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ABSTRACT

With the emergence of interactive learning technologies, there are many questions which must be addressed concerning young learners. Such sophisticated technology combined with thoughtful instructional design has the potential for both encouraging achievement and stimulating important scholarly attributes such as curiosity and other aspects of motivation. The purpose of this study was to evaluate the effectiveness of variations in learner control (also referred to as lesson control) on children's level of curiosity and learning from computer-based interactive video (CBIV). The lesson content was art education and contained both facts and concepts. It was presented as a videodisc visit to the Everson Museum in Syracuse, New York. A posttest only control group design was employed with 103 first and second grade subjects who were randomly assigned to one of three experimental conditions (designer control, learner control, or learner control with advisement) or a control group. The independent variable for this study was the degree of lesson control which the subjects had over the content. The dependent variables were the posttest scores in achievement and curiosity. Results indicated that children in the learner-control with advisement group scored significantly better in the achievement posttest than did the learner control subjects. They also tended to score higher on certain of the curiosity subscales. (7 tables, 32 references) (Author/BBM)

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# Effects of Variations in Learner Control on Children's Curiosity and Learning from Interactive Video

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## ABSTRACT

With the emergence of interactive learning technologies, there are many questions which must be addressed concerning young learners. Such sophisticated technology combined with thoughtful instructional design has the potential for both encouraging achievement and stimulating important scholarly attributes such as curiosity and others aspects of motivation. The purpose of this study was to evaluate the effectiveness of variations in learner control (also referred to as lesson control) on children's level of curiosity and learning from computer-based interactive video (CBIV). The lesson content was art education and contained both facts and concepts. It was presented as a videodisc visit to the Everson Museum in Syracuse. A posttest only control group design was employed with 103 first and second grade subjects who were randomly assigned to one of three experimental conditions (designer control, learner control, or learner control with advisement) or a control group. The independent variable for this study was the degree of lesson control which the subjects had over the content. The dependent variables were the posttest scores in achievement and curiosity. Results indicated that children in the learner-control with advisement group scored significantly better in the achievement posttest than did the learner control subjects. They also tended to score higher on certain of the curiosity subscales.

## INTRODUCTION

Increasing academic achievement while encouraging a young learner's motivation to learn is an important task for educators. More and more interactive learning materials such as computer-assisted instruction (CAI) and combuter-based interactive video (CBIV) are being developed for learners of all ages. The literature, however, is lacking in empirical research in interactive learning technologies on the effects of learner control (also referred to as lesson control) on children's achievement and motivation. This study used the following definition of learner-control: "Learner control can be described as the degree to which a learner can direct his or her own learning process . . . [The term] most often describes the instructional choices made during a particular lesson. By definition these choices can be made either by the instructional program (as originally defined by the designer) or by the learner during the presentation of materials (Milheim and Asbell, 1988, p.3)." The literature cited herein will include studies which examine degrees of learner control ranging from complete designer or program control (the learner makes no decisions about his/her learning process) to full learner control (the learner is in complete control of the available instructional options).

Most research involving interactive video and learner control have been conducted with sophisticated learners (Balson, Manning, Ebner & Brooks, 1985; Gay, 1986; Hannafin & Colamalo, 1987; Gay & Trumbell, 1988). Issues related to lesson control can have different implications for children (Hannafin, 1984). Although a completely unstructured format many prove challenging and acceptable for many adult learners, children with fewer prerequisite cognitive strategies may feel overwhelmed in an environment with so little guidance. Yet, overly restrictive conditions whether in a classroom setting or a designer controlled interactive video lesson, for example, leave little opportunity to stimulate the important scholarly attribute of curiosity. The literature in the two separate areas of learner control (as it relates to CBIV and CAI) and curiosity was helpful in designing a study which combines these factors.

A number of studies show that positive effects have been achieved with the use of interactive video (for example, Dalton, 1986; Bosco & Wagner, 1988; Hannafin M. & Colamalo, 1988; Abrams, A., 1986). Of particular interest are the studies in which lesson control was a factor. In the Hannafin study, subjects were randomly assigned to one of three treatments: linear control, designer control, or learner control. The designer control and learner control groups performed better than the linear control group. There were no significant differences, however, between the designer control and learner control groups. In the learner control treatment, students were advised up front of the recommended lesson sequence. This could be the reason

why there were no significant differences between these two groups; essentially, all students in the learner control treatment followed the recommended path through the lesson. The potential for individualization and learning efficiency are cited as some of the benefits that accompany greater learner control (for example, Laurillard, 1984; Merrill, 1975). In CAI study involving 98 eighth graders, students performed better under learner control than program control; however, the form of learner control also offered the students a kind of advisement (Kinzie, Sullivan, & Berdel, 1988).

