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ABSTRACT

Previous studies indicate that only 6 percent of the nation's population possess the minimum level of understanding of science and technology needed to function minimally as citizens and consumers. Many educators speculate that scientific illiteracy originates in elementary school classrooms, not from intellectual inferiority, but rather from specific teacher attitudes. Under the assumption that analytical ability and spatial ability are measurements of the same cognitive skills, a pilot study examined those skills as measured by the Learning Style Profile, with pre- and post-test scores for three treatment groups and one control group from a total of 24 undergraduates with an elementary education major. The first treatment group was exposed to an animated video activity; the second treatment group participated in a cube comparison test (flexibility of closure) developed from the Educational Testing Service's Kit of Factor Referenced Cognitive Tests; the third treatment group was involved in both of these activities; and the control group was not exposed to either activity. No significant differences were found across or within the groups on the pre- and post-test scores. It is hypothesized that a larger study population, a longer test of spatial ability, and a longer treatment will detect improvement in spatial ability. (JJK)

Paper and Cube Interventions Preceded By a Three Dimemsional Computer Graphics Animation To Improve Spatial Ability Among Elementary Education Majors

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INTRODUCTION

With the increasing number of current jobs demanding scientifically competent people, science educators are alarmed at the large population of persons who are scientifically illiterate. According to Miller only 6% of adults possess the level of understanding of science and technology needed to function minimally as citizens and consumers (Miller, 1989). Gabel and Enoch (1987) have indicated that the source of this issue may originate in the classroom from the time students begin their educational experience. For one reason or another, the educational system is losing many students from science fields as they get into high school and into college. "These students are not generally intellectually inferior to their classmates; rather they have never been encouraged to think iconically and have never developed the ability to reconstruct in their minds three-dimensional models of two-dimensional illustrations" (Lord, 1985a). That is, they are deficient in their spatial cognitive skills.

Perhaps it is crucial for elementary teachers to possess the ability to think spatially. "Theorist have found that one's cognitive style affects one's interests, and therefore involvement, in specific subject areas" (Lord, 1985b). In other words, if teachers do not encourage their students to think iconically and provide assignments which will enhance their spatial-visualization skills, then science educators cannot expect their pupils to obtain a true understanding or even show interest in the science courses. It is critical for science educators to recognize the importance of spatial visualization skills to promote success in academic science courses.

DEFINITION OF SPATIAL ABILITY

Presently, there is a great deal of uncertainty associated with the term spatial ability. Until recently, spatial ability as a cognitive skill has been thought of independently from analytic skills as described by Bloom (1956).

Current research indicates that analytic ability may in fact be certain aspects of spatial ability. Keefe (1988) defined spatial and analytic ability as follows:

> Spatial skill assesses two generally accepted components of spatial reasoning - pattern recognition is the capability of identifying a pattern, remembering it, and discriminating it from other similar patterns. Spatial rotation is the capacity to rotate objects in the imagination.
> Analytic skill is the capability of identifying figures concealed (embedded) in a complex background field.

Educational Testing Service's Kit of Factor Referenced Cognitive Tests (Ekstrom et al., 1976) lists a test (Flexibility of Closure) that accesses the ability to disembed an image from its environment and ignore extraneous information under spatial measures. In addition, Lord (1985b) used this particular test to determine the effects of a intervention on the student's cognitive processing of spatial information. Furthermore, a factor analysis conducted by Melear (1990), showed that two components of spatial ability overlapped with some components of analytic ability on the Learning Style Profile.

Therefore in this study, analytic and spatial ability are considered to be measurements of the same cognitive skills, although we examine them separately prior to combining them.

RESEARCH HYPOTHESIS

Spatial and analytical cognitive processing skills, as measured by items on the Learning Style Profile, of elementary education majors, will improve significantly as a result of various cube activities.

DESIGN AND PROCEDURE

The experimental design was developed as a 2 x 2 factorial design consisting of three different treatments and a control group. The first of the three treatments consisted of a video activity, where the subjects viewed a oneminute lesson without narration illustrating the principle that, when the edges of a cube are doubled, the volume is increased by a factor of 8. The animation was designed to illustrate the relationship of an edge to the volume of a cube (Cambre, Belland, and Baker, 1986). After the video illustration was presented, the subject was asked to explain, while using as many details as possible, exactly what he or she had just seen on the video tape. After they responded, the subjects were asked to demonstrate this by actually assembling small wooden cubes to mimic what they saw.

