Specific recommendations for improvement of the three programs

Where appropriate, an explanation is provided to contextualize a comment. The classification schemes, comments, and discussions are presented next.

Comments common to all three programs

Overall quality of the courseware programs

There was a progression in the lesson format so that courseware 3 had more functions and better computer design.

Overall, this (courseware 2) is the best of the three programs.

This courseware (courseware 2) was much better, in relation to the first (courseware 1).

It made good use of graphics (face, etc.) and language to communicate with the student.

Good amount of info per screen. Good balance of info and text.

Chunk of Information Presented

Too much text per screen and poorly formatted.

The amount of text displayed at once was overwhelming.

Text screens long, could be broken up, layered or shortened.

Language style

A number of experts remarked that "profanity" or "demeaning" phrases were used in feedback statements to the user when responding to questions presented by the

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courseware programs. The issue, as seen by most of the experts, is that users might be offended by the use of "profanity words" with the consequence that learning processes would be inhibited. The following statements represent some of the experts comments on the issue.

> Profanity (e.g., 'Damn') and demeaning comments (e.g., 'You can not be serious!') will turn off some people and interfere with their learning from the lesson.
>
> Do not say a question was too easy, then whoever misses it is insulted.
>
> Some of the feedback is condescending, such as answering a question correctly but having it dismissed as 'an easy one.' The use of the words 'ridiculously easy' is guilty of this attitude, also. I think the idea here is to make the learning 'informal' and 'relaxed,' but I think a little more sophistication would help.

Interactivity and learner control

Not better than a book. Too hard to go backward.

Very 'book like.' Little in this unit could not be achieved in a book (save responses to students' answers to questions and buttons to elicit help. Many screens are filled with text, and, again, the charts and pictures used could easily be part of a book.

Limited in branching, interactivity, and testing.

I could not go back to review previous questions.

Not enough branching opportunities; no reviews either. But most importantly, no way to back-up to previous screen to 're-do' material.

Page controls (previous and next) will be helpful.

Frustrating that I couldn't exit from middle or return to start of the programs.

Very linear design. Students benefit from the ability to review previous screens and they don't have that opportunity here.

I find all of these programs to be very linear. Users have to use the "Continue" buttons and are not allowed to skip sections.

Questions and Feedback

Part 1 of this courseware (courseware 3) provides some questions and feedback which provide some form of review for the users.

More questions, feedback, and student self-testing will make the programs more effective. Longer quiz with some form of feedback.

Lesson Review

Summary page at end to review coverage and things learned would be helpful in all the programs.

Summary at the end of what should have been learned and possible suggestions to students about more info should be included.

User Interface Design

The content (of courseware 3) is rich and complete, but the application seems a little fragmented in interface design. The use of table of contents would have allowed me to go back and forth through the programs.

The design issues (interface design) that seem relevant to all the modules relate (for me) to navigation control. I would like to see some fixed controls repeating on every screen in the same place: Forward, Backward, etc. I would also like more feedback or notification of where I am in the courseware (Page No., or Unit No., for example). There is some sense of disorientation when these elements are not present.

Since we live in a button happy world, the pages need to be designed in such a way that it is always clear where to click. This is often unclear in these courses. I think many people tend to click whenever they see a box. I also think there needs to be more consistency in the placement of the navigational buttons. There should be a portion of the screen that contains forward, backward, etc. At one place I was unable to return to a previous page when I wanted to review a concept.

Sometimes too many elements on screen or too many visual cues, i.e., text box with border, text box without border, text on screen with no background color (the easiest or most aesthetic tone), buttons, arrows, etc.

Visual Appeal

Very nice visual appearance.

Polished appearance.

Black text on yellow screen was hard for me to read.

Some text fonts/styles are difficult to read, e.g., italics.

Media Use

Use of video and/or sound would make each a better program.

Environmental factors — equipment and systems

Monitor screen size affects program size - on my Pentium system with 15-inch monitor program windows appear in the center of the monitor about half size. On my 14-inch monitor, I get full screen!

On Windows systems running in 1024x768 mode, text is often misaligned.

Windows is a horrible platform for courseware. My experience is typical. It took a whole hour before I could view any of the courseware.

Some expanded introduction needed - defining what course(s) this services, who is the intended audience, what is the goal (study aid - test prep, etc.) of the software. We jump into content abruptly without some context for the material. Structure is too linear, not enough opportunities to reverse, quit, start over.

Evaluating the programs and quality improvement

The text needs proofreading/editing for spelling/typos/grammatical errors, that distract and interrupt the flow of reading for understanding.

Difficult to evaluate without content knowledge or knowledge of (the target) students.

Comments Specific to Courseware 1

This courseware was like a book transferred to a computer screen. It would have been much easier to work with in book form. The text lines were too long for the eyes to follow comfortably. Also, the "Next Question" button appeared on every page, but there was only one question to start with and a couple at the end. The last couple of questions did not seem to be directly related to the main content of the courseware.

Screen titled 'nerve cell action potential' is excellent. However, screens are crammed with black and white text.

There are a lot of full pages of text in this tutorial — for that, it's better to use a book.

No animation in spots where there were obvious ways to use it. No 'worked' problems, except for a hint. No important links to definitions of 'new' terms. Does not seem to take advantage of the unique features of a computer, compared to say, a book.

Too easy and oversimplified for medical students, but okay for undergraduates.

If this is new information, it seems to be too much and could be broken into smaller steps. If it is review, the text screens could be shorter with not so much to read.

The program referred to 'Next Question' when it actually meant another section.

The user can get stuck in the first example. The buttons only let you go forward. The 'go forward' button should be in the same place on every screen so that the user doesn't have to move the mouse to a different place on the screen at every new page. Instead, just press the mouse to go forward.

I think some questions put in during the long lesson would help the user instead of the user reading forever and then getting the transmembrane potential -70 mV question. Plus, you can't go back to read any part of the section which precedes this question.

I think the background section which is on paper should be in the programs.

The title deals with one subject — the action potential. The program deals with defining the various parts of action potential and what issues are involved, also propagation in repolarization and unrepolarization nerves and finally with a reflex arc, delay times at a receptor and effector and propagation time in a reflex arc. My impression is that the last part, although related to the action potential, could be a separate program with more examples of the calculations of conduction time, etc. The title did not reflect the content of the tutorial and it was not clear where the user was being led. Some answers to wrong responses could have been more 'friendly', less disparaging or belittling. Ability to go forward or backward is only used in one place in the program.

Content is good, however overall package was poorly organized and designed.

Comments Specific to Courseware 2

Best of the three.

Nice screen on 'How this tutorial works.' 'Five element model' is a good organizer. One example 'A Simple Application' is mostly text.

The content of this lesson was stated clearly and followed in a logical order. There were only a few questions to test the student. But, it did point to another source of review questions at the end of the presentation. It seemed that this lesson could use more interactive examples to illustrate control processes.

Control systems (i.e., courseware 2) in particular can exploit animation.

Biological example #2 may be oversimplified and misleading.

I'm told here that the tutorial reviews chapter five — but I'm not told the name of the text, or number of the course. Again, as in courseware 1, I feel a need for introductory contextualization. One improvement is the incorporation of an 'EXIT' button early on. The 'background' screen is helpful and an improvement with regard to setting up the context. Use of graphics improved over courseware 1.

1. I like the word definitions.
2. It is difficult to determine if boxes are buttons or just design.
3. Testing is better than the first program.
4. Needs objectives, table of contents, or menu bar so you can navigate better or know where you are.
5. Nice graphics.

1. Typing is weird on "many physiological reflexes operate on the basis..." page. The blue section.
2. Some text is difficult to read, font size too small.
3. Good use of examples.

Comments Specific to Courseware 3

The graphics, especially the diagrams, were not tied to the text clearly to illustrate a point. The quiz was poor. For example, there were two questions where you were presented with true or false response option and neither was correct.

Much too easy. Most of the material is about classic reflexes, not synaptic mechanisms per se. One conceptual error (use of term conductance when meaning current).

Choices (navigation) sometimes overwhelming. Transitions are great except for dissolve, too slow activating.

It was confusing to navigate at times — options are presented in menu form, but it is assumed that they will be selected in order. If the last option is chosen, the user can't go back.

Part 1 (Synaptic Mechanisms I):

Question 5 (page 30) is confusing. Both foils are wrong (true or false).

The blur on yellow frame telling how to control the program is messed up — text is in lower case, button names are in upper case. Text book readings at the end of Part I is useful.

Under definitions - suggestion section, the words are messed up - on top of each other.

At 'the plan' page (with the frog) you are limiting the user's ability to navigate as there is no forward button. Those who already know this are still forced to go through the plan.

Part II (Synaptic Mechanisms II):

Just information presentation with weak interactivity.

It is difficult to read text in yellow box on the 'So what?' page.

This part was harder to grasp due to several links.

In the second section of courseware, screen dissolves and wipes are used in a more or less random fashion. These tend to slow down the computer and really don't add value.

Specific recommendations for improvement

1. Check spelling and syntax.
2. Provide menu (especially in courseware 3) to allow for better organization so user can choose parts of the program to review so that he/she doesn't have to start from the beginning to access a certain part.
3. Go button should be placed in standard location.
4. Comments for incorrect answers are inappropriate.
5. No swearing
6. Include Table of Contents.
7. Include well defined statement of objectives.
8. When students give an incorrect response, they should be directed back to appropriate material for review.
9. Include opportunities to practice skills learned; apply things learned and used in other programs
10. Present questions that not only test recall of facts.
11. Present feedback, rating % scores and suggestions to better scores.
12. Make the programs more interactive (either through questions, not just multiple choice, or navigations).
13. Change buttons colors when button is activated.

Summary

In summary, comments made by the experts regarding special features of the computer courseware programs were compiled and classified under four major sections:

1. Comments common to all the three courseware programs
2. Comments specific to courseware 1
3. Comments specific to courseware 2
4. Comments specific to courseware 3

In general, two main observations were made regarding the substance of the comments made by the experts. First, the comments relate more to features that were lacking in the programs rather than unique features or characteristics of the programs that they perceived as helpful in effectively learning the lesson content. The second major observation was that the comments provided concrete suggestions and specific recommendations on ways to improve the quality of the courseware programs.

CHAPTER VI

SUMMARY, DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

This study investigated factors and characteristics that determine the success or efficacy of computer courseware programs designed to support students' learning of concepts in physiology. There were four purposes for conducting the study. The first purpose was to determine the effects of using computer courseware programs designed to teach physiology concepts on students' learning achievement. The second purpose was to assess the level of importance of characteristics, as perceived by the experts, that promote effective learning via computer courseware. The third purpose was to assess the impact of the quality of computer courseware characteristics in promoting effective learning as perceived by both students and experts. The fourth purpose was to construct an evaluation framework that courseware developers, instructional designers, researchers, project managers, curriculum designers, educators, administrators, program evaluators, and manufacturers of software programs can use to analyze and assess computer courseware programs for the characteristics of instructional quality or efficacy.

Summary of the Study

Population

Three groups of subjects participated in this study. The first group consisted of students in the Physiology 431 class of Fall semester 1995, which was further divided into three sub groups. One subgroup consisted of 55 students who used the courseware programs under study and responded to the Computer Courseware Evaluation Form that accompanied the programs. The second subgroup consisted of students who used the programs, but did not respond to the evaluation questionnaire. The third subgroup consisted of students who neither used the programs nor responded to the evaluation questionnaire.

The second major population group consisted of 32 experts with expertise in physiology, classroom teaching, courseware development, educational psychology, or educational research. This group responded to the Computer Courseware Evaluation Checklist Rating Form and was called the Expert Rating Form Group.

The third major group consisted of 34 experts with similar professional experience as those experts in the second group. The experts in the third group responded to the Computer Courseware Evaluation Checklist Form and were called the Expert Courseware Evaluation Group.

Data Collection

Four sets of data were collected in order to answer the research questions. The first set of data consisted of exam grades for all students in the Physiology 431 class. The second set of data was comprised of the students' demographic characteristics and their perceptions regarding the quality of the characteristics of the courseware programs used in this study. The data was collected using the Computer Courseware Evaluation Form (Appendix A). The third set of data was comprised of the demographic characteristics of respondents in the Expert Rating Form Group, as well as their perceptions regarding the level of importance of the characteristics of computer courseware in promoting effective learning. The fourth set of data was collected from respondents in the Expert Courseware Evaluation Group. The data consisted of the respondents' demographic characteristics, as well as perceptions regarding the quality of the characteristics of the courseware programs in promoting effective learning. All three evaluation questionnaires used in collecting data for the study were constructed by the researcher based on Gagné's instructional theory, as well as findings from current research on educational psychology and academic uses of new technologies. The evaluation instruments were reviewed by members of the doctoral committee and pilot tested on sample subjects from both the students' and experts' population groups.

Data Analysis

Data collected to answer the research questions examined in this study were analyzed under two chapters. While the analyses of data collected from students were presented in Chapter IV, the analyses of data collected from the two groups of experts were presented in Chapter V.

In examining data collected from students, one way analysis of variance (ANOVA) was used to compare adjusted raw score differences among students who used all the courseware programs, those who used one or two programs, and those who did not use any of the programs. Regression analysis was then used to determine the extent to which learning achievement depended on students' demographic factors, rather than the use of the computer courseware programs. Means, standard deviations, and ranks were used to report the students' perceptions regarding the quality of the characteristics of sections of the courseware programs under study. Also, one way analysis of variance (ANOVA) was used to determine whether students' perceptions regarding the quality of computer courseware characteristics varied by their demographic characteristics such as: gender, academic discipline, class level, and computer ownership. Regression procedure was then used to determine demographic factors that were significant predictors of the students' perceptions.

