The Search for Experimental Control in Evaluating the Cognitive Consequences of Participation in the Fifth Dimension After-School Program

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Abstract

How can we determine whether participation in a voluntary after-school computer club called the Fifth Dimension improves elementary school children's literacy? In order to answer this question, we identified a group of elementary school students who attended the Fifth Dimension, housed at a neighborhood Boys and Girls Club, at least 15 times during an academic year. In their school classrooms students completed pretests at the beginning of the year and posttests at the end of year. Although Fifth Dimension participants produced pretest-to-posttest gains on cognitive measures of literacy, a major methodological challenge involved the selection of an appropriate comparison group. In this presentation, we report on three different techniques for constructing comparison groups--matching based on student characteristics, matching based on pretest score, and comparisons of less and more experienced participants. We also show how our decisions about experimental control affected the results of our evaluation of the cognitive consequences of Fifth Dimension participation.

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Introduction

The Fifth Dimension is an innovative educational experiment in which children learn in an informal technology-based after-school environment. Anyone who has had the opportunity to visit a Fifth Dimension site cannot help but come away with the impression that good things are happening. However, more than good impressions are needed to convince our peers in the research community, our colleagues in decision making roles, and educational leaders who are engaged in educational reform. When they see the Fifth Dimension, these observers can legitimately ask, "Does it work?" This is a question that is often raised, for example, by school board members when instructional programs are recommended to the board.

Educational reformers have recognized the role of non-school activities in improving children's literacy. The informal learning experiences afforded through out-of-school activities may be a valuable supplement to traditional school curricula. As the demand for high-quality after-school activities increases, it becomes increasingly important to examine the effectiveness of well-designed programs for informal learning.

Our goal is to provide a response to the deceptively simple question, "Does it work?" In particular, the assignment given our evaluation team was to conduct a traditional evaluation of the cognitive consequences of participation in the Fifth Dimension. In particular, we focused our evaluation on students' problem-solving transfer--that is, the degree to which students' activities in the Fifth Dimension would affect their performance on academic literacy skills.

The search for problem solving transfer has a long and somewhat disappointing history in educational and cognitive psychology. Both in laboratory studies and field studies it is remarkably difficult to find evidence that students who learn to solve problems in one setting can transfer what they have learned to another setting. Given past difficulties in this elusive search for problem-solving transfer, we accepted our current assignment concerning the Fifth Dimension with some trepidation.

Evaluation Issues

In order to answer questions about the effectiveness of the Fifth Dimension, it is first necessary to resolve five basic issues concerning the what, where, how, who, and when of the evaluation. These issues are summarized in Figure 1.

Insert Figure 1 Here

What to evaluate. First, it is necessary to determine what to evaluate. In short, what should be the dependent measure? We wished to select measures that would tap the informal nature of the Fifth Dimension and at the same time have some relevance to academic measures of literacy. Based on the goals of the project--to promote literacy--we decided to examine literacy skills that were related to Fifth Dimension activities. Given the difficulties in demonstrating problem solving transfer in the research literature, we invented or adapted tests to measure skills ranging near to far transfer. These skills are summarized in Figure 2. The near transfer tests evaluated students' learning of how to play educational games and computer literacy knowledge. These tasks consist tap skills that are part of Fifth Dimension activities. The medium transfer tests evaluated students' ability to follow directions, to comprehend instructions, to comprehend word problems, and to use grammar correctly. In the Fifth Dimension students must understand and explain game instructions so these tests tap literacy skills that are emphasized in the Fifth Dimension. The far transfer tests evaluated basic reading and mathematics achievement. Although these skills are not directly taught in the Fifth Dimension, many of the educational games involve mathematics and reading activities.

Insert Figure 2 Here

Let me give you an example of one test we developed--the word problem comprehension test. In this 12-item paper-and-pencil test, students are given a word problem and asked to select which of four equations represents it, which numbers are needed to solve

the problem, or which arithmetic operations are needed to solve the problem. Examples are given in Figure 3. Thus, the issue of what to evaluate was resolved by focusing on changes in students' academic literacy skills that are related to Fifth Dimension activities.