While some evidence exists that even secondary school-aged students can make thoughtful decisions in learner control situations (Robson, Steward & Whitfield, 1988), Carrier (1984) states plainly that there is little confirmation that learners make good choices when given the chance. One study which substantiates this claim showed that students selected fewer than the optimal number of examples of math rules to support their learning when in a learner control treatment (Ross & Rakow, 1981). The learner control group did not perform as well as the program control group which received examples based on need as indicated in a pretest. Time on task may also be a factor contributing to poorer performance as learner control students tend to spend less time in the lesson (Tennyson, 1980; Tennyson & Buttrey, 1980; Johansen & Tennyson, 1983). This would indicate that students choose to exit the lesson before they achieve mastery. Steinberg (1989) suggests that beginning level students in a particular subject area may lack the descrimination skills and subject-specific learning strategies necessary for learner control to be effective.

While studies such as the above have shown learner control to be associated with poorer performance, the addition of some form of advisement to a learner control lesson has been associated with positive results in increasing achievement (Tennyson, 1980; Johansen & Tennyson, 1983; Tennyson, 1984; Tennyson, Christensen and Park, 1984). Johansen & Tennyson (1983) used an advisement strategy which informed subjects of their performance relative to the mastery criterion, and suggested the amount of instruction needed. Subjects then could make their own decisions about the sequence and the amount of instruction based on their perceptual understanding of their needs. In the advisement learner control condition, subjects stayed on task longer than either the partial learner control group or the program control group and exceeded the mastery criterion level established for the lesson. This form of adaptive advisement was also found to be effective, appealing, and efficient in a study by Santiago & Okey (1990).

The appropriate level of learner control may be

contingent on factors such as individual differences or prior conceptual understanding. In one study, subjects with low prior conceptual understanding of a content area made poor decisions relative to sequencing and learning strategies when presented with a high degree of learner control (Gay, 1986). Goetzfried & Hannafin (1985) also found that prior achievement affected performance.

With few exceptions, the studies cited above used college students or adult workers as subjects. Hannafin (1984), cited earlier, notes that older learners may be better able to utilize the learner control options because of their refined cognitive abilities. Younger subjects (elementary or junior high school age) may not yet have the necessary skills to make the most of such a lesson. Therefore, there is a potential danger in generalizing the results of the existing findings to the young learner. This exploratory study is an attempt to expand the base of empirical evidence in the area of learner control and children in a CBIV lesson.

Let us now turn to the subject of curiosity. There are those who would argue that exemplifying curiosity in learning is even more essential than focusing on specific subject areas. One author writes of curiosity, "Without it we are condemned to be ordinary. With it we have a shot at being a part of the future (Weintraub, 1986, p.160)." That children do well in situations in which they are allowed choices and encouraged to learn through active exploration are principles embraced by proponents of the Montessori method of teaching as well as by the National Association for the Education of Young Children (Calvert, 1986). Materials are developed which stimulate a child's interest and curiosity.

Curiosity is often associated with exploratory behavior. Berlyne (1960) identified two forms of exploratory behavior, specific exploration and diversive exploration. Diversive exploration occurs as a person seeks new experiences or relief from boredom whereas specific exploration is encountered in situations in which there is conceptual conflict often resulting in curiosity arousal. The curiosity motivates exploration which resolves the conflict. According to Berlyne, the arousal state that motivates the "quest for knowledge" and is relieved when the individual attains that knowledge is epistemic curiosity (1960, p.274). Curiosity is also described as an arousal state in which the individual desires to know more about self or environment (Maw and Maw, 1966). Cecil, Gray, Thornburg, and Ispa (1985) extend the definition of Maw and Maw and consider curiosity to be an arousal state that leads to and is a prerequisite for exploration, play, and creativity. In proposing a model of teaching and learning, another author defines curiosity as "the individual's desire to

question or investigate (Parker and Engel, 1983)."

In one part of a study in which children were asked to look at pictures and respond by asking questions about the picture, it was found that high curious children asked more questions and had more independent ideas (multiple questions that represented the same idea were counted only once) than low curious children (Maw and Maw, 1964). Another study tested whether epistemic curiosity can be intensified by pre-questioning subjects and determined that there was a significant difference in mean scores between subjects who received questions and those that did not (Berlyne, 1960). Not only did questions heighten epistemic curiosity but they also served to facilitate retention of facts when subsequently subjects encountered the questions associated with the facts.

Stimulating curiosity is an important responsibility of both parents and educators. The hypothesis that high curious children show better overall social adjustment than low curious children was accepted in one study of 577 fifth graders from New Castle County, Delaware (Maw and Maw, 1965). Other findings of the same study included that high curiosity children tend to be more consistent in thought processes as well as more creative and flexible, and high curiosity children seem to be more self-sufficient than low curiosity children.