As had been done for the students' group, two levels of analyses were conducted in examining data collected on the perceptions of respondents in both the Expert Rating Form Group and the Expert Courseware Evaluation Group. The first level of analysis used descriptive statistics including means, standard deviations, and ranks to report the experts' perceptions regarding the level of importance of the characteristics of courseware programs used in the study and their perceptions regarding the extent to which the quality of the characteristics helped in promoting effective learning. The second level analysis used inferential statistics including one way analysis of variance (ANOVA) to determine whether the experts' perceptions varied by their demographic characteristics such as gender, age, professional discipline, previous experience in using computer productivity tools, and computer ownership. Regression procedure was then used to determine the demographic factors that were significant predictors of the experts' perceptions. A separate, intensive analysis, using the MDS procedure, was conducted to determine whether specific patterns of perceptions regarding the level of importance of courseware characteristics in promoting effective learning existed among the respondents in the Expert Rating Form Group.

Findings and Discussions

Research Question A

Research Question A was concerned about the effects of computer courseware programs on students' learning achievement. Two specific subsidiary questions were examined to delimit the scope of the question. The findings regarding these questions are presented and discussed below.

Research Question A1

Does courseware usage predict students' level of learning achievements?

The results of ANOVA and Tukey's post-hoc analyses revealed that students who used all three programs significantly performed better than those who used just one or two programs, who, in turn, performed significantly better than those who did not use any of the programs. It appeared that the more courseware programs used, the better the students' performance, albeit an additive effect.

Discussion

Any additive effect resulting from interacting with courseware programs several times is not necessarily undesirable. While efficiency is an important concern in any learning situation, the ability to engage learners in learning activities, including interaction with courseware programs, in an enthusiastic and a repetitive manner, holds promise for some beneficial and meaningful learning outcomes. One only needs to recall young adults' experience with computer and video games. Young adults not only love to play computer-video games, they often play the same set of games for several hours at a time without becoming bored. Moreover, young adults often demonstrate an amazing depth of retention and understanding of the content of games they interact with, a learning outcome unmatched by most of their classroom learning experiences as demonstrated by their abilities to recount detailed plots and themes of numerous games. This phenomenon poses a fundamental question: what characteristics or features of computer and video games produce such "edutainment" effects? Computer courseware programs can learn from the "edutainment" properties of computer-video games.

Questions for Further Study

1. Why are young adults addicted to playing computer and video games that require an amazing depth of knowledge of the content unmatched by most classroom learning experiences, as demonstrated by their abilities to recount detailed plots and themes of numerous games?
2. What, if any, elements or characteristics of such computer or video games, particularly Nintendo, can influence the way we develop computer courseware programs to better engage students' attention and sustain interest in learning processes?
3. Why have courseware authors and developers failed to incorporate "edutainment" properties of computer video games in academic courseware programs?

<u>Research Question A2</u>

> To what extent is the students' level of learning achievement dependent on factors other than the use of the computer courseware, for instance, the respondents' demographic characteristics (gender, age, GPA, academic discipline, class level, previous experience with computers, and computer ownership)?

Out of the three courseware programs used in the study, the amount of usage of courseware 2 (i.e., Control Systems) alone was a significant predictor of learning achievement as measured by adjusted raw score. When the students' demographic characteristics were used as covariates in the analyses conducted, however, gender and GPA emerged as the only significant predictors of learning achievement. Consequently, courseware usage had little or no effect on learning achievement.

Discussion

The finding that, in general, computer courseware usage had little or no significant effect on students' learning achievement, confirms the findings of a number of studies on media effects (Clark, 1983; Creswell, 1986; McNeil and Nelson, 1991; Reeves, 1991; Thompson et al., 1992; Schlosser, 1994). It appears, though, that the use of computer courseware had other beneficial effects that may translate to increased learning achievement. For instance, almost all (96.4%) of the students who used the programs and responded to the evaluation questionnaire indicated that the courseware programs helped them to effectively learn the lesson materials. The only two exceptions were missing data. Also noteworthy, is the finding that nearly all (96.2%) the students who used the programs and responded to the evaluation questionnaire indicated that they would like to use similar courseware programs in other college courses. Again, the only exceptions were missing data. It may be, therefore, that a main effect of using the programs was an increase in the level of students' motivation to learn. This conclusion is consistent with the result found by Askar, Yavuz and Köksal (1992) in their study of fifth-graders' perceptions of computer assisted instruction environment and their attitudes towards computer assisted learning. However, while only 63 percent of the students in that study stated interest in using computers in all other courses (Askar, et al., 1992, p. 138), virtually all the college students in the present study expressed such an attitude. In addition, the student respondents in this study expressed a clear preference for computer courseware usage in the sciences.

Since attitude, motivation and learning processes are intricately linked (Johnston, 1987; Askar, et al., 1992) , it may be that stating or demonstrating the benefits of a particular computer courseware for the target audience will positively impact on the learner's attitude toward, and level of motivation in, using the program. Under such conditions, the use of the program may not only result in more courseware usage, but also in better learning achievement. For instance, positive statements regarding the usefulness of a particular courseware, made by sample subjects drawn from the target population during formative evaluation of the courseware, may be embedded as part of the introduction or overview of the final courseware product. Indeed, the inclusion of review statements as a standard "sneak preview" feature of computer courseware may be beneficial in motivating target learners to use courseware programs. In this regard, the box office experience of the movie industry may be instructive.

Questions for Further Study

1. What are the effects of changes in the learners' levels of motivation as a result of interaction with the programs, on their attitudes toward computer courseware?
2. What are the effects of changes in the learners' levels of motivation, as a result of interaction with the programs, on learning achievement?

3. Does the inclusion of testimonial or review statements about the usefulness of courseware programs influence how much learners use, or benefit from, the programs?

4. Under what conditions would the amount of computer courseware usage influence learning achievement?

Research Question B

Research Question B assessed the student respondents' perceptions regarding the quality of the characteristics of computer courseware programs used in this study. The following section presents and discusses the findings relating to three specific subsidiary questions that examined the perceptions.

<u>Research Question B1</u>

> What are the student respondents' perceptions regarding the quality of the characteristics of the computer courseware programs used in this study in promoting effective learning?

In general, students perceived courseware 3 (Synaptic Mechanisms I and II) as the best, in terms of the quality of courseware characteristics in promoting effective learning, followed by courseware 1 (Action Potential), and then courseware 2 (Control Systems). In terms of specific courseware components across the three programs, the students rated the characteristics of instructional procedures better in quality than courseware structure characteristics, which, in turn, were rated better than media characteristics. The results applied across all three courseware programs. Interestingly, no significant relationship was found between the students' perceptions regarding the quality of courseware characteristics and their learning achievement. Also, there was no significant relationship between students' perception regarding the quality of computer courseware and the amount of usage of the programs.

Discussion

When the findings of this research question is compared with the findings observed under Research Question A2, concerning the extent to which learning achievement depended on courseware usage, it is interesting to observe that it was not courseware 3 (Synaptic Mechanisms I and II) that the students rated as best in quality that enhanced their learning achievements, but courseware 2 which they rated last. However, as indicated in the discussion under Research Question D1 below, the observation regarding the effect of courseware 2 (Control Systems) on learning achievement makes sense when it is realized that it was this program that the experts rated as best in quality. Further discussion about the disparity in the results are presented under Research Question D1 below. Suffice it to say here, that a more tightly controlled experiment comparing students and experts in how and what they evaluate about computer courseware may help clarify the apparent disparities.

It is noteworthy that the students perceived the characteristics of instructional procedures and lesson content to be better than courseware structure characteristics and the characteristics of media. It is not clear, however, whether the students thought that these categories of courseware characteristics had any relative level of importance to the success of the programs in promoting learning achievement. The knowledge of what courseware end-users consider to be important may be an important factor to the success of the programs.

Questions for Further Study

1. Do learners' perceptions regarding courseware quality vary by levels of motivation to interact with computer courseware?
2. Do learners' perceptions regarding computer courseware quality and their levels of motivation change over the course of interaction with the courseware? If they do change, what factors are involved?
3. What are the perceptions of students regarding the level of importance of the characteristics of computer courseware compared to the success of the programs in promoting effective learning?

Research Question B2

> Do the student respondents' perceptions regarding the quality of the computer courseware characteristics vary by their demographic characteristics such as gender, class level, academic discipline, previous experience using computer productivity tools, previous experience using computer courseware, previous experience with computer programming, or computer ownership?

Among the demographic variables examined, only students' class level and previous experience using computer courseware had a significant relationship to their perceptions regarding the quality of the computer courseware in promoting effective learning. In all three courseware programs, the junior students were more positive in their perceptions regarding the quality of instructional procedures characteristics than the senior students. However, both groups were similar in their perceptions regarding the quality of other dimensions of the programs. Another finding relating to the effect of demographic characteristics on students' perceptions was that students who had no previous experience using computer courseware had more positive perceptions of the quality of courseware characteristics. Gender, academic discipline, computer ownership, and, surprisingly, previous experience with computer programming, had no significant relationship to the students' perceptions.

Discussion

It is not clear from the results of the study why junior students were more positive in their perceptions regarding the quality of the courseware used in the study compared to senior students. One conjecture behind the differences in perceptions may be the element of novelty. It may be that, in general, junior students, compared to senior students, were less exposed to computers, in general, and computer courseware, in particular. If this conjecture is true, then it is plausible to surmise that their relatively less exposure to computer courseware made the use of the computer courseware in this study a novel experience for the junior students more so than for the senior students. Thus the gap in their familiarity with computers may have led junior students to be more accepting of the quality of the courseware programs.

Similar explanations may be advanced for students with or without experience in computer programming. In this instance, students with no computer programming experience did not have the essential computer skills to adequately evaluate the courseware programs, and so, were less critical than students with programming experience.

One clear implication of the differences in perceptions regarding the quality of the courseware between different groups who participated in the study is the need to determine specific constructs that separate one group from another in their perceptions. Answers to this need will be helpful in developing courseware with wider appeal, acceptance, utility, and thus greater success in promoting effective learning. It may be that the differences in perceptions observed in this study, reveal a fundamental need for literacy in the use of computer courseware.

Questions for Further Study

1. What constructs differentiate different class levels of students in their perceptions of the quality of computer courseware?
2. Are differences in perceptions regarding the quality of computer courseware due to differences in attitudes toward computers?

Research Question B3

> What other features of the courseware programs do the student respondents perceive as unique and helpful in promoting effective learning?

Ten main features of the courseware programs used in the study were identified by the students as helpful in enabling them to effectively learn the lesson materials. The students remarked that the programs:

1. Reviewed and synthesized the Physiology 431 course materials in a way that adequately prepared the students who used the programs for the class exams.
2. Presented lesson concepts in a clear and concise manner. As a student noted, the programs "clarified a lot of points that were confusing in the book (i.e., the textbook)". Another student remarked: "The material was clear, focused and relevant to the class. It helped out in that it simplified things. It made it much easier to understand a concept."
3. Presented the lesson concepts in a systematic fashion.
4. Used concrete examples, especially in feedback statements, that helped in sustaining students' interest in learning the lessons presented and in facilitating better understanding of physiology concepts. As one student remarked, "The courseware kept my interest longer than reading a textbook. It helped me to visualize concepts more clearly."
5. Used humor in feedback statements that sustained students' learning interest.
6. Provided feedback that facilitated meaningful learning.

7. Applied theory to real life situations.

8. Helped in developing problem solving and thinking skills.

9. Individualized lesson instructions.

10. Presented review questions that enabled the students to apply concepts and to practice skills learned.

Discussion

It is interesting that virtually all the features listed as helpful in learning the content of the programs used in this study were related to characteristics of the subject matter and instructional procedures rather than glitzy effects. This is an important finding, given that, as the literature in educational psychology indicates, the nature and structure of subject matter content as well as the characteristics of instructional procedures are essential components of factors that promote effective learning (Hannum, 1988; West, et al., 1991; and Jonassen and Wang, 1993).

As the students indicated, however, the use of humor as a vehicle for conveying lesson content was as a factor that made interaction with the programs fun and interesting for them. Virtually all the student respondents indicated that they liked the way humor was used in the courseware programs, particularly the way it was used to provide feedback for answers that go with questions at the end of each lesson unit. Although humor falls under the rubric of motivation, and a large body of literature exists on the use of motivation in instruction, little or no research has been conducted on the use and effects of humor as a pedagogical strategy in computer courseware. Clearly, the emphasis that the majority of the students placed on the motivational influence of the humor used in the courseware programs, underscores the need for further study in this area.

Most of the students perceived the courseware programs under study to be a useful supplement to classroom instruction. The programs were considered useful in promoting effective learning particularly when perceived to be helpful in adequately preparing the student for exams.

A closely related finding is the perception that the courseware programs embodied the essence of the Physiology 431 course. While the perception may be helpful in focusing students' attention to important aspects of the course content, it may, however, be potentially counterproductive. For instance, while some students may have used the programs only as a supplement to and a review of the course materials, other students may have used the programs exclusively, totally ignoring other course materials. The risk is clearly implied in a student's remark cited earlier. According to the student:

> I heard from students who had taken the class earlier that the courseware was all that was needed. It seems as though it became the center of the material to be tested rather than merely a learning supplement.

Unless courseware programs are really designed, in the words of one of the students, as "complete tutorial" instructions and as a full substitute for classroom instruction, students who rely solely on the programs may be doomed to failure. It is necessary, therefore, for instructors using courseware programs for an academic instruction to explain clearly the relative importance of the programs in relation to other course materials. It must be pointed out that the programs under study were clearly explained as only supplements to classroom instruction. Nonetheless, some students perceived the programs as the component of the course materials that was most important to the instructor.