The second treatment group participated in a cube comparison test which was developed from the Educational Testing Services Kit of Factor Referenced Cognitive Tests written by Ekstrom, French, and Derman (1976). Various numbers and letters were placed on small wooden cubes where some could be similar, whereas others were different from each other. The entire test consisted of 13 pairs of cubes with two of these pairs used as examples. After the subject answered the question by indicating whether the cubes were similar or different from one another, their response was keyed into an answer sheet. Furthermore, the subject was asked to explain their reasoning behind their answer to eliminate guessing. The third treatment group received both previous treatments mentioned with the video activity preceding the cube comparison test. Finally, a fourth group was assigned as the control group and did not participate in any of the above treatments.

In order to discover if there was an effect of the video activity preceding the cube comparison test, data from the cube test only group and data from the video plus cube test group were evaluated. A table and graph of scores from the two groups which received the cube comparison test (cube test only group and video plus cube test group) are presented in Table 1, Figure 1 and Figure 2.

A total of 24 elementary education majors participated. Pretest and posttest scores were calculated using portions of the Learning Style Profile as the instrument (Keefe, 1988). More specifically, the pretest and posttest consisted of five questions listed under analytic skills and five questions listed under spatial skills. Analytic items were classified as embedded figures. Spatial items were of two types: pattern recognition and spatial rotation. Individual group means for pretest and posttests were calculated for analytic and spatial scores separately (Table 2) and then summed together and recorded (Table 3). A graph of these means, comparing pretest scores with posttest scores for each treatment grcup are illustrated in Figure 3.

FINDINGS AND RESULTS

Scores for the group receiving the only cube test were distributed as a normal bell curve where the scores ranged from 54.55 to 90.91 with three subjects in the mid range (72.73). Scores for the group receiving the video activity before the cube comparison test were skewed in the direction of one standard deviation above the mean score of the cube comparison test only group. Furthermore, the scores of the group receiving the video activity before the cube comparison test ranged from 72.73 to 81.82 with the minimu. score occurring at the mean score of the group receiving the cube comparison test only. There were no significant differences found between the treatment groups. However, the implication of these findings is that subjects receiving the video pre-treatment before being asked to perform manually with cube activities scored higher.

Although there were no significant improvements in scores as a result of a particular treatment, all scores improved with the exception of the analytic score for the cube test only group, which declined 1.88 points, and the spatial score for the video only group, which decreased 1.67 points. The spatial score for the cube test only group improved the most of all eight scores (by 3.88 points).

Examination of pretest scores for different treatment groups, show that the random assignments did not yield homogeneous groups. This is illustrated by the large range of pretest scores. The data also support an increase in all posttest scores from the initial pretest scores, with the group receiving both the video and cube test together increasing the most.

CONCLUSIONS

Spatial cognitive processing skills of elementary education majors were not enhanced by the exposure to various cube activities and video treatments as measured by the analytic and spatial items on the Learning Style Profile. However, the treatments hold promise. Many researchers have found spatial aptitude can indeed be enhanced through carefully constructed learning sessions (Lord, 1985b, Gabel and Enoch, 1987). The present study was a pilot study to establish an effective treatment using an amplified cube comparison treatment. The authors believe that the video preceding the cube comparison test amplified the effectiveness of the performance on the latter. It is also hypothesized that a larger study population, a longer test of spatial ability, and a longer treatment will detect improvement in spatial ability. Therefore, a larger study with the video and cube comparison test combination is planned.

In this study, improvement due to certain treatments have occurred, but the failure to detect improvement could be the result of several factors. First, the instrument used to measure improvement (analytic and spatial portions of the Learning Style Profile) may not have been sensitive enough to detect any improvement. Each section consisted of only five questions, combining for a total of ten questions for the entire instrument. Secondly, the pretest scores were so near the maximum level to begin with that little room for improvement existed. Third, the treatment groups may have been too small.

IMPLICATIONS FOR FUTURE STUDY

As a result of this pilot study, another larger study is in progress, based on the likelihood of improvement of spatial ability due to a video pre-treatment using the more standard Ekstrom cube comparison test. Appropriate alterations will be made. A new longer test instrument of spatial ability will be used from the Educational Testing Service Kit of Factor Referenced Cognitive Tests (Ekstrom et al., 1976). Furthermore, improvement of all the treatments will occur by increasing them in length and frequency. There will also be a focus on the treatment which utilizes both the video pre-treatment activity and the cube comparison tests together, because the pilot study indicates that acceleration of cube activity manipulation occurs as a result.