To operationalize the definition of curiosity, the authors of this study used Maw and Maw's definition as it relates to school children. Maw and Maw went to great lengths to define the construct including informal and formal inquiries, review of the literature, and an examination of the historical development of the term. It seems to incorporate much of what was cited earlier, especially the work of Berlyne. "...curiosity is demonstrated by an elementary school child when he:

1. reacts positively to new, strange, incongruous, or mysterious elements in his environment by moving toward them, by exploring, or by manipulating them.
2. exhibits a need or a desire to know more about himself and/or his environment.
3. scans his surroundings seeking new experiences.
4. persists in examining and exploring stimuli in order to know more about them (p.31)."

This study focused on #1, #2, and #4 above. Number 3 is associated more with diversive curiosity whereas this study was more concerned with epistemic curiosity.

Learner control and curiosity is a challenging issue. For example, if the child is given a learner controlled lesson in order to facilitate curiosity and exploration, might he/she flounder for the lack of

direction? Given a totally designer controlled lesson, might the child's potential to be curious about learning be stifled? Can interactive learning technologies such as CBIV be utilized to both stimulate curiosity and provide adequate direction and guidance? The purpose of this study is to investigate the comparative effectiveness of variations in learner control on children's curiosity and learning about art.

The null hypotheses for this experiment are (note that the hypotheses relate to content-specific achievement and curiosity):

1.) There will be no significant difference in achievment scores demonstrated in a posttest between control group subjects and subjects in any of the three experimental groups.
2.) There will be no significant difference in curiosity demonstrated in a posttest between control group subjects and subjects in any of the three experimental groups.
3.) There will be no significant difference in the achievement level of students receiving a designer control lesson and comparable students receiving a completely learner control or learner control with advisement lesson.
4.) There will be no significant difference in the achievement of students receiving the completely learner control lesson and comparable students receiving a learner control with advisement lesson.
5.) There will be no significant difference in curiosity of students receiving a designer control lesson and comparable students receiving the same lesson in a completely learner control or learner control with advisement condition.
6.) There will be no significant difference in curiosity of students receiving a completely learner control lesson and comparable students receiving a learner control with advisement lesson.
7.) There will be no significant differences found in the correlations between achievement and any of the curiosity measures.

## METHODS

### Subjects

The sample consisted of 103 first and second grade students who attended a moderately sized public elementary school in upstate New York. Only individuals who were given parental permission participated in the study. No attempt was made to group subjects by ability or reading level. Two subjects were dropped from the study; one had severe mental and physical handicaps which

made it impossible for the subject to respond to the touch screen, and the other did not participated due to illness.

Description of Lesson

An interactive video lesson was developed using a Sony Laservision videodisc player interfaced with a MS-DOS compatible computer, a touch-sensitive screen, and headsets. The lesson was programmed using ICON Author. A combination of motion video, slides, and computer graphics was used in the presentation. A subject matter expert in art education provided the content for the treatments. The lesson was designed as a visit to an art museum. The subject matter expect had previously served as Curator of Education for the museum and it was possible to acquire many visuals for the treatments. Prior to the lesson, each subject had the opportunity to practice using the touch screen. The lesson itself included a general introduction and three segments on ceramics, sculptures, and paintings. The content involved both facts and concepts and the lesson provided opportunities for practice, feedback, and remediation. The subject matter expert reviewed the posttest for content validity and determined that it adequately represented the content presented in the lesson. Another expert from Syracuse University Division for the Study of Teaching who works with talented and gifted children reviewed the posttest for evidence that it contained measures which addressed the aspects of curiosity as defined by the study.

The lessons were designed for subjects with limited reading experience and contained no text. A narrator was used where text would have been necessary. The use of a touch screen in place of a keyboard further simplified the young learners' task of responding.

CBIV Instructional Treatments

Three treatments were developed for this study: designer control, learner control, and learner control with advisement. All treatments contained the same essential content and all provided opportunities for practice, remediation, and feedback. Two instructional designers provided judgements on the appropriateness of the treatments in reflecting the three constructs as described below.

*Designer Control*: Subjects receiving the designer controlled lesson followed a linear path through the lesson. These students received practice items, feedback, and were automatically branched to a remediation segment after a second incorrect response. Following remediation, the practice question was posed again; if the student still responded incorrectly

he/she was given the correct response and moved to the next item.

*Learner Control*: In the learner control group, subjects were given the opportunity to sequence the material in any way they preferred. Whether to review segments where practice items had been missed was also a decision left to these subjects. Students had the opportunity to omit entire sections or sub-sections, or opt out of the lesson altogether, if they so desired. Students controlled their own pace through the lesson. Additionally, subjects in this group could freeze images on the screen. We called this a "STOP and LOOK" routine since whenever a particular icon was present, the subject could freeze the image on the screen to explore it more closely. Subjects were familiar with the icon since they had been exposed to the icon and its meaning in the pre-lesson practice session.