The students' comments reveal that the level of use of courseware programs depends largely on the degree to which they perceived the programs to be relevant to their learning needs, particularly the need to perform well in exams. Since, as the society dictates, performance in exams is the prime indicator of students' intellectual skills and learning achievements, courseware programs must be designed to enable the student to process information in a way that fosters meaningful learning and, consequently, successful performance in exams. Of course, the potential of a particular courseware program to facilitate learning outcomes that ensure success in exams must be made clear.

The students were strongly in favor of courseware programs that facilitate the use of students' learning styles. It must be point out, however, that while learning styles-centered programs may be desirable, they are usually very difficult and expensive to produce.

A salient feature that the students liked about the courseware programs under study was the nature of feedback presented for review questions at the end of each lesson unit. The students particularly liked how the feedback presentations explained why answer selections were correct or wrong. They claimed that the use of feedback to explain answer choices helped to clarify misconceptions they might have had about the lesson concepts and principles presented and thereby helped them to better understand the Physiology 431 course contents. The claim agrees with previous findings in research literature that the use of feedback as a learning strategy is one way in which courseware programs can foster effective learning (Lillie et al., 1989).

Clearly, the majority of the students would like to use computer courseware for academic instruction. However, the students differed on the subject areas and topics for which computer courseware will be appropriate. It may be that the different viewpoints actually indicate underlying differences in learning needs among the students. Further study should examine the variety of learning needs among college students in a particular subject discipline and how computer courseware can be designed to provide learning experiences that fulfill the needs.

The chief concern students expressed about availability of the courseware programs relates to the need to make similar programs available in other subject areas where they do not currently exist. University administration must listen to this perceived needs by providing necessary support and incentives to encourage faculty to develop and integrate computer courseware into their academic courses.

Closely related to availability is the issue of accessibility. The students' comments revealed that those who had limited access to adequate computer systems to use the courseware programs felt disadvantaged and, as such, were opposed to academic uses of computer courseware. For the students who complained about limited access to the programs, their real problem was failure to successfully follow procedures required to use the courseware programs as set up in the microcomputer labs on campus. One solution to the problem is to provide a short introductory tutorial session in which a teaching assistant would show the students how to access and use the programs in the microcomputer labs. Alternatively, the class instructor could use an overhead projection system to present a short demonstration of how to log into the microcomputer lab systems and use the programs. The demonstration could be provided during a class session just before asking the students to use the programs in the labs.

Questions for Further Study

1. What are the effects of the use of humor as a vehicle of conveying instructional lessons in computer courseware?
2. What type of humor can be utilized in computer courseware to foster effective learning ?
3. What learning needs exist among college students in particular subject disciplines where computer courseware can provide meaningful learning experiences?
4. How can the factors identified by the learners as essential to their ability to effectively learn the computer courseware lessons be combined for optimum learning effectiveness?

Research Question C

Research Question C assessed the perceptions of the respondents in the Expert Rating Form Group regarding the level of importance of the characteristics of computer courseware in promoting effective learning. The following section presents and discusses the findings relating to three specific subsidiary questions that examined these perceptions.

Research Question C1:

> What are the experts' perceptions regarding the level of importance of computer courseware characteristics in promoting effective learning?

Presenting complete, accurate, or current lesson content, was the characteristic rated highest in terms of level of importance in promoting effective learning via computer courseware. Rated last in the order of level of importance, though still considered of medium importance, was the characteristic of testing the learner on restating lesson information in his or her own words. All the characteristics were rated as either high or medium in their level of importance, with each level having an equal number of characteristics. No characteristic was considered to be of low importance.

In terms of courseware sections, the characteristics of both courseware structure and new lesson content were rated equal and at the top of the level of importance. Third in the level of importance were the characteristics of prerequisite skills, followed by the characteristics of screen layout and design. Media use characteristics ranked last, but nonetheless was considered to be of medium importance in promoting effective learning.

Discussion

Even though the students used a different evaluation instrument , the pattern of ratings of the level of importance of courseware characteristics by the experts was essentially similar to the pattern of characteristics that the student group identified as helpful to them in effectively learning the courseware programs in the study (see the discussion under Research Question 3B above). For both groups, the characteristics related to knowledge (verbal information, intellectual skills, and cognitive strategy skills) to be mediated, and the appropriate pedagogical strategies to convey the knowledge were the most important factors in determining the success of computer courseware. It remains to be seen whether specific courseware characteristics are actually related to learning processes and/or learning achievements.

It is noteworthy that of the 40 characteristics rated to be of high level of importance to the success of courseware in promoting effective learning, the ratings of the items relate to Gagné's events of instruction as follow:

- 9 (22.5%) items clearly relate to presenting new information
- 8 (20%) items relate to providing learning guidance
- 6 (15%) items relate to eliciting performance
- 4 (10%) items relate to providing feedback
- 3 (7.5%) items relate to gaining learner attention
- 3 (7.5%) items relate to informing the learner of the instructional objectives
- 3 (7.5%) items relate to stimulating recall of prerequisite skills
- 2 (5%) items relate to assessing performance
- 1 (2.5%) item relates to enhancing retention and transfer.

The proportion of items related to each event of instruction may be indicative of the magnitude of features to look for, when considering the quality of courseware programs or assessing the potential of the programs to engender effective learning. However, the strength of this conclusion should be held with caution since, to start with, each category of Gagné's Events of Instruction did not have an equal number of characteristics on the evaluation instrument. Besides, there were other characteristics on the instrument that the experts rated as high in level of importance, which although were derived from the literature on current research in educational psychology and academic computing, were not directly related to Gagné's events of instruction. These characteristics are primarily related to unique cognitive capabilities made possible by unique properties of the new information technologies. One challenge posed by these findings is the prospect of quantifying courseware characteristics for the purpose of evaluating courseware quality.

Questions for Further Study

1. In what ways are the specific characteristics that the experts identified as important to the success of computer courseware related to learning processes and/or learning achievements?
2. What criteria should be used to formulate standard measures for quantifying the instructional effectiveness potential of computer courseware?

<u>Research Question C2:</u>

> Do the experts' perceptions regarding the level of importance of computer courseware characteristics in promoting effective learning vary by their demographic characteristics such as gender, age, professional discipline, teaching experience, courseware development experience, experience using computer productivity tools, and computer ownership?

Courseware structure was the only courseware component in which there was a significant difference in the perception of experts regarding the level of importance of computer courseware characteristics. Gender and age were the only two demographic factors that accounted for the significant difference.

Age was the only significant predictor of perception regarding the level of importance of courseware structure characteristics in promoting effective learning. Compared to experts over 46 years old, those between 36 and 45 years of age were predicted to have higher perceptions regarding the level of importance of the characteristics of the following sections of computer courseware: courseware structure, prerequisite skills, and new lesson content. In the case of screen layout and design, experts over 46 years old were predicted to have significantly lower perceptions regarding the level of importance of the characteristics associated with that section. In sum, it appears that the older an expert is, the less likely he or she would consider the computer courseware characteristics under study as important in promoting effective learning. Gender, teaching experience, previous experience using computer courseware and multimedia, and even professional expertise in courseware development all appeared not to be significant predictors of the experts' perceptions regarding the level of importance of the computer courseware characteristics under study in promoting effective learning.

Discussion

The observed differences in perceptions due to age may be related to a generational gap in background experience related to computer-related technologies. For instance, experts who were below 36 years of age compared to those over 36 years of age, may have been exposed more to computers and computer-related technologies, such as television, video games, and computer games, including Nintendo. Perhaps the relatively younger experts have had greater exposure to new technologies, and as such, greater identification with, and/or appreciation for, the computer courseware characteristics evaluated in this study. However, the observed differences are meaningful only as they shed light on how courseware characteristics relate to learning processes and achievements. It is important, therefore, to establish a clear understanding of the relationship between the ratings of the level of importance of courseware characteristics and learning processes, as well as learning achievements. The first step in establishing this relationship is to determine the reliability of the evaluation instrument. The overall reliability index of the Computer Courseware Evaluation Checklist Rating Form used in this study was 0.9592.

It is plausible, therefore, to conclude that experts who were below 36 years of age provide a more adequate view of the level of importance of the courseware characteristics under study. This conclusion should be considered tentative, however. The finding about differences in perception due to age is tempered by the limited number of experts who participated in the study. Further study on the issue involving greater number and diversity sample subjects is warranted.

Research Question C3

> What other features do experts perceive as important to the success of computer courseware in promoting effective learning?

In addition to the characteristics specified and examined in this study, the experts indicated the following features as necessary for computer courseware to be successful in promoting effective learning.

1. Features that serve the instructor's classroom teaching goals
2. Features that match teaching goals with students' learning needs
3. Modularization of program lessons to meet specific instructional and learning goals.
4. Providing feedback that explains why answer choices are correct or incorrect as a way of facilitating meaningful learning.

Questions for Further Study

1. What computer courseware features can empower instructors to effectively meet their teaching goals in support of their students' learning needs?
2. How can instructors effectively utilize computer courseware to support their teaching goals and student's learning needs?

Research Question D

Research Question D assessed the perceptions of the respondents in the Expert Courseware Evaluation Group regarding the quality of the characteristics of computer courseware programs used in this study. The following section presents and discusses the findings relating to three specific subsidiary questions that examined these perceptions.

Research Question D1

> What are the experts' perceptions regarding the quality of the characteristics of the computer courseware programs used in this study in promoting effective learning?

Overall, courseware 2 (Control Systems) was rated best, followed by courseware 3 (Synaptic Mechanisms I and II), with courseware 1 (Action Potential) having the lowest rating. In general, the experts had a more positive perception of the quality of courseware 2 characteristics than courseware 3 characteristics which, in turn, were perceived better than the characteristics of courseware 1.

In terms of quality, almost all the courseware sections were rated as fair. The only exception was the prerequisite section of courseware 1 which was rated as poor in quality.

Discussion

In comparing the qualities of characteristics of the three courseware programs used in the study, whereas the students perceived courseware 3 as the best, the experts rated courseware 2 as the best. The difference in perception regarding courseware quality observed between the student evaluation group and the expert evaluation group was quite an interesting finding in light of the students' learning achievements. It was courseware 2, which the experts rated as the best in quality, and not courseware 3 which the students rated as the best, that had significant effect on students' learning achievement. Two plausible reasons may account for the disparity. One possible reason may be the separate instrument that each of the subject groups used for the courseware evaluation. Perhaps the evaluation instrument used by the experts, compared to the one used by the students, yielded a more dependable measure of the courseware quality. The second plausible reason may be that since the experts were generally more experienced than the students, then the thoughts, views, and perceptions of the experts were a more valid measure of the courseware quality. To the extent that this second assumption was true, one may conclude that the experts were likely to be more dependable in providing a more valid, and perhaps more reliable, measure of computer courseware quality.

Questions for Further Study

1. When students and experts use the same instrument to evaluate computer courseware, do they differ in their perceptions regarding the quality of the program characteristics?
2. When students and experts use the same instrument to evaluate computer courseware, would the experts group provide a more reliable measure of courseware quality than would the student group?

Research Question D2

> Do the experts' perceptions regarding the quality of the computer courseware characteristics vary by their demographic characteristics such as: gender, age, professional discipline, teaching experience, courseware development experience, experience using computer productivity tools, and computer ownership?

Significant differences in perceptions regarding courseware characteristics existed among the experts by expertise in courseware development and content. Experts who had developed no programs had a more positive perception about the quality of courseware 1 new lesson content characteristics than those who had developed some programs. The experts without content expertise had a more positive perception of the quality of courseware 2 structure characteristics, as well as courseware 3 prerequisite skills characteristics, than experts with content expertise.

Discussion

The observed differences among the experts in their ratings of courseware quality revealed clear bias or preference for characteristics that were related to their own area of expertise. A closer look at the pattern of responses to the evaluation instrument revealed that, in general, the experts tended to rate the courseware characteristics that are related to their own expertise, while skipping, by indicating on the evaluation instrument lack of expertise to evaluate, the characteristics that did not relate to their expertise.

A clear implication of this pattern of response is the need to have experts with expertise in diverse areas or disciplines, or a team of experts with diverse expertise, rather than a single expert or a monolithic area of expertise, to be involved in courseware evaluation. In this scenario, an expert will only review or evaluate aspects of courseware programs that relate to their own expertise. Together, the team of experts, except in the rare instance where an expert has all the necessary expertise to conduct all aspects of courseware evaluation, will provide a composite of cross-sectional evaluation of courseware programs. It is hypothesized that such an approach will yield a more reliable measure of courseware quality.

Research Question D3

> What other features of the courseware programs do experts perceive as helpful in promoting effective learning?

In general, the experts did not indicate that the programs offer unique features that are helpful in promoting effective learning. However, they did provide useful suggestions on how to improve the quality of the programs.

One important suggestion the experts made was to restructure Part B of the Computer Courseware Evaluation Checklist Form, dealing with lesson content characteristics, in such a way that the characteristics are grouped together in terms of Gagné's learning outcomes categories rather than the events of instructions. The suggestion was given on the grounds that the classification of lesson content characteristics by events of instruction as presented in the evaluation instrument that the experts used may inadvertently cause the impression that courseware programs are expected to exhibit all the characteristics listed on the instrument. However, courseware programs need not exhibit all the characteristics, though at times they may do so where the purpose and objectives of the programs involve all the learning outcomes. Stated differently, a courseware program may contain all, or only some, of the characteristics of the learning outcomes. Thus if the purpose of a program is to teach intellectual and cognitive skills learning outcomes, it would be wrong to evaluate the program for characteristics of attitude and/or motor skills outcomes. However, if the objectives of a program include all the learning outcomes, it would be wrong not to evaluate the content in terms of the characteristics of all the learning outcomes. In sum, restructuring the lesson content characteristics by learning outcome categories and including statements that clearly explain the nature, functions, and how to use the instrument, will help improve the utility of the evaluation instrument.

