MOTION VERSUS NON-MOTION IN INTERACTIVE VIDEO LESSONS IN HIGH SCHOOL PHYSICAL SCIENCE

DISSERTATION

Presented to the Graduate Council of the
University of North Texas in Partial
Fulfillment of the Requirements

For the Degree of

DOCTOR OF PHILOSOPHY

By

Jimmy D. Speers, B.S., M.S.

Denton, Texas

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The most important question addresed in this study was whether there is any difference in student learning between a motion group and a non-motion group. The population for the study was regular high school physical science students. Two teachers were involved in the study. The experimental group had 81 students in five classes with one teacher. The contrast group had 42 students in three classes with the other teacher. The interactive video courseware is currently a part of the curriculum in this district. It was used in its original form with the contrast group. For the experimental group one unit of the courseware was modified to remove the motion video and replace it with photorealistic graphics that served as the non-motion part of the study. Covariates were selected to compensate for any differences in the two groups. A pretest and posttest was administered to both groups. Analysis of the posttest scores indicated that there was no difference in learning if motion in the presentation was the only variable.

The remaining three research questions dealt with students' perceptions about multimedia, ease of using computers, and taking more courses using multimedia. There

was no significant difference between the two groups' perceptions except that the motion group thought that the software was easier to use.

Technology will continue to provide new opportunities to improve instruction, but the increase in capabilities must always be balanced against the cost. Sometimes a step backwards in technological capabilities will be the best choice. Interactive video has not become widely used in education because of the high costs involved. This study has shown that the absence of motion in a presentation will not decrease its effectiveness. Courseware developers should carefully consider presentation media that are more cost-effective without surrendering educational integrity.

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INTRODUCTION

The use of interactive video in the classroom has not proliferated as quickly as some educators first anticipated. One of the problems with the use of interactive video courseware is the high cost of development (Geasler, 1992). Interactive video can successfully be used with video tape or the videodisc as a source of the video segments (Greenfield, 1992). The videodisc, commonly called a laserdisc, is currently the best method used in interactive video because of the random access to different information segments that it affords. A major problem is the high cost of developing a master, which is the first in a production run.

Advances in technology have added another alternative to laserdisc, placing the video and audio on a computer's hard disc in digital form. This would limit the use of motion in the lessons because of the high expense associated with storing the video. A CD-ROM platform could be used, but it is difficult to update the completed program (Geasler, 1992).

The objective of this study is to determine whether motion can be removed without detrimental effects to the educational value of the lessons. An implication of this study is that an interactive digital video format could possibly be used in a local area network environment and be cost effective. Many of the schools that use interactive video have only one system in the classroom for the teacher to use during large group instruction. Other schools have established interactive video labs, using several stand-alone systems for small groups of students to use. If multimedia courseware could be used on a local area network, students would be able to access the instructional material from their own computers. The increased individualization would enable the student to progress at their own pace.

Statement of the Problem

It is not known if using multimedia will be as effective in producing knowledge gains by students as interactive video with full motion capabilities.

Purpose of the Study

The purpose of this study is to determine the effects of removing the motion from interactive video lessons on the outcomes of a unit in physical science.

Research Questions

Q1 Is any difference in learning found when one group of students using interactive video with the motion removed is compared with a contrast group using the interactive video in its original form?

Q2 Is any difference found in student perceptions about multimedia presentations when one group of students using interactive video with the motion removed is compared with a contrast group using the interactive video in its original form?

Q3 Is any difference found in student perceptions about ease of using computers when one group of students using interactive video with the motion removed is compared with a contrast group using the interactive video in its original form?

Q4 Is any difference found in student intentions about taking more courses using multimedia when one group of students using interactive video with the motion removed is compared with a contrast group using the interactive video in its original form?

Definitions

Courseware - Instructional software that is designed for a course of instruction. A course is divided into units and units are divided into lessons.

Hard disk - A nonremovable magnetic storage disk that is a part of many personal computer systems.

Interactive Video - A videodisc player controlled by a computer using interactive software with output to an A/V monitor.

Local area network - A number of personal computers connected to a common computer that acts as a file server to share programs and files. Such a network can be as small as the computers in one classroom, but no larger than the school district's facilities.

Motion - Full motion video from a videodisc player that is displayed at a rate of 30 frames a second on an A/V monitor.

Multimedia - The ability of a computer system to use text, photorealistic graphics, and good quality sound in an interactive presentation.

Non-motion - Photorealistic graphics displayed on a computer monitor for a time period not less than one second.

Photorealistic graphics - Video captured from a laser disc and changed into a computer graphics format using 256 colors.

Videodisc - A laser optical disc which has digitally encoded pits arranged in spiral tracks on its surface. These discs can be read by a videodisc player and displayed on an A/V monitor or television.

REVIEW OF LITERATURE

Motion in Educational Research

The study of motion in instructional media has been going on since the first use of film in education. In the 1920's studies compared film to filmograph or photographs. Although this type of research continued throughout the thirties and forties, the findings were not conclusive. Some studies found film to be superior, while others suggested that the filmstrip was more effective. The conclusion of Hoban and van Ormer (1950) was that most of the research had not taken into account other significant variables. Studies done in the 1950's and early 1960's continued to show that neither medium was superior (Allen, 1958; MacLennan and Reid, 1964).