*Learner Control with Advisement*: Subjects in the learner control with advisement group received the same opportunities to explore the lesson as the completely learner control group. However, certain "advisement" strategies were also employed in this group which provided some guidance while at the same time encouraged curiosity. For example, if a student decided to skip out of a section, he/she would receive this advisement: "Are you sure you want to end the lesson? This next section is very interesting. You might really enjoy it" or "Aren't you going to wonder about what you'll be missing?" Care was taken not to instill fear of evaluation as a motivation to continue the lesson since it would not be conducive to stimulating curiosity. While subjects in the learner control group could take advantage of the "STOP and LOOK" routine whenever they saw the associated icon appear on the screen, subjects in the learner control with advisement group were advised by the narrator to take advantage of the "STOP and LOOK" routine to explore the images more closely. The final form of advisement was in the form of a "STOP & THINK" routine which generally was preceeded by a question to arouse curiosity. For example, after presenting some interesting information about a painting that generally intrigues young children, this question was posed: "Do you wonder how you can tell this from looking at the painting? STOP and THINK about it! Then, touch the screen when you are ready to find out." All audio and visuals were programmed to freeze at that point and would resume only when the subject touched the screen to proceed. Since the learner had no control over the freezing of the screen, this was considered an advisement strategy and not a learner control option.

Other than the advisement, the instructional content remained the same as all other groups.

## Research Design and Data Analysis

To test the hypotheses, this study employed a posttest only control group design. Subjects were randomly assigned to one of three experimental conditions in which they received a lesson followed by a posttest, or to a control group in which they received only the posttest. The research design is diagramed in Figure 1.

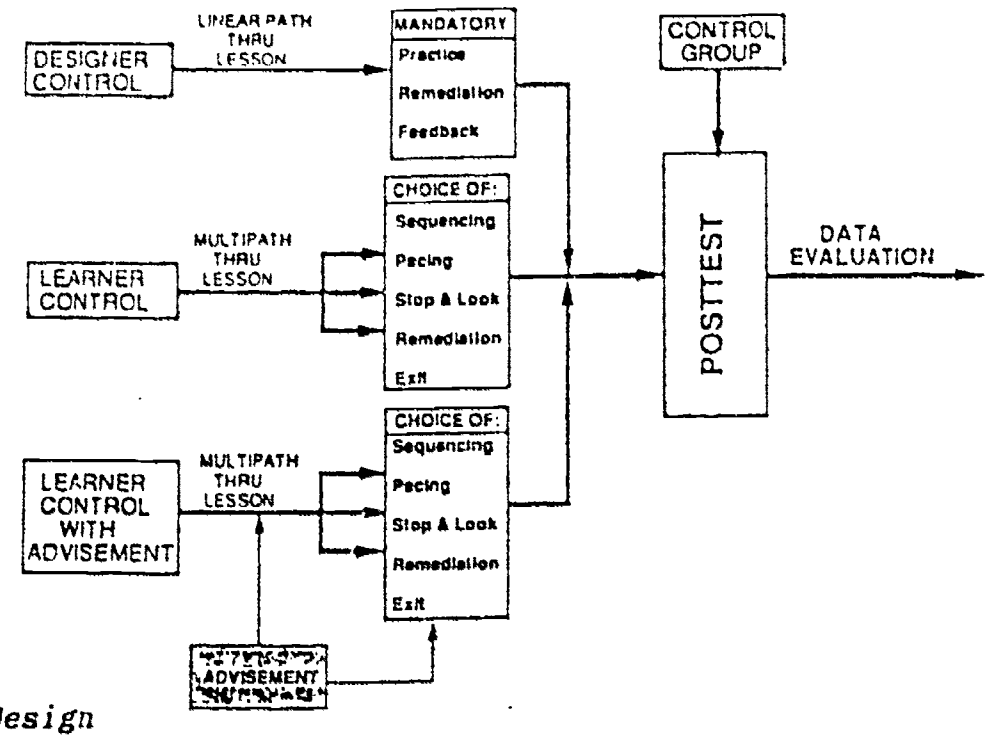


FIGURE 1
*Research Design*

Random assignment and the control group were used to control for differences in prior knowledge of museums and ability level. One-way analysis of variance was used to determine differences among the four groups on achievement (Hypotheses #1, #3 and #4) and again for curiosity (#2, #5 and #6). A .05 probability level was selected to determine significance. Since this was an exploratory study, the first in a series, a least conservative measure, Tukey's Least Significant Differences (LSD) test, was selected to analyze the differences between means in the follow-up tests.

Finally, correlations were run to test Hypothesis #7 using Pearson Product Moment Correlation Coefficients to determine the relationship between the three curiosity measures and achievement.

Procedure

Subjects were administered the treatments individually. In a pre-lesson exercise, a treatment administrator familiarized the subject with how to use the touch screen and introduced several icons they would encounter during the lessons.

Posttest responses were recorded both on audio tape and noted on a paper and pencil instrument. In one sub-section, the computer was used to track responses.