The experts' suggestions, along with the important findings presented above form the core of the framework for evaluating computer courseware constructed below.

Limitations of the Study

The scope of this study was limited in three important ways. First, as a case study, the research project was conducted only on a set of programs that were developed and used by the faculty-developer in one college-level semester course offered only at Michigan State University. Moreover, the set of programs were used only as supplements to classroom instruction. Secondly, the student subjects who participated in the study were self-selected. Thus the real effects of using the courseware programs on students' learning processes and achievements may be difficult to isolate from the effects of the idiosyncratic realities of the particular class and courseware programs under study. Any generalizations about the effects of computer courseware on students' learning processes and achievements drawn from this study must necessarily be limited to this student population.

Thirdly, the number of experts readily available to participate in the study were very limited, thus making random sampling of subjects impractical. Besides, all but one of the experts were drawn from Michigan State University. Thus the views expressed by the experts who participated in the study may not be representative of the views of other experts with similar skills. Any generalizations drawn from the study on the perceptions of experts regarding the characteristics of computer courseware in promoting effective learning must necessarily be limited to this population of experts.

Conclusions and Implications

1. Although the computer courseware programs helped in enhancing the students' learning achievements, GPA and gender were the significant predictors of learning achievement.
2. The courseware programs enhanced learning achievement more for higher achieving students (i.e., those with higher GPA scores) than for lower achieving students (i.e., those with lower GPA scores).
3. In general, the amount of courseware usage had little or no effect on learning achievement. The amount of usage of Courseware 2 (Control Systems) was, however, a significant exception to the conclusion, at least with regards to this study. It is therefore imperative to determine the conditions under which the amount of courseware usage will predict learning achievement. Such information will provide a very useful addition to the knowledge base on academic uses of computer courseware.
4. As the students indicated, the computer courseware programs made the lesson content clearly understandable and fun to learn.
5. One important reason the students gave as to why the courseware programs helped them to learn the lesson content better, was that the programs were developed by the same instructor who taught the course. It appeared that content expertise combined with knowledge of both students' characteristics and specific

class situations have decisive influence on the quality and acceptance of computer courseware.

A closely related matter is the claim by most of the student respondents that they perceived the courseware programs used in the study as representing the topics that were important to the class instructor. The "same instructor" perception could provide the motivation that the students need to pay careful attention to the lesson information that the courseware programs present, and thereby promote effective learning. Instructors should, therefore, be encouraged to be savvy in using new technologies and integrating computer courseware into their academic curriculum.

6. Students with basic computer literacy skills favor and support full integration of computer courseware into academic curriculum. On the contrary, students with no computer literacy skills opposed academic uses of computer courseware. Two main implications can be deduced from the different viewpoints. One implication relates to pedagogical practices in the age of information technology. The pervasiveness and versatility of new information technologies in almost every aspect of life today as well as the widespread societal demands for academic uses of computer-related technologies suggest that the integration of computers in academic curriculum will continue to grow by leaps and bounds. If computers become an integral part of academic instruction, then all students must be required to have basic computer literacy skills. The prerequisite will help to eliminate one source of frustration with the use of computer courseware and therefore increase

the likelihood that courseware programs will succeed in promoting effective learning. The second implication of the students' attitude concerning the integration of computer courseware in academic curriculum for administrative policy is that schools and colleges must, at least in the interim, provide students who lack the prerequisite skills the opportunity to acquire the skill. Failure to provide such an opportunity is a recipe for failure of any attempt to promote effective learning via computer courseware.

7. The majority of the students liked and wanted computer courseware programs as supplements to classroom instructions, but not a replacement for lecture and textbook materials.

8. Instructors must educate their students that although courseware programs used as a supplement to classroom instruction can help in preparing for exams, the programs should be viewed and used only as a supplement, and not as the sole source of information for exams.

9. Most of the students expressed the need for similar programs in other academic disciplines, particularly in the sciences (e.g., physics, biology, and biochemistry) where there is the need to "relate various concepts and apply them." However, a number of the students indicated that computer courseware programs are only appropriate in the sciences and not in non-science subject areas. It must be noted that most of the students who participated in the study were either pre-medical or natural science students. It is only fair to assume that their view about subject areas that are appropriate for computer courseware development was biased in

favor of science disciplines. It is critically important, therefore, to determine subject areas that students think are appropriate for computer courseware. Such information may help provide the knowledge base to deal with issues relating to adoption and acceptance of technology innovations in education. Further study is needed to determine if students in social sciences and humanities have a similar or different view about academic uses of computer courseware.

10. Wherever possible courseware programs should be developed to be multi-platform compatible as a way to make the programs extensible and thus solve potential problems of limited availability and accessibility. One emerging technology that offer great potential for developing multi-platform compatible courseware is the Internet, particularly the World Wide Web (WWW). As some student respondents suggested, the Web technology should be promoted and utilized more for the purpose of providing academic instruction. Although more technology does not necessarily mean better performance, nonetheless, the more options that can be made available to learners, the better the chances for the learner to achieve optimum effective learning.

11. As some students indicated, developing computer courseware is a way for faculty who are disorganized in their lectures and have never developed educational software, to "bring some organization to a seemingly structureless lecture."

12. Learners have different learning styles and learn through different learning modalities. Some students learn best by reading books or other printed materials, while some learn more by using any combination of different media of instruction,

including books, television, and computer-based instructional materials. Therefore, the traditional concern of educators regarding whether or not certain media are more effective in promoting learning achievement than traditional classroom instruction is a moot question. The proper questions to ask are:

- What specific courseware characteristics will promote effective learning processes and achievements?
- How should the characteristics of intellectual and cognitive skills, learning styles, instructional strategies, and media be combined and represented in computer courseware to facilitate meaningful learning and enhance learning achievement?
- How can the variety of computer-related technologies available today be effectively utilized to empower learners to "learn how to learn", solve problems, conduct research, and generate new knowledge?

13. In general, most students thought that the feedback statements used in the courseware programs were humorous. On the contrary, most of the experts expressed that the use of what they perceived as, 'profanity words' in the feedback statements can be insulting or offensive to the user. Clearly, further study is needed to understand the underlying cause of this difference and to determine the effects of the use of humor as a vehicle of providing instruction via computer courseware.

14. A minority of the student respondents expressed concern that the contents of the computer courseware programs were simply a repetition of the same materials

presented both in the classrooms and the assigned readings from the textbooks and study guides. As one student noted "the materiel on the courseware should not be too repetitive of information found in course readings and lectures. Sometimes I found the courseware a bit too repetitive of what we had already learned." This concern is critically important, given that the experts felt that the most important characteristic of computer courseware is presenting "complete, accurate, or current lesson materials." The issue then: can courseware programs designed to supplement classroom instruction be "complete, accurate, and current" without being "wordy" as both the students and the experts critiqued with respect to the programs under study? What levels of information should be included and how should the information be organized in supplementary courseware programs to achieve optimum information requirements, and at same time, conciseness and clarity. These and similar concerns can be easily identified and corrected through formative evaluation. Another way the problem can be corrected is to provide ample opportunities through hyperlinks to allow the learner to control how they interact with and explore courseware programs.

15. One major criticism of the courseware programs under study was the wordiness of the presentation of information. Courseware developers need to present lesson information using simple and concise statements.

16. Computer courseware must not take too much time for the learner to complete.

17. The computer courseware lesson content must be easy to understand and manipulate.

18. Courseware programs should be designed to allow users easy navigation, control over the pace, and dynamic interaction with the programs in ways that are intuitive, meaningful and relevant to the learner.

19. Visual or special effects must not hurt the eyes.

20. Use text styles, fonts, and sizes that do not strain the eyes.

21. The students alleged that the programs had some spelling errors. Courseware developers can improve the quality of courseware programs by using a spell checker to correct misspelled words and a grammar checker to correct spelling, grammatical and punctuation errors.

22. Whenever possible, computer courseware should be usable across different computer systems (multiplatform compatibility).

23. The kinds of subject matter and topics that computers are pedagogically suitable for was a concern to some students. One common suggestion was that computer courseware should be designed to provide learning experiences that allow abstract concepts to come alive or turned into virtual reality using simulations and multimedia elements such as video, audio, and graphics animation. The students insisted that computer courseware should be developed primarily in subject areas that are highly abstract, difficult to visualize, or very expensive and/or dangerous to present otherwise. As a student remarked, "use the computer to convey information in non-traditional ways, using graphics and case histories." So, in addition to other forms of instruction, computer courseware should be used

primarily to present new forms of information, knowledge, or learning which could not be easily accomplished through traditional classroom lecture or reading assignments. It should avoid presenting same information available otherwise, and, thereby prevent boredom and fatigue that occur from redundancies, information overload, and excessive reading which adds little or nothing to learning and knowledge gained.

24. Use animation to portray complex systems and processes (such as control systems) in a way to facilitate learners' understanding of the processes and sustain their interests. Both the students and the experts concurred on the need.

25. While the experts were more stringent in rating the quality of courseware characteristics, the students were more detailed as to the specific ways the programs enhanced learning. Both provide perspectives that are useful for obtaining necessary information for meaningful formative evaluation.

26. Part B of the Computer Courseware Evaluation Checklist Form, as suggested by some experts, will be restructured by reclassifying lesson content characteristics under distinct lesson outcome categories instead of the nomenclature of events of instruction. Other changes are warranted on the evaluation instrument by the research findings discussed above. The new evaluation instrument, presented below, will be structured as follows:

    A. Part A deals with human user interface design

    B. Part B deals with characteristics of media use

C. Part C deals with lesson content by the following categories:

- Verbal information
- Intellectual skills
- Cognitive strategy
- Attitude skills
- Motor skills

Recommendations

One goal of this study was to construct a framework for evaluating computer courseware based on the findings of the study in concert with findings from the literature on current research in educational psychology and the new information technologies. The final evaluation instrument, presented below, should serve as a comprehensive framework for a valid and reliable evaluation of all aspects of computer-based multimedia courseware programs including the level of importance and the degree of quality of instructional and learning characteristics presented or represented. The evaluation instrument is designed to allow flexibility in the scope or aspects of courseware evaluation. For instance, the instrument can be used to conduct courseware evaluation at five levels:

1. Evaluation of only the general features of courseware that uses no media elements (audio, sound, and video).

2. Evaluation of the general features of courseware and the use of media elements (audio, sound, and video).

3. A comprehensive and detailed evaluation of only the lesson content.

4. A comprehensive and detailed evaluation of the lesson content and the use of media.

5. A comprehensive and detailed evaluation of various aspects of computer-based multimedia courseware.

The evaluation instrument can be used for both formative and summative evaluation. As a framework for formative evaluation, the instrument can be used as a means of prescribing the components or features of a computer courseware development project. The careful use of the instrument will allow early and continuous detection of any errors and defects in courseware programs during the development cycle. As such, courseware authors, developers and publishers can utilize the instrument as a checklist to ensure the adequacy and quality of courseware programs under development. As a framework for summative evaluation, the instrument can be used by schools, educators, administrators, and others in charge of academic curriculum, to assess the worth or determine the suitability of computer-based multimedia programs for curriculum adoption. The instrument will allow evaluators to determine the potential of computer-based multimedia courseware programs to promote effective learning.

A FRAMEWORK FOR ANALYZING AND EVALUATING COMPUTER-BASED MULTIMEDIA COURSEWARE

Evaluator's Name or ID ______________________________
Evaluator's Expertise ______________________________

Introduction

This instrument was constructed based on the findings of the study on evaluating the success or efficacy of computer. The study was conducted to examine the degree to which aspects of Gagné's theory of instruction, findings from research on technology in education, and findings from educational psychology research on effective instruction and effective learning are essential to the success or efficacy of computer courseware.

There are two aspects to this instrument. The first aspect deals with the **level of importance** of each listed item characteristic in terms of the purpose for which the courseware program is designed or will be used. The second aspect of the instrument serves as a framework for evaluating the **quality** of presentation or representation of the computer-based multimedia courseware characteristics in terms of the following three components: (1) the courseware structure including human-interface design; (2) media use; and (3) the lesson content (i.e., facts, concepts, principles, procedures, attitudes, as well as instructional strategies).