An important study, done by Miller at the University of Southern California in 1967, examined the hypotheses that motion in film increases the emotional response, creates a more positive attitude and does not influence audience information retention (Miller, 1967). A total of eighty college students were shown one of two treatments in groups of five. The motion treatment was a twelve minute film with factual narration. The non-motion treatment was a filmograph, made from the film, with a single frame of film shown for the duration of each scene. The narration remained the same for both treatments. There was a significant difference in attitude in favor of motion; however there was no significant difference in informational learning between motion picture and filmstrip groups.

In the early 1970's, researchers continued to investigate the effects of motion versus non-motion on learning. One study compared Super 8mm film with single-frame enlargements from the movie. In this case the film was superior to the photographs (Troth. 1971). Photographs were again found to be inferior when compared to motion pictures and slides in a study using college students at Purdue University (Wells, 1970). In both of these studies, motion concepts were involved in the instructional material. Apparently, the use of photographs is not the best method to teach subject matter that involves motion concepts.

Atherton (1971), in a study of the use of a three screen slide program compared to 16mm film found that both treatments were equally effective in producing attitude change and cognitive learning. Both treatments had the same sound, were the same length, and were in color.

In another study the effects of seven presentation modes upon learning tasks were compared (Russell, 1970). The seven presentation modes were: (1) motion picture with spoken verbal; (2) motion picture, silent; (3) still pictures with spoken verbal; (4) still pictures, silent; (5) printed verbal and spoken verbal; (6) printed verbal; (7) spoken verbal. The learning tasks in the study were concept formation, classification, generalization, and application. The results of the study indicated that no presentation method was superior in concept formation, generalization, and application; however, printed verbal and spoken verbal modes of presentation produced significantly superior performance on test scores in the classification tasks. Russell concluded that when the type of learning task can be identified, a particular presentation mode may be more effective than the others.

A study that examined effects of motion on learning movement patterns with high and low spatial aptitude subjects was done by Blake (1977). There were 84 undergraduate college students involved in the study. They were divided into three groups. Each group was taught the movement patterns of five chess pieces using one of three instructional films. One film simulated a slide presentation for the "still" condition. Two types of motion were used for the two remaining groups, animated arrows over still pictures and a full motion condition which followed a standard motion picture format. He found that the low aptitude subjects, as measured by the Guilford-Zimmerman Test of Spatial Visualization, performed better with the motion. Subjects of high aptitude showed no difference between instructional modes.

In another study, Ghazzawi (1980) investigated the effects of motion, media format, sex of the learners, repetition type, and order of presentation on students learning and retention in relation to chemical concepts. Three methods of instruction were used in the study: lecture, film and slides. Ghazzawi found that motion had no significant effect on learning certain concepts in chemistry.

Hall and Buckolz (1981) studied subjects recognition memory of movement patterns and their corresponding pictures. Recognition of pictures was significantly better than that of movement patterns. They suggest that the pictorial image code and the verbal code are qualitatively superior to the movement image code.

Listening retention was the subject of a study involving 20 classes of third-graders. A story was presented to the children, using three methods: a film, a filmstrip, and the teacher reading from a book. The findings showed that the results of the presentation modes were not significantly different (Sullivan and Rogers, 1981).

How presentation modes affect the brain's beta wave production was the question that Hines (1982) tried to answer. In the study, Hines measured and analyzed viewers' electroencephalographic reactions to motion and still pictures. Since beta brain waves indicate focused attention and mental concentration, it is important to know if there are significant differences in beta brain wave production when students view motion as opposed to still pictures. It was found that neither mode caused more beta brain wave production than the other.

Another study in the early 1980's examined the effects of motion and subjects' cognitive style on learning spatial concepts and rules (Glick, 1982). Glick wanted to show that motion could be used to influence perception by focusing the learners' attending behavior and to provide structure and organization for encoding. In a control group posttest-only design, eighty-five beginning nursing students were randomly assigned to three groups: motion, no-motion and control. The motion group viewed electronic simulations of sensory impulse conduction to emphasize the location and function of the two major sensory pathways. The no-motion group received the same visualized instruction without the motion. There was no significant difference in learning between the two treatment groups, indicating that motion did not provide additional processing support.

Two studies in the mid-1980's considered the use of animation in computer graphics as an instructional aid. In one study using four treatment groups, there was no significant difference in learning between the groups when the groups were compared one on one. However, when the animation group was then compared to the other three groups combined, a significant difference was found. In the other study the result of no significant difference in learning was explained as the subjects' not utilizing the potential for additional cognitive processing. (Ponick, 1986; Rieber, 1987)

There is one condition when it is apparent that motion is needed; that is when the motion itself is the object to be learned. Spangenberg's (1974) study involving the disassembly of an M85 machine gun showed that motion did not help subjects to learn the sequence of steps but subjects in the motion group outperformed the non-motion group in the disassembly operation.