A number of provisions was made to protect the study's internal validity. Subjects were blind to which treatment they were receiving and were not informed about the nature of the experiment. So that all subjects would have the sense that they had received the same experience, all subjects including the control group participated in the same non-academic interactive video activity following the posttest. Since all the treatments were somewhat novel (i.e. all were interactive) and all ended with the same "fun" activity, the possibility for the Hawthorne effect to occur was reduced. To control for experimenter bias the authors of this study did not administer the treatments. Three administrators were selected to introduce the children to the lesson and to interview them for the posttest. The administrators were assigned treatments on a rotation basis so no one was responsible for just one treatment. All administrators participated in a training session on treatment and posttest procedures prior to the experiment and a beta test was conducted to assess the inter-rater reliability of the test. Raters came to 100% agreement on the rating by the end of the training session. There were three complete interactive video stations set up at the school which allowed for three students to participate at one time. The lessons and the posttest were reviewed by experts for evidence that the constructs defined in the study were adequately represented in the lessons and instruments.

Measurement

Part of the challenge of designing measures to test the effectiveness of the treatments had to do with the type of content that was to be presented. "Pat" answers would be inapproriate in an area such as art education and museums. In measuring achievement, we needed to devise an instrument that gave the child the opportunity to be more expressive while demonstrating that he/she had indeed acquired the new information. In measuring curiosity towards the content, an instrument that gave the child more freedom to explore possible answers was needed. Maw and Maw (1964) developed a number of tests to measure curiosity, one of which included presenting pictures to students. The student was be given one statement about the picture and then

asked, "What else would you like to know about this?" Although Maw and Maw's first preliminary study showed that fewer questions were asked by students when too many pictures were shown together, their second study was modified to include fewer pictures. In that study, it was found that the mean number of questions asked and the mean number of independent ideas expressed in the questions was greater for the high curious children than for low curious children. This type of test seemed appropriate especially in the content area of art where presenting images would seem natural.

*Achievement*: The first section of the posttest, then, consisted of 8 items which measured achievement. To control for order effect and fatigue, the computer was programmed to randomly generate the test items for each subject. Because of the open-ended nature of the questions, we found that it was necessary to distinguish between responses which were specific to the lesson (lesson-related) and those which were not (lesson-unrelated). The control group had the opportunity to list numerous responses which had no bearing on the actual instruction (for example, in an item which represented a concept such as portrait, the control group child could increase number of responses merely by stating the various objects in the picture). To a lesser extent, subjects in other groups also provided such unrelated responses in addition to lesson-related responses. In the achievement measure, the subject was presented video still images of aspects of the museum encountered in the lesson such as paintings, sculptures, textures, and ceramics. For each item, the administrator requested the subject to tell him/her everything the subject knew about the picture. Responses were recorded on a paper and pencil instrument and also audiotaped. After responding, the subject touched the screen to proceed to the next image. The rationale was that prior to the treatments, the subjects would demonstrate little knowledge of the material and have limited vocabulary. Following the treatment, the subjects should be capable of demonstrating more and richer responses. For example, in the control group, a student might refer to a painting of Niagara Falls as "some waterfalls" whereas post-treatment response in the experimental condition might be "That's a landscape painting. It shows the natural scenery." The instrument was devised to take somewhat qualitative data and give it points based on 1) increased use of vocabulary and understanding of concepts introduced in the treatment 2) increase in the number of responses 3) recall of specific information.

*Curiosity*: Three sub-scales measured curiosity toward the content area. Subscale A was curiosity towards museums, Subscale B represented the number of questions the child generated when presented with a previously

unencountered image, and Subscale C measured the time a child persisted in exploring new stimuli (indicated by the length of time the subject examined a new image before moving on to the next). Subscales B and C measured aspects of curiosity as defined in parts 1, 2, and 4 of the construct. As in the achievement section of the posttest, the computer was programmed to randomly generate the test items for subscales B and C. It should be noted that the number of items in the subscales was not large. This was a decision based on Maw and Maw's discovery that the more items asked the fewer the number of questions which were elicited from the learner. In Subscale B, the subject was rated on the number of questions they asked the administrator and on the number of independent ideas expressed by those questions. In other words, the more questions and more ideas--the more curious the subject had become towards the content area. Although the images presented in the posttest were art-related, subjects had never encountered the specific images in the treatment. The increase in questions, therefore, should not be related to the increase in information they had acquired, but rather an increase in curiosity brought about the treatment of the content.

Another measure of curiosity for this study which pertains to exploring new stimuli was the length of time a student stopped the videodisc in the STOP and LOOK mode during the lesson itself. This information was tracked by the computer. Since students in the designer control treatment did not experience this control option, there were five STOP and LOOK items on the posttest for all groups. These items comprised Subscale C.

The computer was also used to track each student's progress through the lesson. The authors plan to use this information to assess which learner control attributes of the interactive video technology the students' utilized most to explore the content, and which treatment was most conducive to encouraging curiosity about the content. Through analysis of the child's path through the lesson, we will also determine how thoroughly the child explored his path through the lesson (which relates to both #1 and #4 in the operationalized definition).