Recommendations for the Use of the Instrument

The following table presents suggested ways that either the entire or parts of the instrument can be used:

Part A (alone)	Evaluation of only the general features of courseware that use no media elements (audio, sound, and video)
Parts A and B	Evaluation of the general features of courseware and the use of media elements (audio, sound, and video)
Part C (alone)	A comprehensive and detailed evaluation of only the lesson content
Parts B and C	A comprehensive and detailed evaluation of the lesson content and the use of media
Parts A, B and C	A comprehensive and detailed evaluation of various aspects of computer-based multimedia courseware

Directions

For the level of importance of the courseware characteristics, please indicate on the left column 4-point rating scales your opinion about the degree to which a particular characteristic is essential to the success or efficacy of the courseware. **For example, if you think that the level of importance of a particular characteristic (say Characteristic A) is:**

Very high (i.e., essential), then circle **4** **4 3 2 1**
High, then circle **3** **4 3 2 1**
Medium, then circle **2** **4 3 2 1**
Low, then circle **1** **4 3 2 1**

For the degree of quality of the courseware program, please indicate on the right column rating scales your opinion about the extent to which or how well a particular characteristic is presented or represented. **For example, if you think that the quality of a particular characteristic (say Characteristic A) is:**

VERY GOOD, then circle **VG** .... **VG G F P NA NE**
GOOD, then circle **G** .... **VG G F P NA NE**
FAIR, then circle **F** .... **VG G F P NA NE**
POOR, then circle **P** .... **VG G F P NA NE**
NOT APPLICABLE, then circle **NA** .... **VG G F P NA NE**
[NOT APPLICABLE means that the characteristic does not apply to the objectives of the courseware]
NO EXPERTISE,. then circle **NE** .... **VG G F P NA NE**
[NO EXPERTISE means that you do not have the expertise to evaluate a particular characteristic]

LEVEL OF IMPORTANCE				Part A: COURSEWARE GENERAL FEATURES		LEVEL OF QUALITY							
					Courseware Structure								
4	3	2	1	1	Statement of objectives	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	2	Identification of intended audience	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	3	Directions on how to use the courseware	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	4	Review of relevant content or prerequisite skills at the beginning of the lesson	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	5	Match between courseware objectives and lesson content	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	6	Statement or demonstration of the courseware relevance to the learner	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	7	The level of difficulty of lesson materials for the intended audience	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	8	The logical organization of lesson content	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	9	The complexity of lesson structure for the intended audience	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	10	The amount or chunk of information presented on each screen or in each lesson unit	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	11	The use of instructional strategies (e.g., hints, examples, illustrations, analogies, flowcharts, outlines)	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	12	Review of the main concepts and principles at the end of the lesson	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	13	Review questions to clarify the lesson content	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	14	Match between performance tests and lesson objectives	VG	G	F	P	VP	NP	NA	NE

4	3	2	1	15	Feedback to students' responses	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	16	The use of branching or hyperlinks	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	17	Learner control over the rate of information presentation	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	18	The level or degree of interactivity the learner has with the lesson materials (opportunity for the learner to participate)	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	19	The ease of correcting errors (e.g., typing errors)	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	20	Considerations for different learning styles	VG	G	F	P	VP	NP	NA	NE
					Human-Computer Interface								
4	3	2	1	21	General visual appeal of the overall screen design	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	22	Simplicity of the screen layout and elements (graphics, color, buttons, text, etc.)	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	23	Consistency of the screen layout and elements (graphics, color, buttons, text, etc.)	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	24	Balance in the screen layout and elements (graphics, color, button, text, etc.)	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	25	Coherence among screen elements or components (background, foreground, pages, navigational tools, etc.)	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	26	The use of courseware navigational tools (buttons, hotwords, etc.)	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	27	The use of INDEX or TABLE OF CONTENT to access information	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	28	The use of MENU to access information	VG	G	F	P	VP	NP	NA	NE

4	3	2	1	29	The use of HELP function to get context sensitive information	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	30	The availability of GLOSSARY to provide meaning of terms or additional information	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	31	The use of color to enhance the readability of text	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	32	The use of text sizes to enhance the readability of text	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	33	The use of text styles to enhance the readability of text	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	34	The use of icons to communicate meaning or expected action	VG	G	F	P	VP	NP	NA	NE

LEVEL OF IMPORTANCE				Part B: MEDIA USE CHARACTERISTICS		LEVEL OF QUALITY							
4	3	2	1	35	The use of graphics in enhancing learning of the course materials	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	36	The use of animations in enhancing learning of the course materials	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	37	The use of video in enhancing learning of the lesson materials	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	38	The use of audio in enhancing learning of the lesson materials	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	39	The use of special effects (text animation, highlighting, transition effects, etc.)	VG	G	F	P	VP	NP	NA	NE

LEVEL OF IMPORTANCE				Part C: LESSON CONTENT		LEVEL OF QUALITY							
					Gaining Learner Attention								
4	3	2	1	40	Introduction focuses learner attention on the learning situation or context	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	41	Introduction focuses learner attention on the tasks and skills to be learned	VG	G	F	P	VP	NP	NA	NE
					Verbal Information								
4	3	2	1	42	States what the learner will be able to say or do after the lesson	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	43	Stimulates recall of relevant facts and context that will make the learning tasks or processes meaningful	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	44	Presents information in simple and concise statements	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	45	Presents complete, accurate, or current lesson materials	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	46	Provides instruction to guide the learner in linking simple to more complex lesson content	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	47	Asks the learner for information in his/her own words	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	48	Confirms the correctness of learner's response to question about statements of facts	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	49	Tests the learner on restating lesson information in his or her own words	VG	G	F	P	VP	NP	NA	NE

					Intellectual Skills								
4	3	2	1	50	Describes and demonstrates concepts, principles, and procedures to be learned	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	51	Stimulates recall of prerequisite concepts and principles or rules	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	52	Presents varied examples of concepts and rules or principles	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	53	Provides instruction to guide the learner in following the proper sequence of steps to master the lesson content	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	54	Asks the learner to apply concepts and rules to instances not previously encountered in the lesson	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	55	Confirms the correctness of learner's use or application of concepts and rules	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	56	Tests the learner on applying concepts and rules to new situations or examples	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	58	The use of spaced reviews including a variety of examples throughout the lesson	VG	G	F	P	VP	NP	NA	NE
					Cognitive Strategy								
4	3	2	1	59	Clarifies the general nature of problem solutions expected from the learner	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	60	Stimulates recall of skills, situations and actions that will be involved in the learner making personal choices or decisions	VG	G	F	P	VP	NP	NA	NE

4	3	2	1	61	Describes and shows the use of mental strategies or procedures to solve problems (e.g., strategy of asking proper questions; a strategy to "work the problem in steps backward from the goal")	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	62	Presents novel problems for the learner to solve	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	63	Provides prompts and hints to help the learner find novel solution to stated problem	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	64	Provides a variety of opportunities for the learner to practice or use cognitive strategies learned	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	65	Confirms the correctness of learner's solution to problems presented	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	66	Confirms originality of learner's solution to problems presented	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	67	Tests the learner on solving a variety of novel or unique problems	VG	G	F	P	VP	NP	NA	NE
					Attitude								
4	3	2	1	68	Provides example of the kind of behavior or attitude (action choice) expected of the learner	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	69	Stimulates recall of skills, by modeling or illustration, that the learner can imitate in learning new behaviors or attitudes	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	70	Presents information to be learned about desired behaviors or attitudes by modeling or illustrating actions and consequences related to the behaviors or attitudes	VG	G	F	P	VP	NP	NA	NE

4	3	2	1	71	Describes or demonstrates the desired behavior or attitude by simulating, modeling, or illustrating actions and consequences related to the behavior or attitude	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	72	Provides opportunity for the learner to practice making choices related to the attitude learned	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	73	Shows direct consequences of personal actions taken or decisions made by the learner	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	74	Tests the learner on making choice of action in a real or simulated situation	VG	G	F	P	VP	NP	NA	NE
					Motor Skill								
4	3	2	1	75	Demonstrates performance of motor (physical) skills expected of the learner	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	76	Presents instruction on and demonstrates proper steps required for the motor skill performance desired	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	77	Requires the learner to practice the skills learned and provides feedback on the learner's performance	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	78	Provides opportunity for the learner to practice performing all physical skills or tasks taught in the lesson	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	79	Provides feedback on the degree of accuracy and timing of the learner's performance of skills	VG	G	F	P	VP	NP	NA	NE

4	3	2	1	80	Tests the learner on using all physical skills taught in the lesson	VG	G	F	P	VP	NP	NA	NE
4	3	2	1	81	Provides additional opportunities for the learner to practice the skills learned	VG	G	F	P	VP	NP	NA	NE

APPENDIX A

APPENDIX A

Student Number ____________________

COMPUTER COURSEWARE EVALUATION FORM

Directions:

Please fill out this courseware evaluation form for the computer courseware programs you used in this study. Note that there are two major parts [Part A and Part B] to the evaluation form. For each item in Part A, please indicate on the 6-point scale your opinion about the computer courseware characteristic by circling one of the six indicators. **For example, if in your opinion the quality of a particular characteristic (say Characteristic A) is:**

SUPERIOR [exceptionally good], then circle S .... S AA AV BA I NA
ABOVE AVERAGE [better than the typical representation of the courseware characteristic], then circle AA .... S AA AV BA I NA
AVERAGE [typical of the courseware characteristic], then circle AV .... S AA AV BA I NA
BELOW AVERAGE [not as good as the typical representation of the courseware characteristic], then circle BA .... S AA AV BA I NA
INFERIOR [exceptionally poor], then circle I .... S AA AV BA I NA
NOT APPLICABLE or ABSENT, then circle NA .... S AA AV BA I NA

Courseware Content																			
		COURSEWARE 1 Action Potential						COURSEWARE 2 Control Systems						COURSEWARE 3 Synaptic Mech [I and II]					
1	The clarity of objectives	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA
2	Identification of intended audience	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA

3	The appropriateness of lesson content in reflecting course objectives	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA
4	Directions on how to use the courseware.	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA
5	Beginning the lesson with a review of the relevant content	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA
6	The clarity of lesson content	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA
7	The appropriateness of lesson concepts and principles (for the intended audience)	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA
8	The appropriateness of chunks of information (e.g., each screen, unit segment, etc.) presented	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA
9	Ending the lesson with a review of the main concepts and principles	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA
10	The relevance of the courseware content to the learner	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA
11	The use of graphics in enhancing learning of the course materials	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA

12	The use of animations in enhancing learning of the course materials	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA
13	The use of video in enhancing learning of the lesson materials	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA
14	The use of audio in enhancing learning of the lesson materials	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA
15	The presentation of INDEX/TABLE OF CONTENT to aid in searching information	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA
16	The usefulness of MENU in accessing information	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA
17	The adequacy of the HELP function.	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA
18	The adequacy of information provided in GLOSSARY	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA

Instructional Procedures																			
		COURSEWARE 1 Action Potential						COURSEWARE 2 Control Systems						COURSEWARE 3 Synaptic Mech [I and II]					
19	The adequacy of the courseware's navigational tools (buttons, hotwords, etc.)	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA
20	The use of instructional cognitive strategies (such as hints, examples, illustrations, analogies, flowcharts, outlines)	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA
21	Providing the learners with opportunity for participation	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA
22	The clarity of review questions	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA
23	The usefulness of review questions in clarifying the lesson content	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA
24	The usefulness of problem solving questions in helping learners apply lesson content to real life situations	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA

25	The appropriateness of feedback to students responses	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA
26	Informing learners about their performance	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA
27	Learners' control over the rate of information presentation	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA
28	The design of the screens	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA
29	The appropriateness of text color	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA
30	The appropriateness of text sizes	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA	S	AA	AV	BA	I	NA

Part B — General Information

Please supply the following information about you.

31. Gender: Male _____ Female ______

32. Age range in years: Below 20 ___ 20 - 25 ___ 26 - 30 ___ 31 - 35 ___ 36+ ___

33. GPA: ______

34. Academic discipline: Premed _____ Natural Science _____ Humanities ___

35 Class level: Freshmen _____ Sophomore _____ Junior ______ Senior ____

36. Total credits earned at MSU: _____

37. Which of the following have you had experience with? Please check all that applies.

____________________ WORDPROCESSING software
____________________ SPREADSHEET software
____________________ DATABASE software
____________________ COMMUNICATION TOOLS (e.g., Email, Pilot, Netscape)
____________________ PROGRAMMING LANGUAGES (e.g., Basic, Pascal, C++)
____________________ MULTIMEDIA DEVELOPMENT TOOLS (e.g., HyperCard, ToolBook, Director)
____________________ COMPUTER GAMES
____________________ COMPUTER COURSEWARE
____________________ ASSEMBLING COMPUTER SYSTEMS

38. Do you own a computer: Yes _____ No _____

39. On average, how many times (sessions) a week did you use courseware 1 [Action Potential]? _________________

40. On average, how many times (sessions) a week did you use courseware 2 [Control Systems]? ________________

41. On average, how many times (sessions) a week did you use courseware 3 [Synaptic Mech 1 & II]? ____________

42. On average, how much time did you spend per session on courseware 1 [Action Potential]? ________________

43. On average, how much time did you spend per session on courseware 2 [Control Systems]? ________________

44. On average, how much time did you spend per session on courseware 3 [Synaptic Mech 1 & II]? __________

45. In your own opinion, did the courseware help you to effectively learn the topics or lesson materials presented?
Yes __________ No __________

Comments:

46. Would you recommend the courseware program(s) to other students in your academic discipline?
Yes __________ No __________

47. Would you like to use such courseware programs in your other college courses?
Yes __________ No __________

Comments:

48. Please write any other comments you may have about <u>Courseware 1</u> [Action Potential] in the space below.

49. Please write any other comments you may have about <u>Courseware 2</u> [Control Systems] in the space below.

50. Please write any other comments you may have about <u>Courseware 3</u> [Synaptic Mech 1 & II] in the space below.

Thank you very much for your cooperation and participation in this study.

APPENDIX B

APPENDIX B

Evaluator Name or ID ____________________________

COMPUTER COURSEWARE EVALUATION CHECKLIST RATING FORM

Introduction

The purpose of this instrument is to allow you to rate the degree to which aspects of Gagné's theory of instruction as well as findings from research in educational psychology (on characteristics of effective instruction and effective learning) are critical to the success or efficacy of computer courseware. Gagné's theory of instruction is selected for this study because of its preponderant influence on research in educational psychology in general and classroom instruction in particular.