Interactive Video in Education Research

Much of the literature in recent years calls for more research on interactive video (Matta and Kern, 1989; Slee, 1989; Grabawski, 1989). Interactive video has been shown to be cost effective in a whole group setting, as well as an effective instructional delivery system with significant knowledge gains and time savings when compared to traditional lecture methods. (Bunderson, Olsen, and Baillio, 1981)

In a paper presented to the Association for Educational Communications and Technology, Cushall, Harvey, and Brovey (1987) suggested that one way for research to measure the effectiveness of interactive video was to codify the attributes of the medium. It is certainly true that an interactive video lesson is more than the sum of its parts and each of these parts has an effect on the whole. Cushall, Harvey, and Brovey listed audio over still frame as one of the attributes that should be studied and also recommended that researchers focus on generalizable results.

Brody (1984), in a paper presented to the American Educational Research Association, makes a distinction between research on interactive video and research with interactive video. Research on interactive video is that which attempts to find ways to increase its effectiveness or how it relates to more general instructional questions. Research with interactive video is using the medium as a research tool to control variables in stimulus materials, as a data gathering device, or to eliminate interviewer bias. He also acknowledges that these distinctions are sometimes not clear cut. Sometimes research falls into both categories. The research reported in this paper is most clearly categorized as research with interactive video in that it attempts to control the variables in the presentation of information.

The more expensive media have always been the more glamorous. Because of this, and because it has been shown to be an effective medium, interactive video is emerging as a major media delivery system (Schramm, 1973; Ely, 1988). Although this proposed study does not intend to find ways to make interactive video more effective, it does attempt to find answers that will make it more cost-effective without relinquishing any of its educational integrity.

Texas Learning Technology Group

This study modified an existing unit in the Texas Learning Technology Group (TLTG) physical science courseware. It follows that the relative merit of this courseware should first be discussed. Texas Learning Technology Group is a partnership formed by the Texas Association of School Boards, the National Science Center Foundation, and 12 Texas school districts. Texas Learning Technology Group began in 1985, with a $500,000 grant from the National Science Center for Communications and the

Electronics Foundation. Another $1,500,000 came from the 12 school districts that bought shares in the group (Keathley,1989).

The group developed a complete physical science curriculum that would be delivered by an interactive videodisc system. Three factors led to the selection of physical science: the shortage of qualified science teachers, high student failure rate, and lack of student motivation.

In the pilot study of the physical science courseware, which was done in the fall semester of the 1987-88 school year, the one-semester chemistry portion of the curriculum was implemented. Twenty-six teachers participated in the study with data collected from 338 of their students. The major findings were that students using the courseware generally achieved higher scores than students who did not use the courseware, and that students using the courseware also indicated they would be more inclined to take an elective science course than the control students (Savenye and Strand, 1989).

The following school year both the chemistry and physical science semesters of the courseware were studied. Students from 23 school districts participated in the study. Students using the courseware again scored significantly higher on both mastery of physical science content and science process skills. However, in this study no difference was found between students using the courseware and students in the control group on any affective variable related to student attitude toward interactive video, intent to enroll in subsequent courses using videodisc technology, intent to enroll in a subsequent chemistry or physics course or perceived value of science courseware (Borich, 1989). Other studies, however, indicate that students using the Texas Learning Technology Group courseware or other interactive video lessons have significantly more positive attitudes toward learning from this presentation method (Sanveye, 1989; Cushall, Harvey, and Brovey, 1987). These studies indicate that this use of interactive video is an appropriate tool for teaching physical science in high school.

METHODOLOGY

Population

The population for the study was high school students enrolled in physical science. Using intact classes was necessary in this study because of scheduling procedures in the high school. The experimental group had 81 students for which all data was available, and 102 students that completed the questionnaire. The contrast group had 42 students for which all data was available, and 53 students that completed the questionnaire.

Two teachers were involved in the study. The experimental group included all students enrolled in five physical science classes taught by one teacher. The contrast group consisted of all of the physical science students in three classes taught by the second teacher. When asked by the researcher if they were willing to be involved in the study, both teachers readily agreed to participate. During the unit of instruction both teachers continued to display a positive attitude. The teacher of the contrast group was pleased that the only addition to her classroom routine was the administration of the pretest and the student questionnaire. Both teachers were very professional and displayed a very positive attitude toward the study. There was no evidence of teacher bias.

Treatment Development

The Texas Learning Technology Group courseware is currently a part of the curriculum in this district. This is an interactive video format using a laserdisc for the video segments. It was used in its original form with the contrast group. For the experimental group one unit of the courseware was modified to remove the motion video and replace it with photorealistic graphics. This modified unit served as the non-motion part of the study. All other aspects of the courseware remained the same. The unit dealing with force and motion was modified to be used in this study. The laserdisc is controlled by an IBM personal computer using the InfoWindow Presentation System (International Business Machines Corporation, 1986). All video and audio segments reside on the laserdisc while graphics and branching is controlled by the computer.