Insert Figure 3 Here

Where to evaluate. Second, we needed to determine where to evaluate. In short, where should we administer the dependent measure? Based on our interests in examining a range of transfer, we decided to employ a range of test settings. Some of the tests were embedded within authentic Fifth Dimension activities such as playing an educational game at the site, whereas other tests were administered as paper-and-pencil exercises in a traditional classroom setting. Our goal was to determine whether skills learned in the Fifth Dimension would influence not only similar activities in the same setting but also traditional school tasks in a classroom setting. Thus, this issue of where to evaluate was resolved by focusing on both game-like activities embedded within a Fifth Dimension setting and paper-and-pencil tests administered within a traditional classroom setting.

How to evaluate. Third, perhaps the most challenging issue involves the problem of how to create experimental control in an informal field setting. This issue concerns the nature of independent variable. Among the challenges are that attendance in the Fifth Dimension is voluntary. It is not enough to find that Fifth Dimension participants produced a pretest-to-posttest gain in their performance, because we need to compare their performance to the performance of a comparison group that did not attend the Fifth Dimension. Figure 4 lists five techniques that we used to create comparison groups. In method 1, we invited a group of students to attend the Fifth Dimension (treatment group); for each we identified a non-attending matched student from the same grade level, teacher, level of English language proficiency, and gender (comparison group). In method 2, we invited a group of students to participate in the Fifth Dimension (treatment group); for each we identified one or more non-attending students

who attained the same pretest score. In both method 1 and 2, each group took a pretest and a posttest, so we could compare the pretest-to-posttest gains of the two groups. Figures 5 and 6 shows that these two methods yielded similar results (with 16 treatment and 16 comparison students in method 1 and 15 treatment and 45 treatment students in method 2). In method 3, treatment and comparison students were matched based on student characteristics as in method 1, but only a posttest was administered. In method 4, treatment and comparison students were matched based pretest score, with the posttest as the major dependent variable. In both method 3 and 4, we compared the posttest scores of the two groups. In method 5, when no non-attending comparison group was available, we compared the test performance of an experienced group of students (e.g., students who have attended at least 15 times) and an inexperienced group (e.g., students who are tested on their first visit but who eventually attended at least 15 times). Each method was adapted to field situation, and allowed for some level of experimental control.

Insert Figures 4, 5, and 6

Who to evaluate. Fourth, the issue of who to evaluate was resolved by focusing on elementary school children including a large proportion of language minority students from the Latino community and a large proportion of girls. We were particularly interested in including students who might not otherwise have had access to computer technology in an informal setting. In short, we focused on less experienced students who were thus likely to show the greatest benefits of exposure to the Fifth Dimension environment.

When to evaluate. Fifth, the issue of when to evaluate was resolved by testing students at the beginning of the school year and at the end of the school year, and focusing on treatment students who attended 10 to 15 to 20 sessions in the Fifth Dimension during the school year. This is a fairly short treatment (at least, compared to many other educational activities), but was necessitated by the voluntary nature of the program. In addition, previous research on cognitive

process instruction revealed that substantial effects could be produced after as little as 10 hours of exposure. It is interesting to note, however, that when we retested students at the beginning of the next year treatment students continued to show an advantage over matched controls (although there were only 11 treatment and 11 matched comparison students available using method 1 and 12 treatment and 36 comparison students using method 2. This pattern is shown in Figure 7.

Insert Figure 7 Here

Summary

So what does it mean to say that the Fifth Dimension works or does not work? We have constrained our evaluation to a traditional examination of cognitive outcomes. However, even in this seemingly straightforward evaluation scenario we had to adjust our evaluations to fit the informal and voluntary nature of the Fifth Dimension program.

As in any evaluation of the cognitive consequences of an after-school activity, we had to make choices concerning what, where, how, who, and when to evaluate. In choosing to focus on basic literacy skills, we may have missed important aspects in students' social and motivational growth. In choosing to administer paper-and-pencil tests in a school setting, we may have missed a rich source of information about how students actually perform in a Fifth Dimension setting. In matching students so tightly on relevant characteristics, we lost data for students who could not be matched. In focusing on children who participated in the Fifth Dimension, we may have missed important changes in the volunteer college-student assistants who worked with the children in the Fifth Dimension. Finally, in choosing to focus on short-term changes, we may have missed the larger picture that would be afforded through a longitudinal study. In summary, evaluation of cognitive outcomes always involves choices--such as the five choices in Figure 1--that both enable and constrain the production of interpretable results.