The instrument deals with analyzing and evaluating computer courseware structure and lesson content (i.e., instructional content and strategies). It is being designed as a framework for assessing learning outcomes and instructional events that are manifested in computer courseware. Thus, the framework will allow you to assess how facts, concepts, principles, procedures, and attitudes are presented in the courseware.

Directions:

Your task is to rate the degree to which a particular characteristic of instruction and learning is essential to the success of efficacy of computer courseware. **For example, if you think that the level of importance of a particular characteristic (say Characteristic A) to the success or efficacy of computer courseware is:**

HIGH, then circle 3 .... **3 2 1 0**
MEDIUM, then circle 2 .... **3 2 1 0**
LOW, then circle 1 .... **3 2 1 0**
NOT APPLICABLE, then circle 0 .... **3 2 1 0**

In the blank spaces provided within each section, please include other characteristics or features of computer courseware you think should be assessed and rate them according to the scale.

Please feel free to suggest other ways or labels that can be used to classify the characteristics.

Part A: COURSEWARE STRUCTURE		If necessary, please restate the characteristics in the spaces provided in this column	Degree of importance of characteristic in assessing courseware effectiveness			
Program Structure						
1	Statement of objectives		3	2	1	0
2	Identification of intended audience		3	2	1	0
3	Directions on how to use the courseware		3	2	1	0
4	Review of relevant content (prerequisite skills) at the beginning of the lesson		3	2	1	0
5	Match between courseware objectives and lesson content		3	2	1	0
6	Statement or demonstration of the courseware relevance to the learner		3	2	1	0
7	The level of difficulty of lesson materials for the intended audience		3	2	1	0

Part A: COURSEWARE STRUCTURE		If necessary, please restate the characteristics in the spaces provided in this column	Degree of importance of characteristic in assessing courseware effectiveness			
Program Structure						
8	The logical organization of lesson content		3	2	1	0
9	The complexity of lesson structure for the intended audience		3	2	1	0
10	The amount (chunk) of information presented on each screen or in each lesson unit		3	2	1	0
11	The use of instructional strategies (e.g., hints, examples, illustrations, analogies, flowcharts, outlines)		3	2	1	0
12	Review of the main concepts and principles at the end of the lesson		3	2	1	0
13	Review questions to clarify the lesson content		3	2	1	0
14	Match between performance tests and lesson objectives		3	2	1	0
15	Feedback to students' responses		3	2	1	0
16	The use of branching or hyperlinks		3	2	1	0
17	Learner control over the rate of information presentation		3	2	1	0
18	The level or degree of interactivity the learner has with the lesson materials (opportunity for the learner to participate)		3	2	1	0

			3	2	1	0
			3	2	1	0
			3	2	1	0
			3	2	1	0
			3	2	1	0
			3	2	1	0
Part A: COURSEWARE STRUCTURE		**If necessary, please restate the characteristics in the spaces provided in this column**	**Degree of importance of characteristic in assessing courseware effectiveness**			
Screen Layout and Design						
19	The ease of correcting errors (e.g., typing errors)		3	2	1	0
20	General visual appeal of the overall screen design		3	2	1	0
21	Simplicity of the screen layout and elements (graphics, color, button, etc.)		3	2	1	0
22	Consistency of the screen layout and elements (graphics, color, button, text, etc.		3	2	1	0
23	Balance in the screen layout and elements (graphics, color, button, text, etc.)		3	2	1	0
24	Coherence among screen elements or components (background, foreground, pages, navigational tools, etc.)		3	2	1	0
25	The use of courseware navigational tools (buttons, hotwords, etc.)		3	2	1	0

Part A: COURSEWARE STRUCTURE		If necessary, please restate the characteristics in the spaces provided in this column	Degree of importance of characteristic in assessing courseware effectiveness			
Screen Layout and Design						
26	The use of INDEX or TABLE OF CONTENT to access information		3	2	1	0
27	The use of MENU to access information		3	2	1	0
28	The use of HELP function to get context sensitive information		3	2	1	0
29	The availability of GLOSSARY to provide meaning of terms or additional information		3	2	1	0
30	The use of color to enhance the readability of text		3	2	1	0
31	The use of text sizes to enhance the readability of text		3	2	1	0
32	The use of text styles to enhance the readability of text		3	2	1	0
33	The use of icons to communicate meaning or expected action		3	2	1	0
			3	2	1	0
			3	2	1	0
			3	2	1	0
			3	2	1	0
			3	2	1	0
			3	2	1	0

	Part A: COURSEWARE STRUCTURE	If necessary, please restate the characteristics in the spaces provided in this column	Degree of importance of characteristic in assessing courseware effectiveness			
Media Use						
34	The use of graphics in enhancing learning of the course materials		3	2	1	0
35	The use of animations in enhancing learning of the course materials		3	2	1	0
36	The use of video in enhancing learning of the course materials		3	2	1	0
37	The use of audio in enhancing learning of the course materials		3	2	1	0
38	The use of special effects (text animation, highlighting, transition effects, etc.)		3	2	1	0
			3	2	1	0
			3	2	1	0
			3	2	1	0
	Part B: LESSON CONTENT	**If necessary, please restate the characteristics in the spaces provided in this column**	**Degree of importance of characteristic in assessing courseware effectiveness**			
Gaining Learner Attention						
39	Introduction focuses learner attention on the learning situation or context		3	2	1	0
40	Introduction focuses learner attention on the tasks and skills to be learned		3	2	1	0
			3	2	1	0
			3	2	1	0

Part B: LESSON CONTENT		If necessary, please restate the characteristics in the spaces provided in this column	Degree of importance of characteristic in assessing courseware effectiveness			
Informing the Learner of the Courseware Objectives						
41	States what the learner will be able to say or do after the lesson		3	2	1	0
42	Describes and demonstrates concepts, principles, and procedures to be learned		3	2	1	0
43	Clarifies the general nature of problem solutions expected from the learner		3	2	1	0
44	Provides example of the kind of behavior or attitude (action choice) expected of the learner		3	2	1	0
45	Demonstrates performance of motor (physical) skills expected of the learner		3	2	1	0
			3	2	1	0
			3	2	1	0
			3	2	1	0

Part B: LESSON CONTENT		If necessary, please restate the characteristics in the spaces provided in this column	Degree of importance of characteristic in assessing courseware effectiveness			
Stimulating Recall of Prerequisite skills						
46	Stimulates recall of relevant facts and context that will make the learning tasks or processes meaningful		3	2	1	0
47	Stimulates recall of prerequisite concepts and principles or rules		3	2	1	0

Part B: LESSON CONTENT		If necessary, please restate the characteristics in the spaces provided in this column	Degree of importance of characteristic in assessing courseware effectiveness			
Stimulating Recall of Prerequisite skills						
48	Stimulates recall of skills, situations and actions that will be involved in the learner making personal choices or decisions		3	2	1	0
49	Stimulates recall of skills, by modeling or illustration, that the learner can imitate in learning new behaviors or attitudes		3	2	1	0
50	Stimulates recall of subskills (part skills) and the process of integrating subskills (executive subroutine) neccesary to learn the performance of the total motor skills desired		3	2	1	0
			3	2	1	0
			3	2	1	0
			3	2	1	0
Presenting New Information to be Learned						
51	Presents complete, accurate, or current lesson materials		3	2	.1	0
52	Presents information in simple and concise statements		3	2	1	0
53	Presents varied examples of concepts and rules or principles		3	2	1	0

Part B: LESSON CONTENT		If necessary, please restate the characteristics in the spaces provided in this column	Degree of importance of characteristic in assessing courseware effectiveness			
Presenting New Information to be Learned						
54	Describes and shows the use of mental strategies or procedures to solve problems (e.g., strategy of asking proper questions; a strategy to "work the problem in steps backward from the goal")		3	2	1	0
55	Presents novel problems for the learner to solve		3	2	1	0
56	Presents information to be learned about desired behaviors or attitudes by modeling or illustrating actions and consequences related to the behaviors or attitudes		3	2	1	0
57	Presents instruction on and demonstrates proper steps required for the motor skill performance desired		3	2	1	0
			3	2	1	0
			3	2	1	0
Providing Learning Guidance						
58	Provides instruction to guide the learner in linking simple to more complex lesson content		3	2	1	0
59	Provides instruction to guide the learner in following the proper sequence of steps to master the lesson content		3	2	1	0

Part B: LESSON CONTENT		If necessary, please restate the characteristics in the spaces provided in this column	Degree of importance of characteristic in assessing courseware effectiveness			
Providing Learning Guidance						
60	Provides prompts and hints to help the learner find novel solution to stated problem		3	2	1	0
61	Describes or demonstrates the desired behavior or attitude by simulating, modeling, or illustrating actions and consequences related to the behavior or attitude		3	2	1	0
62	Requires the learner to practice the skills learned and provides feedback on the learner's performance		3	2	1	0
			3	2	1	0
			3	2	1	0
			3	2	1	0
Eliciting the Performance						
63	Asks the learner for information in his/her own words		3	2	1	0
64	Asks the learner to apply concepts and rules to instances not previously encountered in the lesson		3	2	1	0
65	Provides a variety of opportunities for the learner to practice or use cognitive strategies learned		3	2	1	0

Part B: LESSON CONTENT		If necessary, please restate the characteristics in the spaces provided in this column	Degree of importance of characteristic in assessing courseware effectiveness			
Eliciting the Performance						
66	Provides opportunity for the learner to practice making choices related to the attitude learned		3	2	1	0
67	Provides opportunity for the learner to practice performing all physical skills or tasks taught in the lesson		3	2	1	0
			3	2	1	0
Providing Feedback						
68	Confirms the correctness of learner's response to question about statements of facts		3	2	1	0
69	Confirms the correctness of learner's use or application of concepts and rules		3	2	1	0
70	Confirms the correctness of learner's solution to problems presented		3	2	1	0
71	Confirms originality of learner's solution to problems presented		3	2	1	0
72	Shows direct consequences of personal actions taken or decisions made by the learner		3	2	1	0
73	Provides feedback on the degree of accuracy and timing of the learner's performance of skills		3	2	1	0

			3	2	1	0
			3	2	1	0
			3	2	1	0
	Part B: LESSON CONTENT	**If necessary, please restate the characteristics in the spaces provided in this column**	**Degree of importance of characteristic in assessing courseware effectiveness**			
Assessing Performance						
74	Tests the learner on restating lesson information in his or her own words		3	2	1	0
75	Tests the learner on applying concepts and rules to new situations or examples		3	2	1	0
76	Tests the learner on making choice of action in a real or simulated situation		3	2	1	0
77	Tests the learner on solving a variety of novel or unique problems		3	2	1	0
78	Tests the learner on using all physical skills taught in the lesson		3	2	1	0
			3	2	1	0
			3	2	1	0
Enhancing Retention and Transfer						
79	Provides additional opportunities for the learner to practice the skills learned		3	2	1	0
80	The use of spaced reviews including a variety of examples throughout the lesson		3	2	1	0
			3	2	1	0

Part C — GENERAL INFORMATION

Direction: Please supply the following information about yourself.

81. Gender: Male ______ Female ______

82. Age range in years:
    25 and under ______ 26 - 35 ______ 36 - 45 ______ 46+ ______

83. Professional discipline:

    Faculty with expertise in the content area covered by the courseware ______
    Faculty without expertise in the content area covered by the courseware ______
    Faculty with expertise in computer courseware development ______
    Faculty without expertise in computer courseware development ______
    Staff with expertise in the content area covered by the courseware ______
    Staff without expertise in the content area covered by the courseware ______
    Staff with expertise in computer courseware development ______
    Staff without expertise in computer courseware development ______
    Other (Please specify)____________________________________

84. If you are a faculty member, please indicate the range of your teaching experience in years:
    1 - 5 ______ 6-10 ______ 11-15 ______ 16-20 ______ 21+ ______

85. Please indicate the approximate number of courseware programs you have developed:

0 _____ 1 - 3 _____ 4 - 6 _____ 7 - 9 _____ 10+ _____

86. Which of the following have you had experience with? Please check all that apply.

_______________ WORDPROCESSING software
_______________ SPREADSHEET software
_______________ DATABASE software
_______________ COMMUNICATION TOOLS (e.g., Email, Pilot, Netscape)
_______________ PROGRAMMING LANGUAGES (e.g., Basic, Pascal, C++)
_______________ MULTIMEDIA DEVELOPMENT TOOLS (e.g., HyperCard, ToolBook, Director)
_______________ COMPUTER GAMES
_______________ COMPUTER COURSEWARE
_______________ ASSEMBLING COMPUTER SYSTEMS

87. Do you own a computer? Yes _____ No _____

88. **Other Comments**

Thank you very much for your cooperation and participation in this study.

APPENDIX C

APPENDIX C

Evaluator Name or ID ______________________________

COMPUTER COURSEWARE EVALUATION CHECKLIST FORM

There are three parts to this computer courseware evaluation instrument.

Part A deals with evaluating computer courseware structure. Structure refers to how courseware is structurally organized.

Part B deals with analyzing and evaluating courseware lesson content (i.e., instructional content and strategies). The task involves assessing the learning outcomes and instructional events manifest in the courseware. The framework will allow you to assess how facts, concepts, principles, procedures, and attitudes are presented in the courseware.

Part C relates to general information about the courseware evaluator.

Both Part A and Part B have same directions. There is a separate instruction for Part C.