The materials used for the experimental treatment were developed over a three year period. Experimentation with various methods of presenting digital audio and photorealistic graphics led to the selection of IBM's Audio Visual Connection (AVC) software, the IBM M/Audio card, and the IBM Video Capture Adapter/A (International Business Machines Corporation, 1989). The prototype for this experimental material was developed as a semester project by students in the Interactive Video course at the University of North Texas during the spring of 1991. These students completed approximately 70 percent of the experimental materials. First, the audio was converted to digital form with the M/Audio card and saved as a file on the computer's hard disc. All or part of this file could be accessed and played back through the audio card. Single frames of video were then converted to digital form with the Video Capture Adapter/A and saved as computer graphics files. The graphic format allowed the use of 256 colors for each video still. The format was VGA-8 graphics that could be displayed on any personal computer with a VGA graphics card. The computer graphics used with the IWPS was then converted to the same format as the video stills. A program was then written with the AVC authoring language that would present the lesson. Care was taken to insure that the lesson written followed the same sequence and used the same audio as the original courseware. One or more video stills were substituted for the video segments. The video stills were displayed for a minimum of one second to ensure that an animation effect was not produced.

During the summer of 1991, the researcher coordinated a small group of advanced graduate students to complete the authoring process for the remainder of the treatment materials. The researcher then tested and refined the materials to assure consistency with the original lessons. The treatment materials occupied 61,174,947 bytes of disk space.

Instrumentation

The first research question asks if there is any difference in students learning between the experimental and contrast groups. The Mastery test supplied with this unit of the Texas Learning Technology Group Physical Science courseware was used to measure this criterion variable. This is a forty-item test using the multiple choice format. It was developed by Texas Learning Technology Group for use with this unit of instruction. The test is supplied in two forms, Form A and Form B. One form of the unit test was administered to both groups at the beginning of the unit as the pretest. At the end of the selected unit of instruction the other form of the unit test was administered to both groups as the posttest.

The Cognitive Abilities Test scores were used as covariates to compensate for any significant difference in intellectual levels between the two groups. This is a nationally normed standardized test that reports a Standard Age Score, percentile rank and stanine for age group, along with percentile rank and stanine for grade group. The scores are given for three areas: verbal, quantitative, and nonverbal. No total score is reported for the student because it could be misleading for students with uneven patterns of cognitive development. The Standard Age Score for each area was used. Cumulative frequency distributions were used in developing the Standard Age Scores. Normal deviates corresponding to the cumulative percents were determined. These were multiplied by 16 to achieve a scale with a standard deviation of 16. An average of 100 was attained by adding 100 to the members of the scale. This provided a conversion from Universal Scale Score to Standard Age Score at each 3 month age level from 5 years, 0 months to 18 years. Form 4, Level F was used in this study.

Because this study used intact classes, it was very important that the covariates were a reliable measure. Reliability of the Cognitive Abilities Test was estimated using the Kuder-Richardson Formula #20 (KR-20). The KR-20 reliability estimates for all three batteries of the test were done separately (Thorndike and Hagen, 1986). These estimates can be seen in Table 1, alone with the standard deviation (SD) and standard error of measurement (SEM).

Table 1

Summary Raw Score Statistics for the Cognitive Abilities Test

	Verbal	Quantitative	Nonverbal
Number of items	75	60	65
Means	44.69	33.46	32.77
SD	14.12	11.92	12.46
SEM	3.74	3.37	3.52
KR-20	.93	.92	.92

The publishers of the Cognitive Abilities Test have attempted to establish the content, criterion, and construct validity of the test. The content validity is simply a case of best judgment on the part of the authors. They have attempted to match the activities called for in the test with their conception of intelligent behavior. They list six characteristics that they believe describe behavior that it is important to measure for understanding an individual's educational and work potential: (1) tasks that deal with abstract and general concepts; (2) tasks that require the interpretation and use of symbols; (3) tasks that require the examinee to deal with relationships among concepts and symbols; (4) tasks that require flexibility in organizing concepts and symbols; (5) tasks that require the examinee to use experience gained in new patterns; (6) tasks that emphasize power, rather than speed, in working with abstract materials.

To establish criterion validity the batteries of the Cognitive Abilities Test were correlated with the Iowa Test of Basic Skills. Table 2 shows the correlations for Form 4, Level F.

Table 2

Correlations of Scores of the Cognitive Abilities Test with the Grade-Equivalent Scores in the Iowa Test of Basic Skills

Verbal	Quantitative	Nonverbal	
Reading	.77	.67	.60
Language Total	.76	.70	.62
Work-Study Total	.75	.75	.70
Math Total	.71	.81	.72
Composite	.86	.79	.71

The construct validity of the Cognitive Abilities Test can be demonstrated by showing the correlations of the test results with effective cognitive functioning. Table 3 shows correlations with school grades. We would expect a substantial correlation to be shown between the test scores and academic success.