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TABLE 1

COMPARISON OF CUBE TEST SCORES FOR TWO TREATMENTS
CUBE TEST ONLY vs. BOTH VIDEO AND CUBE TEST

TREATMENT			
CUBE TEST ONLY		BOTH VIDEO AND CUBE TEST	
SUBJECT #	SCORE	SUBJECT #	SCORE
1	54.55	4	72.73
2	63.64	2	81.82
3	72.73	3	81.82
4	72.73	1	81.82
5	72.73	5	81.82
6	81.82	6	81.82
7	90.91		

COMPARISON OF CUBE TEST SCORES FOR TWO TREATMENTS

CUBE TEST ONLY vs. BOTH VIDEO AND CUBE TEST

FIGURE 1

Display of Cube Test Only Performance

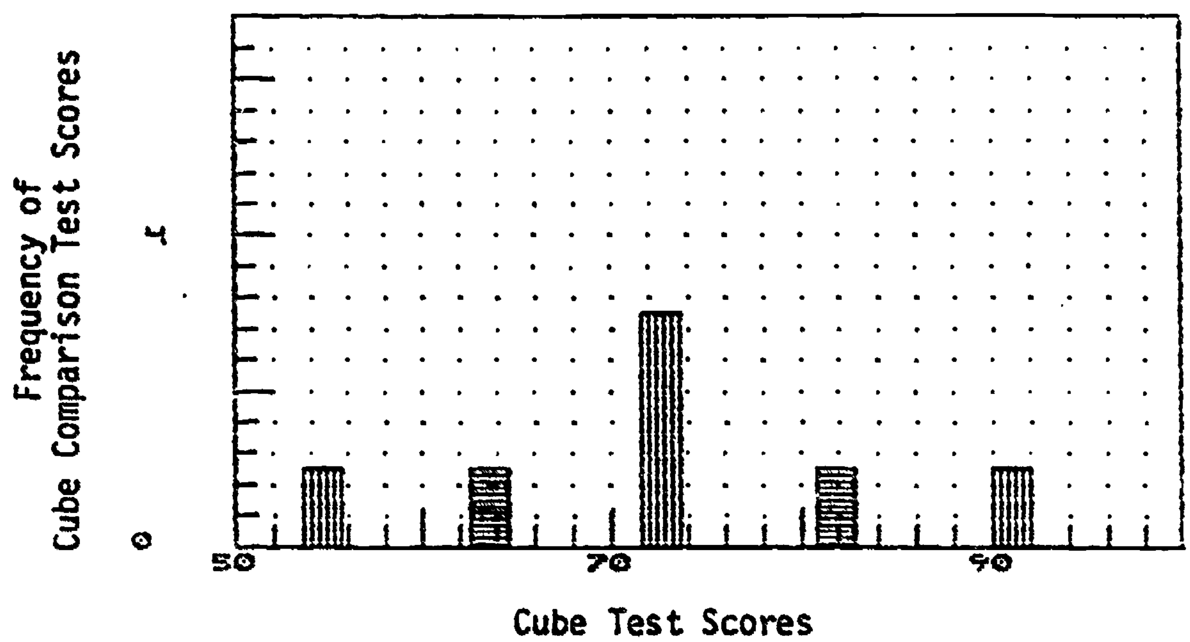


FIGURE 2

Display of Video Pre-treatment and Cube Test Performance

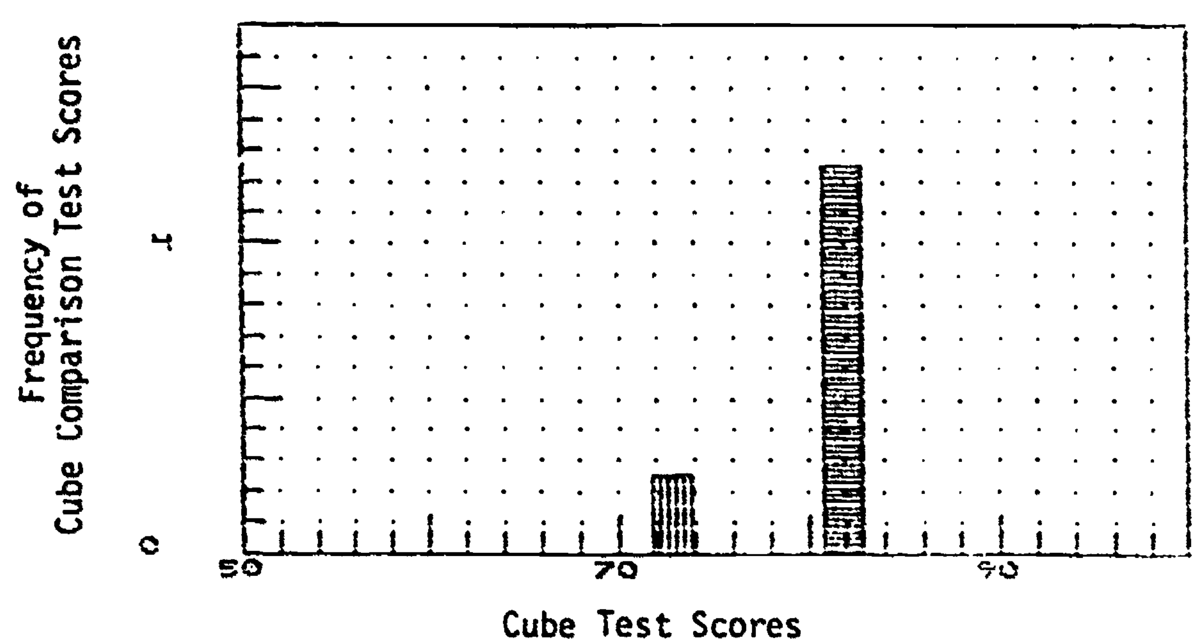


TABLE 2

MEANS OF ANALYTIC SCORES AND SPATIAL SCORES