Directions: Part A and Part B — Analyzing and Evaluating Computer Courseware Structure and Lesson content

For each item in Part A and Part B, please indicate on the 6-point scale your opinion about the quality of computer courseware characteristic by circling one of the six indicators. Quality refers to the extent to which or how well a particular characteristic is presented or represented. **For example, if you think that the quality of a particular characteristic (say Characteristic A) is:**

VERY GOOD, then circle **VG** .... **VG G F P VP NA**
GOOD, then circle **G** .... **VG G F P VP NA**
FAIR, then circle **F** .... **VG G F P VP NA**

POOR, then circle **P** .... **VG G F P VP NA**
VERY POOR, then circle **VP** .... **VG G F P VP NA**
NOT APPLICABLE, then circle **NA** .... **VG G F P VP NA**

[NOT APPLICABLE means that the characteristic does not appy to the objectives of the courseware, or it is ABSENT even though applicable, or that you are not able to evaluate it.]

Note — In the blank spaces provided within each section, please include other characteristics or features of computer courseware you think should be assessed and rate them according to this same scale.

Part A: COURSEWARE STRUCTURE		COURSEWARE 1 Action Potential						COURSEWARE 2 Control Systems						COURSEWARE 3 Synaptic Mech. [I and II]					
Program Structure																			
1	Statement of objectives	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
2	Identification of intended audience	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
3	Directions on how to use the courseware	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
4	Review of relevant content (prerequisite skills) at the beginning of the lesson	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
5	Match between courseware objectives and lesson content	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
6	Statement or demonstration of the courseware relevance to the learner	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA

Part A: COURSEWARE STRUCTURE		COURSEWARE 1 Action Potential						COURSEWARE 2 Control Systems						COURSEWARE 3 Synaptic Mech. [I and II]					
Program Structure																			
7	The level of difficulty of lesson materials for the intended audience	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
8	The logical organization of lesson content	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
9	The complexity of lesson structure for the intended audience	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
10	The amount (chunk) of information presented on each screen or in each lesson unit	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
11	The use of instructional strategies (e.g., hints, examples, illustrations, analogies, flowcharts, outlines)	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
12	Review of the main concepts and principles at the end of the lesson	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
13	Review questions to clarify the lesson content	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
14	Match between performance tests and lesson objectives	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
15	Feedback to students responses	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA

Part A: COURSEWARE STRUCTURE		COURSEWARE 1 Action Potential						COURSEWARE 2 Control Systems						COURSEWARE 3 Synaptic Mech. [I and II]					
Program Structure																			
16	The use of branching or hyperlinks	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
17	Learner control over the rate of information presentation	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
18	The level or degree of interactivity the learner has with the lesson materials (opportunity for the learner to participate)	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
19	The ease of correcting errors (e.g., typing errors)	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
Screen Layout and Design																			
20	General visual appeal of the overall screen design	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
21	Simplicity of the screen layout and elements (graphics, color, button, etc.)	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
22	Consistency of the screen layout and elements (graphics, color, button, text, etc.)	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA

Part A: COURSEWARE STRUCTURE		COURSEWARE 1 Action Potential						COURSEWARE 2 Control Systems						COURSEWARE 3 Synaptic Mech. [I and II]					
Screen Layout and Design																			
23	Balance in the screen layout and elements (graphics, color, button, text, etc.)	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
24	Coherence among screen elements or components (background, foreground, pages, navigational tools, etc.)	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
25	The use of courseware navigational tools (buttons, hotwords, etc.)	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
26	The use of INDEX or TABLE OF CONTENT to access information	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
27	The use of MENU to access information	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
28	The use of HELP function to get context sensitive information	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	G	G	F	P	VP	NA
29	The availability of GLOSSARY to provide meaning of terms or additional information	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
30	The use of color to enhance the readability of text	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA

Part A: COURSEWARE STRUCTURE		COURSEWARE 1 Action Potential						COURSEWARE 2 Control Systems						COURSEWARE 3 Synaptic Mech. [I and II]					
Screen Layout and Design																			
31	The use of text sizes to enhance the readability of text	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
32	The use of text styles to enhance the readability of text	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
33	The use of icons to communicate meaning or expected action	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
Media Use																			
34	The use of graphics in enhancing learning of the course materials	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
35	The use of animations in enhancing learning of the course materials	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
36	The use of video in enhancing learning of the lesson materials	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
37	The use of audio in enhancing learning of the lesson materials	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA

Part A: COURSEWARE STRUCTURE		COURSEWARE 1 Action Potential						COURSEWARE 2 Control Systems						COURSEWARE 3 Synaptic Mech. [I and II]					
Media Use																			
38	The use of special effects (text animation, highlighting, transition effects, etc.)	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
Part B: LESSON CONTENT		**COURSEWARE 1 Action Potential**						**COURSEWARE 2 Control Systems**						**COURSEWARE 3 Synaptic Mech. [I and II]**					
Gaining Learner Attention																			
39	Introduction focuses learner attention on the learning situation or context	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
40	Introduction focuses learner attention on the tasks and skills to be learned	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA

Part B: LESSON CONTENT		COURSEWARE 1 Action Potential						COURSEWARE 2 Control Systems						COURSEWARE 3 Synaptic Mech. [I and II]					
Informing the Learner of the Courseware Objectives																			
41	States what the learner will be able to say or do after the lesson	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
42	Describes and demonstrates concepts, principles, and procedures to be learned	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
43	Clarifies the general nature of problem solutions expected from the learner	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
44	Provides example of the kind of behavior or attitude (action choice) expected of the learner	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
45	Demonstrates performance of motor (physical) skills expected of the learner	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
Stimulating Recall of Prerequisite Skills																			
46	Stimulates recall of relevant facts and context that will make the learning tasks or processes meaningful	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G.	F	P	VP	NA
47	Stimulates recall of prerequisite concepts and principles or rules	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA

Part B: LESSON CONTENT		COURSEWARE 1 Action Potential						COURSEWARE 2 Control Systems						COURSEWARE 3 Synaptic Mech. [I and II]					
Stimulating Recall of Prerequisite Skills																			
48	Stimulates recall of skills, situations and actions that will be involved in the learner making personal choices or decisions	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
49	Stimulates recall of skills, by modeling or illustration, that the learner can imitate in learning new behaviors or attitudes	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
50	Stimulates recall of subskills (part skills) and the process of integrating subskills (executive subroutine) neccesary to learn the performance of the total motor skills desired	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
Presenting New Information to be Learned																			
51	Presents complete, accurate, or current lesson materials	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G.	F	P	VP	NA
52	Presents information in simple and concise statements	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
53	Presents varied examples of concepts and rules or principles	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA

Part B: LESSON CONTENT		COURSEWARE 1 Action Potential						COURSEWARE 2 Control Systems						COURSEWARE 3 Synaptic Mech. [I and II]					
Presenting New Information to be Learned																			
54	Describes and shows the use of mental strategies or procedures to solve problems (e.g., strategy of asking proper questions; a strategy to "work the problem in steps backward from the goal")	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
55	Presents novel problems for the learner to solve	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
56	Presents information to be learned about desired behaviors or attitudes by modeling or illustrating actions and consequences related to the behaviors or attitudes	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
57	Presents instruction on and demonstrates proper steps required for the motor skill performance desired	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA

Part B: LESSON CONTENT		COURSEWARE 1 Action Potential						COURSEWARE 2 Control Systems						COURSEWARE 3 Synaptic Mech. [I and II]					
Providing Learning Guidance																			
58	Provides instruction to guide the learner in linking simple to more complex lesson content	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
59	Provides instruction to guide the learner in following the proper sequence of steps to master the lesson content	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
60	Provides prompts and hints to help the learner find novel solution to stated problem	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
61	Describes or demonstrates the desired behavior or attitude by simulating, modeling, or illustrating actions and consequences related to the behavior or attitude	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
62	Requires the learner to practice the skills learned and provides feedback on the learner's performance	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA

Part B: LESSON CONTENT		COURSEWARE 1 Action Potential						COURSEWARE 2 Control Systems						COURSEWARE 3 Synaptic Mech. [I and II]					
Eliciting the Performance																			
63	Asks the learner for information in his/her own words	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
64	Asks the learner to apply concepts and rules to instances not previously encountered in the lesson	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
65	Provides a variety of opportunities for the learner to practice or use cognitive strategies learned	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
66	Provides opportunity for the learner to practice making choices related to the attitude learned	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
67	Provides opportunity for the learner to practice performing all physical skills or tasks taught in the lesson	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA

Part B: LESSON CONTENT		COURSEWARE 1 Action Potential						COURSEWARE 2 Control Systems						COURSEWARE 3 Synaptic Mech. [I and II]					
Providing Feedback																			
68	Confirms the correctness of learner's response to question about statements of facts	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
69	Confirms the correctness of learner's use or application of concepts and rules	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
70	Confirms the correctness of learner's solution to problems presented	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
71	Confirms originality of learner's solution to problems presented	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
72	Shows direct consequences of personal actions taken or decisions made by the learner	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
73	Provides feedback on the degree of accuracy and timing of the learner's performance of skills	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA

Assessing Performance																			
74	Tests the learner on restating lesson information in his or her own words	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
75	Tests the learner on applying concepts and rules to new situations or examples	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
76	Tests the learner on making choice of action in a real or simulated situation	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
77	Tests the learner on solving a variety of novel or unique problems	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
78	Tests the learner on using all physical skills taught in the lesson	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
Enhancing Retention and Transfer																			
79	Provides additional opportunities for the learner to practice the skills learned	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
80	The use of spaced reviews including a variety of examples throughout the lesson	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA
		VG	G	F	P	VP	NA	VG	G	F	P	VP	NA	VG	G	F	P	VP	NA

Part C — General Information

Direction: Please supply the following information about yourself.

81. Gender: Male ______ Female ______

82. Age range in years:
25 and under ______ 26 - 35 ______ 36 - 45 ______ 46+ ______

83. Professional discipline:

Faculty with expertise in the content area covered by the courseware ______
Faculty without expertise in the content area covered by the courseware ______
Faculty with expertise in computer courseware development ______
Faculty without expertise in computer courseware development ______
Staff with expertise in the content area covered by the courseware ______
Staff without expertise in the content area covered by the courseware ______
Staff with expertise in computer courseware development ______
Staff without expertise in computer courseware development ______

84. If you are a faculty member, please indicate the range of your teaching experience in years:
1 - 5 ______ 6-10 ______ 11-15 ______ 16-20 ______ 21+ ______

85. Please indicate the approximate number of courseware programs you have developed:

0 _____ 1 - 3 _____ 4 - 6 _____ 7 - 9 _____ 10+ _____

86. Which of the following have you had experience with? Please check all that apply.

_______________ WORDPROCESSING software
_______________ SPREADSHEET software
_______________ DATABASE software
_______________ COMMUNICATION TOOLS (e.g., Email, Pilot, Netscape)
_______________ PROGRAMMING LANGUAGES (e.g., Basic, Pascal, C++)
_______________ MULTIMEDIA DEVELOPMENT TOOLS (e.g., HyperCard, ToolBook, Director)
_______________ COMPUTER GAMES
_______________ COMPUTER COURSEWARE
_______________ ASSEMBLING COMPUTER SYSTEMS

87. Do you own a computer? Yes _____ No _____

88. **General Comments**

Please write any other comments you may have about the computer courseware programs in the space below.

<u>Courseware 1</u>

Courseware 2

Courseware 3

Thank you very much for your cooperation and participation in this study.

APPENDIX D

APPENDIX D

Letter requesting Dr. Thomas Adams' permission to conduct the study using his courseware programs and Physiology 431 Class

September 20, 1995

Dr. Thomas Adams
Department of Physiology
Michigan State University
East Lansing, MI. 48824

Dear Dr. Adams

Letter Requesting Your Permission to Use Your Class for Doctoral Study

I am doing a study for my doctoral dissertation about evaluating the success of computer courseware in a university setting. I am aware of the several CAI programs you've developed for your classes over the years. I would like, therefore, to request your permission to do my study on the use of the programs in your Physiology class 431 during the Fall semester, 1995.

My study will focus on determining factors that influence the success of computer courseware programs when students use such programs as supplement to classroom instruction. The study will involve collection of three types of data. One form of data will be students' perceptions about the usefulness and success of using the programs. The second data will be collected from you as the class instructor and will relate to records of students' academic achievement due to the use of the programs. The third data type will be experts' review of the programs using evaluation criteria based on research findings on effective teaching and effective learning.

This study is strictly formative evaluation in nature with the sole purpose of collecting data that will better inform computer courseware authors on factors to consider in developing successful programs. My central interest is to find out what works and why. In doing so, data collected from subjects involved in the study will be kept strictly confidential by not associating subjects with specific responses. Subjects will not be required to indicate their

APPENDIX D

names on the questionnaire-type checklists that will be used to review the courseware programs.

In my analysis, I may include excerpts from open-ended responses from subjects involved in the study in presenting the report of this study. I will use pseudonyms and disguise any personal identifiers when writing the report and in any publications.

Thank you in advance for your time.

Sincerely

James Obielodan
Computer Laboratory
Michigan State University
East Lansing, MI. 48824

Consent Form

I, Dr. ____________________________
(Name)
have read and understood the attached letter informing me of the requirements of the study and of my rights if I choose to participate.

I _________________________ to participate in the study.
(volunteer/decline)

__________________________ ___________
(signature) (date)

APPENDIX E

APPENDIX E

Letter requesting students in the Physiology 431 class to participate in the study

November 1, 1995

Dear Mr./Ms. ______________

Letter Requesting Your Participation In My Doctoral Study

I am doing a study for my doctoral dissertation about evaluating the success of computer courseware in a university setting. I will like to request your participation in the study which will evaluate three courseware programs used in your Physiology 431 class.

If you choose to participate, the study will require you to interact with the programs and fill out a questionnaire on each program. Also, if you indicate your availability for a follow-up on the attached consent form, you may be requested to participate in a focus-group discussion on the programs. Your participation in this study is expected to take a total of about 2 - 3 hours.