Table 3

Correlations of Scores of the Cognitive Abilities Test with School Grades in Grade 9

Verbal	Quantitative	Nonverbal	
GPA	.58	.63	.52
English	.52	.52	.42
Social Studies	.56	.57	.45
Mathematics	.39	.48	.41
Science	.52	.59	.48

The Cognitive Abilities Test is administered to students in this district during the spring semester of each year. The students test scores were obtained from their records. This study occurred during the early weeks of the fall semester. Those students who did not live in the district during the previous school year, and therefore did not take the Cognitive Abilities Test, were excluded from the part of the study that pertained to student learning.

They were included in the part of the study that pertained to students' attitude and preferences.

The measure of student perceptions of multimedia presentations was accomplished with a portion of the Student Attitude Questionnaire used in the evaluation report of the Texas Learning Technology Group courseware (Savenye, 1989). In this report a factor analysis and content evaluation of the questionnaire grouped the items into four factors. The "liking" factor was used in this study. These items related to general liking of the course and materials, including clarity, interest, and value. References to the "videodisc unit" in the items were changed to "force and motion unit" because the videodisc is not used with the experimental group. The items relating to the use of computers, were also included, as well as those concerning the students intent to enroll in courses using multimedia in the future. Because this study was only dealing with motion vs. non-motion as a presentation variable and student perceptions about the use of the computer, the other items on the questionnaire relating to the teacher, tests, working in groups, and curriculum activities were not needed in this study. The questionnaire will be given to both the experimental group and the contrast group at the end of the unit of instruction. The questionnaire uses a five point scale ranging from "strongly agree" to "strongly disagree" for students responses. Face validity of the questionnaire was established using the physical science teachers in the district. The items appeared on the questionnaire as follows:

1. This force and motion unit was interesting.
2. The information presented to me in this unit was clear to me.
3. The multimedia presentations my teacher made to the whole class helped me learn.
4. As a whole, I liked learning about force and motion using the computer.
5. The information in this unit was easy to learn.
6. I learned a lot in this unit.
7. The information I learned in this unit is useful to me.
8. I will use the information and skills I learned in this unit in future classes in high school.
9. I think computers will improve high school courses in the future.
10. I think other students will enjoy learning about force and motion using the computer.
11. I had used computers before I started this course.
12. I feel more comfortable using computers now as a result of the force and motion unit.
13. The multimedia presentations helped me to pay attention.
14. I think the computer hardware system is easy to use.

15. I think the force and motion unit (for example, the menu screens, practice questions, games, etc.) is easy to use.
16. If I could have, I would rather not have used the computer to learn force and motion.
17. If I could I would take other courses using the computer.

Research Design

The study was a nonequivalent control group design (Campbell and Stanley, 1966). Experimental group classes will be both in the morning and afternoon to compensate for the "time of day" factor.

Procedures

The unit on motion and force was scheduled for seventeen class sessions including the pretest and posttest. The unit covers the following behavioral student objectives:

1. Given two, calculate the third: Speed, distance or time.
2. Given velocity vectors of two objects moving at constant velocity, identify th objects' velocities as being equal in magnitude, direction, both, or neither.
3. Given time and change in velocity, calculate acceleration.
4. State the effect of force on motion.

5. Calculate total force in newtons and determine its direction when two force vectors are involved.
6. Define and differentiate between Newton's three laws of motion.
7. Given examples of circular motion, identify the direction of centripetal force.
8. Contrast weight and mass in terms of their dependence on gravity.
9. Given mass and velocity, calculate momentum.
10. Define energy. Distinguish between potential and kinetic energy.

Instructional activities for both groups included lecture, student use of multimedia, lab, and review. Student worksheets were used with all of the instructional activities. About half of the instructional time was used in the multimedia lab. This could not be increased because both teachers used the same computer lab. The contrast group used the district's InfoWindow systems. The computers running AVC were used by the experimental group. The groups were not in the multimedia lab at the same time. To ensure that the groups did not use the wrong computers, the system monitors were turned off when not in use. The pretest was administered on the first day of the unit. The posttest and questionnaire were administered on the last day of the unit.

FINDINGS

The first research question asks:
Is any difference in learning found when one group of students using interactive video with the motion removed is compared with a contrast group using the interactive video in its original form?

Both the experimental and contrast groups showed gains over the pretest as measured by the posttest ($p<.0001$). The contrast group gained from a mean of 60% on the pretest to a mean of 86% on the posttest. The experimental group gained from a mean of 53% on the pretest to a mean of 82% on the posttest. This was the expected outcome and supports the earlier studies on the effectiveness of this interactive video courseware (Savenye, 1989; Savenye & Strand, 1989). The posttests were compared using standard ANOVA procedures. There was no significant difference in learning between the two groups ($p>.239$).