## RESULTS

*Achievement:* Differences between the treatment groups on achievement were analyzed on two variables, lesson-related responses and lesson-unrelated responses using one-way ANOVA. Descriptive results for the lesson-related responses are reported in Table 1. Means ranged from a low 5.00 for the control group to a high 16.08 for the learner-control with advisement group. Differences between the means for each treatment group on the two

variables are shown in Figures 2-4.

TABLE 1
Means and Standard Deviations for Lesson-Related Achievement Scores By Treatment Group

| Treatment Group | N | M | SD | RANGE |
|---|---|---|---|---|
| Learner Control with Advisement | 25 | 16.08 | 6.54 | 4-35 |
| Learner Control | 27 | 13.35 | 4.49 | 3-23 |
| Designer Control | 25 | 13.89 | 4.98 | 4-22 |
| Control | 24 | 5.00 | 2.38 | 1-9 |

TABLE 2
Results on ANOVA by Lesson-Related Responses

| Source | df | SS | MS | F | p |
|---|---|---|---|---|---|
| Treatment | 3 | 1725.10 | 575.03 | 24.49 | .0001 |

Results from the ANOVA indicated a difference between treatments at $p<.0001$ (See Table 2). Follow-up tests showed that differences were found, as expected, between the control group and all three experimental groups. Of interest to this study was the difference between the learner-control with advisement group scoring significantly higher (+2.731 $p<.05$) than the learner control group. No significant differences were found between the designer-control group and the learner-control or the learner- control with advisement groups. Learner-control with advisement lessons, therefore, resulted in the greatest amount of achievement followed by designer-control and learner-control, and the control group.