FROM THE LEARNING STYLE PROFILE

TREATMENT	PREANA	POSTANA	PRESPA	POSTSPA
Video Only	62.333	64.667	53.333	51.667
Cube Test Only	53.429	51.571	53.714	57.571
Both Video and Cube Test	59.000	60.167	60.333	61.333
Control	53.375	56.875	54.250	56.125

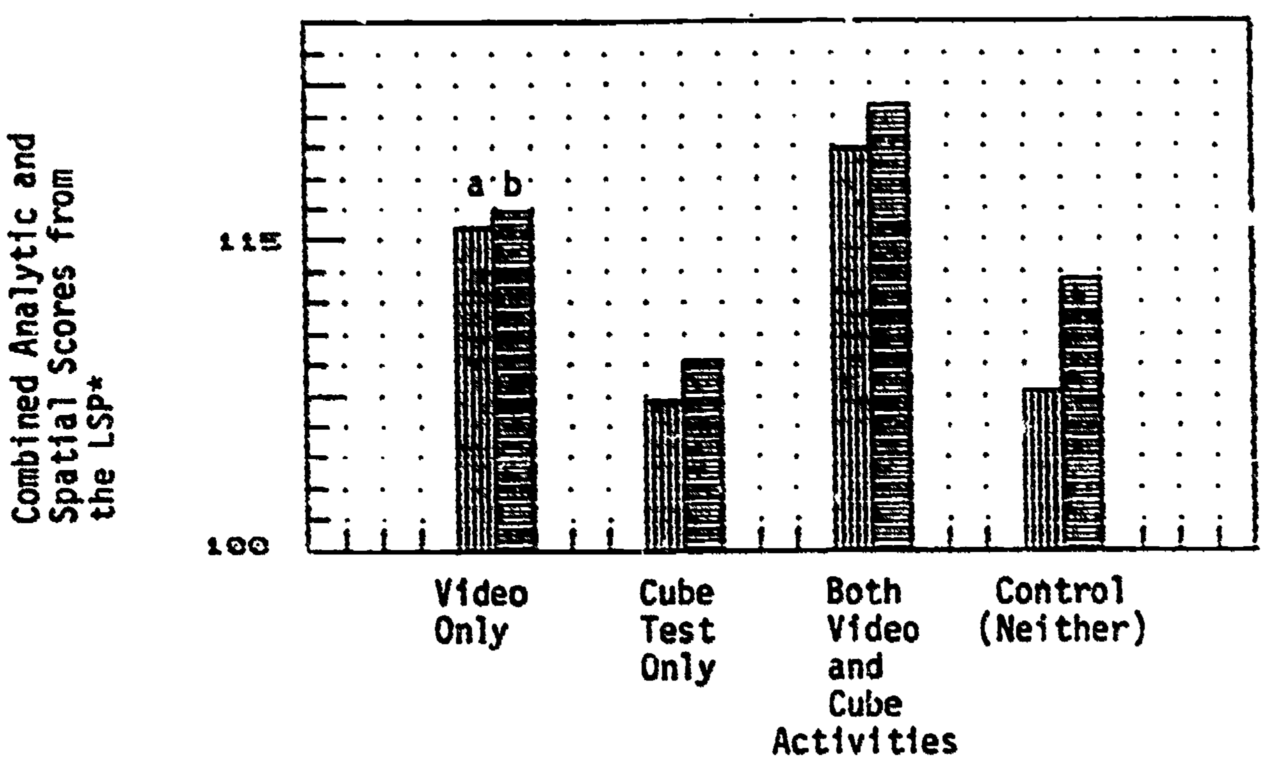
TABLE 3

COMBINED MEANS OF ANALYTIC AND SPATIAL SCORES
FROM THE LEARNING STYLE PROFILE

TREATMENT	PREANASPA	POSTANASPA
Video Only	115.666	116.334
Cube Test Only	107.143	109.142
Both Video and Cube Test	119.333	121.500
Control	107.625	113.000

FIGURE 3

Comparison of Pretest (a) and Posttest (b) Scores from the Analytic and Spatial Ability Portions of the LSP* for each Treatment.



* Learning Style Profile