The covariates used were the pretest, and the verbal, quantitative, and non-verbal batteries of the Cognitive Abilities Test. Comparing these variables between groups revealed that there was a significant difference in intellectual levels between the two groups. The contrast group scored significantly higher on the verbal ($p<.001$) and the quantitative ($p<.05$) batteries of the Cognitive Abilities Test. The mean scores for the contrast group were 112.7 for the verbal battery and 112.2 for the quantitative battery of the Cognitive Abilities Test. The mean scores for the experimental group were 105.9 for the verbal battery and 107.9 for the quantitative battery of the Cognitive Abilities Test. The was no significant difference in the scores on the nonverbal battery of the test ($p>.38$). Prior knowledge was also different between the two groups. The contrast group scored significantly higher than the experimental group on the pretest ($p<.05$). The mean scores on the pretest were 23.9 for the contrast group and 21.4 for the experimental group. A correlation matrix was produced using these variables. It revealed that the covariates were all significantly related to the posttest scores ($p<.001$). This supports the assumption that prior knowledge and intelligence are related to achievement in physical science. Any differences between the two groups could have been controlled by using random sampling, but this was not possible. Intact classes had to be used because of the scheduling procedures in this high school. Using these variables as covariates when comparing the posttest scores acted as a statistical control for the differences between the two groups (Ferguson, 1981).

The second research question asks:

Is any difference found in student perceptions about multimedia presentations when one group of students using interactive video with the motion removed is compared with a contrast group using the interactive video in its original form?

The first ten items on the questionnaire were used to try to answer this question. The students responded to all of the items on the questionnaire using a five point scale from "strongly agree" to "strongly disagree". These responses were then quantified, with "strongly agree" being a 1, and "strongly disagree" being a 5.

The first ten items in the questionnaire are:

1. This force and motion unit was interesting.
2. The information presented to me in this unit was clear to me.
3. The multimedia presentations my teacher made to the whole class helped me learn.
4. As a whole, I liked learning about force and motion using the computer.
5. The information in this unit was easy to learn.
6. I learned a lot in this unit.
7. The information I learned in this unit is useful to me.
8. I will use the information and skills I learned in this unit in future classes in high school.
9. I think computers will improve high school courses in the future.
10. I think other students will enjoy learning about force and motion using the computer.

The students' responses from the two groups were then compared using the Mann-Whitney U test of significance. Differences will be said to be significant at the .01 level. There are two reasons for using this level of significance

Table 4

Results of Analysis of Data from the Questionnaire Numbers 1-10, With Frequency Distribution for Both Groups Combined

Item Number	*p*	Strongly Agree	Agree	Neither	Disagree	Strongly Disagree
1	.094	5.2%	25.2%	34.8%	16.8%	18.1%
2	.565	6.5%	46.5%	25.8%	11.6%	9.7%
3	.010	16.1%	36.1%	24.5%	13.5%	9.7%
4	.028	18.1%	34.2%	24.5%	14.2%	9.0%
5	.064	9.7%	27.7%	34.2%	18.1%	10.3%
6	.011	3.9%	38.1%	36.1%	14.2%	7.7%
7	.471	5.2%	23.9%	41.3%	18.7%	11.0%
8	.530	12.9%	36.1%	28.4%	14.2%	8.3%
9	.328	35.5%	39.4%	14.8%	5.2%	5.1%
10	.363	20.6%	36.1%	25.2%	9.7%	8.4%

instead of the .05 level. First, there were no covariates that could be used with this ordinal data. Second, random sampling could not be done in a public school setting.

Using the .01 level of significance, there was no significant difference in the responses of the two groups on nine of the ten items. The remaining item needs to be examined further.

The groups responded differently on item number three. The mean for the response to this item for students in the contrast group was 2.28. The mean for the response to this item for students in the experimental group was 2.83. Even though there is a significant difference in the two groups' responses, both groups responded in a positive way to this item.

It is interesting to note that the members of the contrast group had a more positive response to item six when in fact they did not learn more than the experimental group. The mean score on item six was 2.52 for members of the contrast group. The experimental group had a mean score of 3.0.

The responses by both groups were generally positive for this group of items. Items nine and ten had a very positive response from both groups. Overall, there does not seem to be a difference in attitudes regarding multimedia presentation between the two groups.

The third research question asks:

Is any difference found in student perceptions about ease of using computers when one group of students using interactive video with the motion removed is compared with a contrast group using the interactive video in its original form?

Items twelve through fifteen on the questionnaire were used to answer this research question. Item eleven was included to give background information on students' prior computer use. The items are:

11. I had used computers before I started this course.
12. I feel more comfortable using computers now as a result of the force and motion unit.
13. The multimedia presentations helped me to pay attention.
14. I think the computer hardware system is easy to use.
15. I think the force and motion unit (for example, the menu screens, practice questions, games, etc.) is easy to use.

Item fifteen was the only one with a significant difference between the responses of the two groups. The contrast group had the more positive response with a mean of 1.87. The experimental group also had a positive response with a mean of 2.60. Even though there is no significant difference in students' perceptions about computers in general, the contrast group thought the lessons easier to use than the experimental group. With item fourteen specifically asking about hardware, it is logical to conclude that the difference was caused by motion in the presentations.

Table 5

Results of Analysis of Data from the Questionnaire Numbers 11-15, With Frequency Distribution for Both Groups Combined

Item Number	p	Strongly Agree	Agree	Neither	Disagree	Strongly Disagree
11	.126	38.1%	33.5%	14.2%	7.7%	6.5%
12	.226	9.7%	20.0%	46.5%	13.5%	9.7%
13	.164	12.9%	24.5%	37.4%	12.3%	12.9%
14	.030	36.8%	37.4%	12.9%	7.1%	5.8%
15	.001	27.71	38.7%	16.1%	8.4%	9.7%

The fourth research question asks:

Is any difference found in student intentions about taking more courses using multimedia when one group of students using interactive video with the motion removed is compared with a contrast group using the interactive video in its original form?