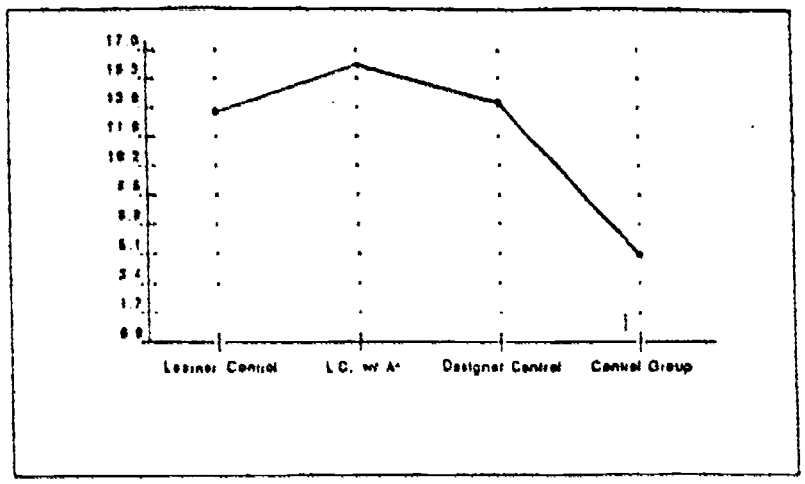


FIGURE 2
Mean Scores on Lesson-Related
Achievement by Treatment Group

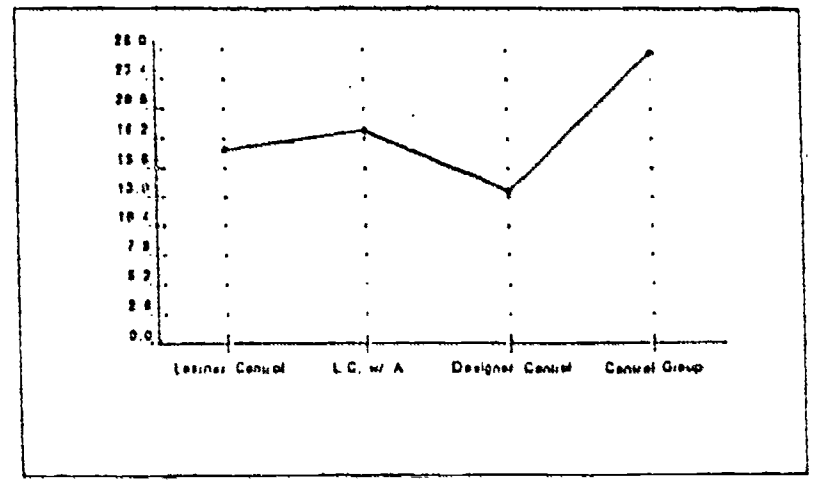


FIGURE 3
Mean Scores on Lesson-Unrelated
Achievement by Treatment Group

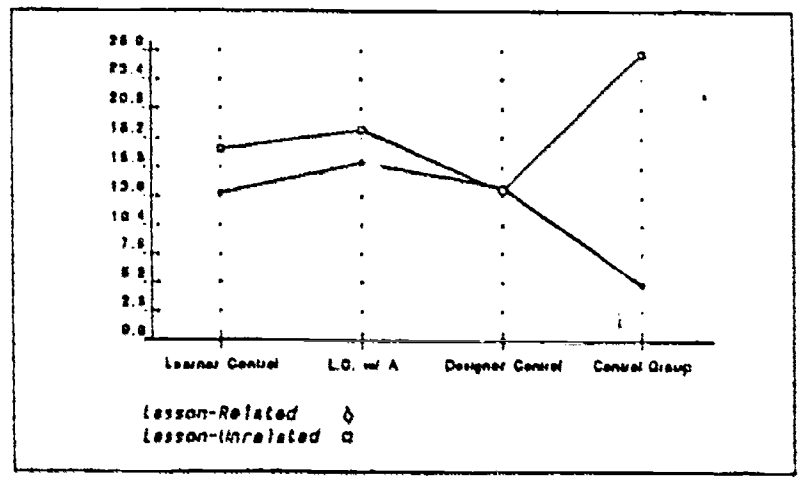


FIGURE 4
Mean Score Achievement Comparisons

Descriptive results for lesson-unrelated responses are reported in Table 3. Differences between the means for each group are shown in Figure 3. Means for unrelated responses ranged from a low of 13.55 for designer-control and a high of 25.76 for the control group. The spread of these responses was quite different than for the lesson-related responses. This spread is accounted for by the control group. Since the control group did not have the lesson, it is reasonable that the number of irrelevant (unrelated) responses would be greater than relevant (lesson-related) ones. Except for the expected tremendous difference in the control group, the analysis of the lesson-unrelated achievement scores yielded similar trends as the lesson-related scores as can be seen in Figure 4.

Results from the ANOVA indicate a difference between the treatments at $p<.0034$ (See Table 4). Follow-up tests showed that differences were found only between the control group and all other experimental treatments. No other significant differences were found.

TABLE 3
Means and Standard Deviations for Achievement Scores by Lesson Unrelated Responses by Treatment Group

| Treatment Group | N | M | SD | Range |
|---|---|---|---|---|
| Learner Control with Advisement | 25 | 18.96 | 12.79 | 5-53 |
| Learner Control | 27 | 17.16 | 9.84 | 3-45 |
| Designer Control | 25 | 13.55 | 9.25 | 2-39 |
| Control | 24 | 25.76 | 13.68 | 10-70 |

TABLE 4
Lesson-Unrelated ANOVA Results

| Source | df | SS | MS | F | p |
|---|---|---|---|---|---|
| Treatment | 3 | 1922.35 | 640.78 | 4.85 | .0034* |

* Indicates significance at <.05

*Curiosity:* Analysis of the difference between the groups on curiosity was conducted on each subscale, Subscale A (curiosity towards museums), Subscale B (number of questions generated) and Subscale C (persistence in exploring new stimuli). Subscale B was also further divided into total number of questions generated (Subscale B1) and number of independent ideas represented by those questions (Subscale B2). Descriptive results for all curiosity subscales are reported in Table 6.

TABLE 5
Means and Standard Deviations for Curiosity Measure Subscales by Treatment Groups

| | Subscale A | | | Subscale B1 | | | Subscale B2 | | | Subscale C | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Trt | N | M | SD | N | M | SD | N | M | SD | N | M | SD |
| LC | 26 | 3.42 | 1.77 | 27 | 13.38 | 7.17 | 27 | 12.89 | 6.81 | 24 | 57.58 | 37.20 |
| LC/A | 23 | 3.74 | 2.32 | 25 | 16.76 | 6.39 | 25 | 15.56 | 6.06 | 23 | 55.57 | 29.25 |
| DC | 22 | 3.18 | 1.33 | 25 | 14.60 | 9.48 | 25 | 13.96 | 9.22 | 23 | 52.70 | 23.21 |
| C | 20 | 2.60 | 1.14 | 24 | 15.90 | 9.24 | 24 | 14.93 | 7.98 | 22 | 75.97 | 45.02 |
| TOT. | 91 | 3.26 | 1.74 | 101 | 15.12 | 8.13 | 101 | 14.30 | 7.50 | 92 | 60.25 | 35.16 |

Results from the ANOVA for each subscale are reported in Table 6. No significant differences were found in curiosity as measured by curiosity towards museums (Subscale A), total number of questions generated (Subscale B1), number of independent ideas represented by the questions (Subscale B2), or persistence in exploring new stimuli related to art (Subscale C).