Students' course grades will be collected from your class instructor only for the purpose of correlating academic performance with the use of the programs. The instructor will be required to provide the students' course grades to the researcher using only students' identification numbers. The instructor will not have access to the questionnaire that students fill out and therefore will not be able to associate any student's name or identification number with any specific response.

You may decline to answer or discuss any question on the questionnaire. You may decide to withdraw your participation at any time during this study.

This study is strictly formative evaluation in nature with the sole purpose of collecting data that will better inform computer courseware authors on factors to consider in developing successful programs. My central interest is to find out what works and why. In doing so, data collected from subjects involved in the study will be kept strictly confidential by not associating subjects with specific responses. Subjects will not be required to indicate their

APPENDIX E

names on the questionnaire-type checklists that will be used to review the courseware programs.

In my analysis and presentation of the report of this study, I may include excerpts from your response to open-ended questions on the research questionnaire. In doing so, I will use pseudonyms and disguise any personal identifiers when writing the report and in any publications.

Attached is a copy of the questionnaire that you and other students will use in evaluating the courseware programs. In case you have any question regarding this study please call me at 355-4500 ext. 137 or email me at 13501jbo@msu.edu.

Kindly complete and sign the attached consent form and the questionnaire and then mail the two items in the self-addressed stamped envelope provided.

Thank you very much for your time and cooperation.

Sincerely,

James Obielodan
Computer Laboratory
Michigan State University
East Lansing, MI. 48824

APPENDIX E

Consent Form

I, Mr. Ms. ____
(Name)

have read and understood the attached letter informing me of the requirements of the study and of my rights if I choose to participate.

I _________________________ to participate in the study.
(volunteer/decline)

I ___________ be available to participate in a follow-up group discussion.
(will/will not)

If you can help participate in a follow-up group discussion on the computer courseware programs, please provide the following information:

Name ____

Address: ____

____

____

Phone: ____

Email:____

__________________________ ______________
(signature) (date)

APPENDIX E

Questionnaire to Evaluate the Computer-Aided Instructional Programs Used in PSL 431, Fall Semester 1995

Attached is a copy of the questionnaire to evaluate the computer-aided instructional programs used in your PSL 431 class this Fall semester. Kindly complete the questionnaire and the accompanying consent form and then mail the two items in the self-addressed stamped envelope provided.

If you have any question regarding this study, please contact:

James Obielodan
Michigan State University
Faculty Facility for Creative Computing
Computer Laboratory
Room 114 Computer Center
East Lansing, MI. 48824

Phone —> 517-355-4500 ext. 137
E-mail —> 13501jbo@msu.edu

Thank you very much for your time and cooperation.

APPENDIX F

APPENDIX F

Letter, email or phone messages to experts requesting them to participate in the study

Dear _____

I would like to request you to participate in my dissertation study which will involve experts like you to respond to a questionnaire on evaluating computer courseware. The evaluation instrument constructed for that purpose will require you to rate the level of importance of each questionnaire item to the success or effectiveness of courseware. The questionnaire will take about $1^1/_2$ hours to complete.

Please let me know of your availability to participate in this study. You can reach me by phone at 517-355-4500 ext. 137 or by email at 13501jbo@msu.edu.

Your cooperation and support will be deeply appreciated.

Sincerely

____

James Obielodan
Faculty Facility for Creative Computing
Room 114
Computer Laboratory
Michigan State University
East Lansing, MI 48824

APPENDIX F

Dear _____

I would like to request your participation in my dissertation study which will involve experts like you to interact with three computer courseware programs and then respond to a questionaire to evaluate the programs. The process is estimated to take about 2 hours.

Please let me know of your availability to participate in this study. You can reach me by phone at 517-355-4500 ext. 137 or by email at 13501jbo@msu.edu.

Your cooperation and support will be deeply appreciated.

Sincerely

____

James Obielodan
Faculty Facility for Creative Computing
Room 114
Computer Laboratory
Michigan State University
East Lansing, MI 48824

APPENDIX F

November 9, 1995

Address

____

____

____

Dear ____

I am doing a study for my doctoral dissertation about evaluating the success of computer courseware in a university setting. I will like to request you — as an expert courseware developer, content expert, researcher, or university faculty — to participate in the study which will evaluate three courseware programs used in the Physiology 431 class during this Fall semester. Your participation in this study will greatly help me in completing my doctoral dissertation in Educational Systems Development at the College of Education here at Michigan State University.

The study will require you to interact with the programs and to fill out a questionnaire on each program. I will provide the questionnaire instrument when you and the other experts convene for the evaluation. The second phase of this evaluation process involves a focus group discussion among the experts participating in this study. The meeting will be held on November 17 at 3:15 PM in Room 500, Computer Center. Your participation in the group discussion is **crucial** to the success of the study. In preparation for the focus group discussion, please respond, as best as you can, to the questions in Part C of the evaluation instrument. Your participation in this study is expected to take about 3 - 4 hours.

I will not use your real name in any conversation, analysis, and reports of the study. I may include excerpts from your response to open-ended questions on the research questionnaire. In doing so, I will use pseudonyms and disguise any personal identifiers when writing the report and in any publications.

APPENDIX F

You may decline to answer or discuss any question on the questionnaire. Also, you may decide to withdraw your participation at any time during this study.

Kindly complete and sign the attached consent form and mail in the self-addressed stamped envelope provided.

In case you have any question regarding this study please call me at 355-4500 ext. 137 or send me an email at 13501jbo@msu.edu.

Thank you in advance for your time and cooperation.

Sincerely,

James Obielodan
Faculty Facility for Creative Computing
Room 114
Computer Laboratory
Michigan State University
East Lansing, MI. 48824

Phone —> 355-4500 ext. 137
Email —> 13501jbo@msu.edu

APPENDIX F

Consent Form

I, Mr. Ms. ____________________________
(Name)
have read and understood the attached letter informing me of the requirements of the study and of my rights if I choose to participate.

I _________________________ to participate in the study.
(volunteer/decline)

__________________________ __________
(signature) (date)

APPENDIX G

APPENDIX G

Cover letters that accompanied the evaluation instruments for the experts

January 3, 1996

Address

____

____

____

Dear ____________

Enclosed with this letter is an evaluation instrument related to my dissertation study. As previously requested or discussed with you, I need your help in responding to the questionnaire.

The Computer Courseware Evaluation Checklist Rating instrument is designed to allow you to rate the importance of each questionnaire item in determining the success or effectiveness of courseware. Instruction on how to complete the questionnaire instrument is included. The questionnaire will take about 2 hours to complete.

Please return the completed evaluation questionnaire in the self-addressed stamped envelope provided or you can call me to pick it up.

In case you have any question regarding the instrument please call me at 355-4500 ext. 137 or send me an email at 13501jbo@msu.edu.

Your immediate response to this urgent matter will be deeply appreciated. Thank you very much for your time and support.

Sincerely,

James Obielodan
Room 114, Computer Center, MSU
East Lansing, MI. 48824

APPENDIX G

January 8, 1996

Address

____

____

____

Dear ______

Enclosed with this letter is an evaluation instrument and three courseware programs related to my dissertation study. As previously requested, I need your help as an expert to interact with them.

The Computer Courseware Evaluation Checklist instrument is designed to allow you to evaluate the quality of the characteristics of computer courseware programs in promoting effective learning. The three computer courseware programs to be evaluated are: Action Potential, Control Systems, and Synaptic Mechanisms (Parts I and II). The programs are available on PC-based Microcomputer Labs around MSU Campus. If you own a PC and prefer to run the programs on the system, a set of four disks containing the programs are enclosed with this letter. Your task is to interact with the programs and then use the checklist to evaluate them.

Please return the completed evaluation questionnaire in the self-addressed stamped envelope provided or you can call me to pick it up.

In case you have any question regarding the instrument please call me at 355-4500 ext. 137 or send me an email at 13501jbo@msu.edu.

Thank you very much for your time and support.

Sincerely,

James Obielodan
Room 114
Computer Center
Michigan State University
East Lansing, MI. 48824

APPENDIX H

APPENDIX H

Follow-up messages to the experts

The second email message

Dear Expert/Research Volunteer

This is just a reminder concerning the evaluation instrument for my dissertation study that I sent you about three weeks ago. It is critical for the study to complete all data collection latest this week Friday.

I will be very grateful for your help in completing and mailing the questionnaire back to me. You can also send an email or call me to pick it up when completed. Please ignore this message if you have already mailed or sent the questionnaire.

Again, thank you very much for your support and help.

____

James Obielodan
Faculty Facility for Creative Computing
Room 114
Computer Center
Michigan State Unviversity
East Lansing, MI 48824

Phone -->517-355-4500 ext. 137
Email -->13501jbo@msu.edu

APPENDIX I

APPENDIX I

MDS coordinates of the experts' perceptions regarding the level of importance of the characteristics of computer courseware in promoting effective learning

1	CCLAOBJ	1.6465	-.3342	.6808
2	CINTAUD	1.3269	.0965	-1.3391
3	CUSEHOW	1.2328	.7025	.3790
4	CLBWREV	.0928	-1.1796	1.4553
5	COBJCON	1.3415	1.1065	.1197
6	CRCCONT	-1.4194	-1.7009	-.5380
7	CLEVDIF	-.2764	-.3104	-2.4139
8	CLOGORG	.8879	1.3531	.4862
9	CCOMPLX	-1.5071	-.3997	-1.0686
10	CICHUNK	.6437	1.2353	.4594
11	CISTRAT	1.3182	-.3155	.1575
12	CREVCON	-.1687	-1.5557	1.2610
13	CREVQUE	.4502	-1.3600	1.3757
14	CTESTOB	.4917	-1.4966	.8314
15	CFEEDBK	.8413	-.9349	1.2850
16	CHLINKS	-1.1307	1.2676	-.6895
17	CLCONTR	1.0806	.5724	-1.3252
18	CINTERA	.7302	1.5951	.1730
19	CCERROR	-.6925	1.5385	-.9163
20	CVISUAL	-.8170	1.0523	-1.2116
21	CSSCRNL	.9674	1.0246	.0659
22	CCSCRNL	.1264	1.6149	.7489
23	CBSCRNL	-1.8125	-.1203	-.1967
24	CCSCRNE	-.6937	.5157	1.4611
25	CNAVIGT	.0339	.3253	1.2961
26	CTABCON	-1.8281	-.2189	1.4752
27	CMENU	-.8363	.4599	1.4750
28	CHELP	-.6968	-.5803	1.8549
29	CGLOSSA	-1.5631	-.7621	1.2417
30	CTXTCOL	-2.0545	.5234	-.2588
31	CTXTSIZ	-1.5115	-.0924	1.1164
32	CTXTSTY	-.8250	1.4088	-.3702
33	CICONS	-1.6540	1.3850	.1139
34	CGRAPH	-.1379	1.3598	.3237
35	CANIMAT	-1.1491	1.0107	.5723
36	CVIDEO	-1.3276	1.5151	.2351
37	CAUDIO	-1.6352	1.0911	.4140

APPENDIX I

38	CSEFECT	-1.9000	-.6999	.4399
39	CGASITU	.6765	1.0266	-.3286
40	CGATASK	1.2981	-.6194	1.0210
41	CILFACT	1.0184	-1.1834	.0210
42	CILCONC	.9459	-.9826	.2365
43	CILPROB	1.0029	-.0951	-.0584
44	CILBEHA	-.4398	-1.5684	-1.4016
45	CILSKIL	-.8942	-2.2072	-1.0046
46	CSRFACT	.7834	-.7673	-.2410
47	CSRCONC	.9844	-.6723	-.7580
48	CSRSKIL	.5322	-.5859	-.8605
49	CSRBEHA	-.3530	-1.1734	-1.2635
50	CSRESUB	-.1421	-1.4863	-.6062
51	CNIACCU	1.5509	.9165	.2595
52	CNISIMP	1.0715	.6949	.4390
53	CNIVARY	1.2501	.6445	-.4991
54	CNICOGS	-.7431	-.0203	-1.0758
55	CNIPROB	-1.0786	1.4043	-.1946
56	CNIBEHA	.5332	-.6375	-1.4482
57	CNISKIL	.8966	-1.1271	-.8145
58	CLGFACT	.9587	1.0801	-.0452
59	CLGCONC	.2257	-1.1950	.1274
60	CLGPROB	.3066	-.4247	-1.4218
61	CLGBEHA	-.6662	-.5749	-1.3821
62	CLGSKIL	1.1380	.5732	.5091
63	CEPFACT	-1.8152	.8352	.5112
64	CEPCONC	-2.0748	-.3512	-.9615
65	CEPPROB	.9467	.8000	-.6251
66	CEPBEHA	.3110	.8264	-.4555
67	CEPSKIL	.3373	-.6923	-1.0697
68	CPFFACT	1.4532	.4645	-.1356
69	CPFCONC	1.4533	.4645	-.1356
70	CPFPROB	1.3875	.0594	.2951
71	CPFORIG	-.8810	.1910	-1.4098
72	CPFCONS	1.0573	.0020	-1.0972
73	CPFSKIL	.4941	-.2964	-1.1612
74	CAPFACT	-1.9095	-.6304	1.3790
75	CAPCONC	.5250	-.5132	1.0296
76	CAPPSIM	.4038	-.4756	1.0640

APPENDIX I

77	CAPNOVP	-.2794	-.2684	1.7290
78	CAPSKIL	-.3706	-1.9855	-.5392
79	CERSKIL	-.0017	-.6537	1.3731
80	CERSREV	.5328	-.6971	1.0382

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