Items sixteen and seventeen were used to answer this question. The items are:

16. If I could have, I would rather not have used the computer to learn force and motion.

17. If I could I would take other courses using the computer.

There was no significant difference between the responses of the two groups on these two items. Both groups indicated that they would not like to have taken this unit without the computers, and that they intend to take courses in the future using the computer.

Item eighteen was added to the questionnaire to gain insight into which input device students prefer. The item is:

18. I prefer using the mouse instead of the touch screen.

The contrast group used the touch screen exclusively

Table 6

<u>Frequency Distribution for Item 18, Experimental Group</u>

Item Number	Strongly Agree	Agree	Neither	Disagree	Strongly Disagree
18	11.8%	7.8%	34.3%	19.6%	26.5%

and therefore were not asked for their preference. The item was only used with the experimental group, which used a mouse as an input device during most of the unit. The touch screen was used by this group during the introduction to the inertia game near the end of the unit.

Slightly less than 20 percent of the students preferred the mouse over the touch screen. Almost half (46 percent) of the students preferred the touch screen. This might be because of the novelty of the touch screen. If studied for a longer period of time the results may not be the same. Another consideration is that the computer was used by a small group of students versus one computer for each student. Further study in this area may be needed.

SUMMARY AND CONCLUSIONS

When motion was first introduced into presentation media, studies were implemented to determine if it was better than other media that did not use motion. These studies have continued to the present without a definitive answer to the motion vs. non-motion question. One of the problems with many of the studies is that the comparisons were between two different media. This made it difficult to control all of the variables in a study which contributed to varying results. The introduction of interactive video as a presentation method has finally given the researcher the element needed to answer this question. In this study care was taken to control as many variables as possible in a quasi-experimental setting.

The most important question this study addressed was whether there is any difference in student learning between a motion group and a non-motion group. Covariates were selected to compensate for any differences in the two groups. A pretest and posttest was administered to both groups. Analysis of the posttest scores, using the covariates, indicated that there was no difference in learning if motion in the presentation was the only variable.

The remaining three research questions dealt with students' perceptions about multimedia, ease of using computers, and taking more courses using multimedia. There was no significant difference between the two groups' perceptions except that the motion group thought that the software was easier to use.

There are three important conclusions to consider as a result of this study. First, if motion in presentations is not necessary for learning, then multimedia presentations can be developed more economically, resulting in an increase in available courseware in the classroom. Smaller school districts could enter the market while larger districts could use multimedia on a broader scale.

Second, the researcher can now control many of the presentation variables with the use of interactive video or multimedia presentations. This, combined with good research design, will enable researchers to find answers to other questions relating to presentations and student learning.

Third, the use of an interactive digital video format on a local area network should be pursued. This would allow students to progress at their own pace. However, the interaction that was available in the groups would not be present if students have their own computer. This should lead to further research into using interactive video in group settings versus individual use.

Technology will continue to provide new opportunities to improve instruction, but the increase in capabilities must always be balanced against the cost. Sometimes a step backwards in technological capabilities will be the best choice. Interactive video has not become widely used in education because of the high costs involved. This study has shown that the absence of motion in a presentation will not decrease its effectiveness. Courseware developers should carefully consider presentation media that are more cost-effective without surrendering educational integrity.

REFERENCES

Allen, W. H. (1960). Audio-visual communication research. Encyclopedia of Educational Research, 3rd ed.

Atherton, L. L., (1971). A comparison of movie and multi-image presentation techniques on affective and cognitive learning. Dissertation Abstracts International. 32, 3056.

Blake, T. (1977). Motion in instructional media: some subject-display mode interactions. Perceptual and Motor Skills. 44, 975-985.

Borich, G. D. (1989). Outcome evaluation report of the TLTG physical science curriculum, 1988-89. Austin: University fo Texas at Austin

Brody, P. J. (1984, April). Research on and research with interactive video. Paper presented at the Annual Meeting of the American Educational Research Association, New Orleans, LA.

Bunderson, C. V., Olson J. B., & Baillio, B. (1981). Proof-of-Concept Demonstration and Comparative Evaluation of a Prototype Intelligent Videodisc System. Final Report. Orem, UT: Learning Design Laboratories, Wicat Inc. (ERIC Document Reproduction Service No. ED 228 989)

Campbell, D. T. & Stanley, J. C. (1966). Experimental and quasi-experimental designs for research on teaching. Chicago: Rand McNally.

Cushall, M. B., Harvey, F. A., and Brovey, A. T. (1987, February). Research on learning from interactive videodiscs: A review of the literature and suggestions for future research activities. Paper presented at the Annual Convention of the Association for Educational Communications and Technology, Atlanta, GA.