TABLE 6
Results of ANOVA by Subscale

| Source | df | SS | MS | F | p. |
|---|---|---|---|---|---|
| Subscale A | 3 | 14.82 | 4.94 | 1.66 | .1816 |
| Subscale B1 | 3 | 170.22 | 56.74 | .85 | .4676 |
| Subscale B2 | 3 | 105.78 | 35.26 | .61 | .6091 |
| Subscale C | 3 | 7413.94 | 2471.3 | 2.07 | .1100 |

Follow-up tests showed significant differences only on Subscale A between learner-control with advisement and the control group, and for Subscale C (persistence) between the designer control and the control group. Further examination yielded an interesting although an only partially significant trend on the last difference. The mean time persisted in attending to new stimuli decreased as the amount of instructional control increased. The most curious students on this measure were the control group students who had not even been exposed to the lesson treatment. The least curious were subjects in the designer control lesson who had the greatest amount of

instructional control imposed on them.

*Achievement and Curiosity*: Lesson-related, lesson-unrelated, and total achievement scores were correlated with each curiosity subscale measure and are reported in Table 7.

TABLE 7
Correlation Coefficients Among Achievement and Curiosity Measures

| | CURIOSITY | | | |
|---|---|---|---|---|
| ACHIEVEMENT | A | B1 | B2 | C |
| Lesson-Related | .29* | .26* | .22* | .02 |
| Lesson-Unrelated | .32* | .47* | .52* | .11 |
| Achievement Total | .47* | .59* | .62* | .12 |

(* indicates significance at p<.001)

The relationship between Achievement and Curiosity measuresB1 (total number of questions generated) and B2 (number of independent ideas represented by the questions) were the only positive correlations.

## DISCUSSION

This study proved more useful in examining links between achievement and learner control among very young children than it was in learning more about the relationship between learner control and curiosity relative to specific content. Achievement in terms of recall was of course much easier to measure in this study. Examining curiosity for the content, on the other hand, proved much more difficult and the results in the area of persistence almost seemed counter-intuitive.

In lesson-related achievement, the learner-control with advisement lesson resulted in the greatest amount of achievement followed by designer-control and learner-control. Naturally, the control group, having received the posttest only, received the very lowest scores. What this seems to indicate is that some structure to a lesson in the form of advisement was better than allowing this age group free reign in discovering the content. Learner-control with advisement also provided the most opportunity for interaction which has been shown in previous studies to result in greater learning of factual information (Schaffer and Hannafin, 1986). It was expected that the learner-control group with no guidance whatsoever would have the lowest achievement scores, but in actuality, this group's scores were only marginally less than those of the designer control group. Whether what was lost in the structured presentation of content provided by the designer-control lesson was made up for in the

learner-control lesson via opportunities to explore at will thereby increasing interest and recall of the information remains unanswered at this point. A thorough analysis of the students' paths may provide further clues on this point.

The young learners who took the learner-control with advisement lesson also generated the most questions and the most independent ideas in those curiosity subscales followed by learners taking designer-control and learner control lessons respectively. The control group settled somewhere in the middle reflecting an average curiosity level. There are several possibilities for the overall lack of significant results in these curiosity subscales. Perhaps, the construct was not adequately captured in the measures which were designed specifically for this study (although they were adapted from previous studies). It could also be that additional strategies which would encourage curiosity need to be incorporated into the lessons themselves, and that the differences between treatments with respect to those strategies need to be strengthened in order to increase the chances of sensing an effect.

Curiously (no pun intended), there was one interesting significant difference related to curiosity between the control group and all other groups. The finding involved the persistence subscale and initially seemed counter-intuitive. It indicated that students who were not exposed to the art education content were more apt to attend longer to stimuli that was totally new to them (that is, although all students were attending to new stimuli at this point in the posttest, the other groups had at least been exposed to the subject matter area in the treatment and thus the type of stimuli was at least familiar). Naturally, one might argue a rival hypothesis for this result being attributable to fatigue or even boredom. The students in the control group were given the posttest only while the others had been through a lesson as well and may well have been ready to move on by this time. The trends indicated by these scores among the four groups, however, may be worth further investigation for if, in fact, learners persist less in attending to new stimuli as instructional control increases, this would suggest potential instructional strategies for young learners. The generalizability of the study is of course limited in that the results were specific to the subject matter domain.

Possibly, a future study using the same interactive video materials, with modifications, should be conducted in which existing validated reliable measures of general curiosity are taken. A study of this sort would provide the opportunity to investigate the differences between high curious and low curious children regarding their preference for and achievement in various learner control conditions. The findings of such a study could provide information to designers of CAI and CBIV to tailor instruction and opportunities for learner control to the intrinsic needs of the students. For example, a low-curious student may hypothetically perform better in a more structured format such as designer-control but certain strategies might then be embedded in that treatment specifically to encourage curiosity

in the low curious child.

Is there an optimal balance between amount of instructional control and achievement and motivation (eg. curiosity)? What other factors may be involved such as cognitive styles, general curiosity, preferences, etc.? What can educators and designers of interactive learning technologies do to encourage children's quest for knowledge and intrinsic motivation to learn? The few significances that were found in this exploratory study combined with the trends in means indicates to us that more research with young learners is warranted in the area of learner control and achievement and motivation.

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