Ferguson G. A. (1981) Statistical Analysis in Psychology and Education (5th ed.). New York: McGraw-Hill.

Geasler, S. (1992, January/February). CD-ROM: A cost-effective alternative. Instruction Delivery Systems, pp. 21-23.

Glick, O. J. (1982). The effects of motion and nursing students' cognitive style on learning spatial concepts and rules. (Doctoral Dissertation, The University of Iowa, 1982). Dissertation Abstracts International, 43/08-A. 2540.

Ghazzawi, M. T. (1980). The effectiveness of repetition, motion and sex of learners on mediated teaching of certain concepts in high school chemistry. (Doctoral Dissertation, Indiana University, 1980). Dissertation Abstracts International, 41/03-A. 907.

Grabowski, B. L. (1989). Reflections on why media comparison studies continue to be conducted--with suggested alternatives. Proceedings of Selected Research Papers presented at the Annual Meeting of the Association for Educational Communications and Technology. Dallas, TX.

Greenfield, E. (1992). Disktop Video: New Technologies Offer New Possibilities. Technological Horizons in Education Journal. 19. 8-14.

Hall, C., Buckloz, E. (1981). Recognition memory for movement patterns and their corresponding pictures. Journal of Mental Imagery, 5(1), 97-104.

Hines, S. J. (1982, May). The effect of mode of visual presentation (motion vs. still) on the brain wave production of college students. Paper presented at the Annual Meeting of the Association for Educational Communications and Technology, Research and Theory Division, Dallas, TX.

Hoban, C. & van Omer, E. (1950). Instructional film research: 1918-1950. Port Washington, N. Y.:Navy Special Devices Center

International Business Machines Corporation. (1989). Audio Visual Connection [Computer program]. White Plains, NY: Author.

International Business Machines Corporation. (1986). InfoWindow Presentation System [Computer program]. White Plains, NY: Author.

Keathely, D. (1989). Discovery through interactive technology. Technological Horizons in Education Journal. 17. 91-93.

Lynch, P. (1991). Multimedia: getting started. (Available from Apple Computer, Inc., 20525 Mariani Avenue, Cupertino, CA 95014).

MacLennan, D. W., & Reid, C. (1964). Abstracts of research on instructional television and films: An annotated bibliography. Stanford: Institute for Communication Research, Stanford University.

Matta, K. F., & Kern G. M. (1989). A framework for research in computer-aided instruction: Challenges and opportunities. Computers and Education. 13. 77-84.

Miller, W. C. (1967). An experimental study of the relationship of film movement and emotional response, and its effect on learning and attitude formation. (Report No.: BR-5-0751). University of Southern California, Los Angeles.

Ponick, D. A. (1986). Animation used as a logical organizer in visualization for concept learning (microcomputer). (Doctoral Dissertation, University of Minnesota, 1986). Dissertation Abstracts International, 47/09-A. 3300.

Rieber, L. P. (1987). The effects of textual, graphic, and animated graphic elaboration strategies and practice on learning from computer-based instruction. (Doctoral

Dissertation, The Pennsylvania State University, 1987). *Dissertation Abstracts International*, *48/10-A*. 2529.

Russell, J. J. (1970). *Comparative effects of seven verbal-visual presentation modes upon learning tasks*. Unpublished master's thesis. University of Southern California, Los Angeles.

Savenye, W. C. (1989). *Evaluation report of student and teacher perceptions and classroom implementation of the TLTG physical science curriculum, 1988-89*. Austin: University of Texas at Austin

Savenye, W. C., & Strand, E. (1989). Teaching science using interactive videodisc: Results of the pilot year evaluation of the Texas Learning Technology Group project. *Proceedings of Selected Research Papers presented at the Annual Meeting of the Association for Educational Communications and Technology*. Dallas, TX.

Schramm, W. (1973). *Big media, little media. A report to the Agency for International Development*. Stanford University, California Institute for Communication Research.

Slee, E. J. (1989). A review of the research on interactive video. *Proceedings of Selected Research Papers presented at the Annual Meeting of the Association for Educational Communications and Technology*. Dallas, TX.

Spangenberg, R. W. (1974, September). The motion variable in procedural learning. *HunRRO Professional Paper*. *14*. 74

Sullivan, J. E., & Rogers, B. G. (1981, April). Listening retention of children as a function of mode of presentation. Journal of Experimental Education. 53. 227-29.

Thorndike, R. L. & Hagen, E. (1986). Cognitive abilities test: examiner's manual. (Available from The Riverside Publishing Company, 8420 Bryn Mawr Ave., Chacigo, IL 60631)

Troth, M. M. (1971). The relative effectiveness of the motion picture and the single still picture presentation modes on facilitating the perception of dynamic action concepts. (Doctoral Dissertation, East Texas State University, 1971) Dissertation Abstracts International. 32. 5680

Wells, R. F. (1970). A study to determine whether general concepts which are commonly taught by motion pictures can be learned as effectively by sequential still photographs during traditional versus self-paced study periods. (Doctoral Dissertation, Purdue University, 1970) Dissertation Abstracts International. 31. 5226