TOWARD OPTIMAL ALLOCATION OF INSTRUCTIONAL RESOURCES: 
DIVIDING COMPUTER-ASSISTED INSTRUCTION 
TIME AMONG STUDENTS 

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ABSTRACT

This paper deals with the question of how to best allocate a finite instructional resource among different students — specifically how to divide time on a computer-assisted instruction (CAI) system among a number of eligible students.

First several possible objectives for a time allocation strategy are considered. Examples include maximizing the students' mean grade placement without increasing the variance and maximizing the number of students who make a particular gain. Then using operations research techniques, time-allocation strategies are described to optimize the chance of reaching each objective. Finally the outcomes of various allocation strategies are predicted by computer simulations that use learning curves estimated from observed data.

The simulation models indicated that for the students and curriculum used, different time allocation strategies make very little difference in overall results when reasonable assumptions are made concerning the ways time can be allocated during a normal school day. A much more important variable is the total amount of CAI time used by students. For example, the school grade-placement average can be increased as much by increasing total CAI time by ten percent as by any allocation strategy tested.

Introduction

In this paper we investigate the question of how to best allocate a finite instructional resource among different students. The example we use involves dividing time on a computer-assisted instruction (CAI) system among a number of eligible students. The concepts and techniques we describe, however, are applicable to any instructional setting where quantitative predic-

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tions of student progress can be made from student characteristics and allocations of some scarce resource such as teacher time, educational supplies, or money (Atkinson, 1972; Calfee and Elman, 1975; Jamison et al., 1974).

We first consider several objectives that might be reached through appropriate allocation of CAI time. Examples include maximizing the students' mean grade placement without increasing the variance and maximizing the number of students who make a particular gain. Using an operations research approach, we suggest time-allocation strategies to optimize the chance of reaching each objective. Finally we use learning curves estimated from observed data and a computer simulation of each strategy to predict the outcomes of various allocation strategies.

Our simulation models indicated somewhat surprisingly, that given reasonable assumptions concerning the ways time can be allocated during a normal school day different time-allocation strategies make very little difference in overall results. What does make a difference, however, is the total amount of CAI time used by students. For example, the school grade-placement average can be increased as much by increasing total CAI time by ten percent as by any allocation strategy we tested.

**Progress Objectives and Time Allocation Strategies**

In a school with CAI terminals there must be some way of allocating the available terminal time among students. Usually there are some constraints imposed on this allocation by features of the CAI system and by features of the school itself. For example, in our simulations we have assumed that every student is scheduled for one 10-minute lesson per day and that no one receives more than one extra lesson per day. In this way we give every student at least some minimum opportunity to benefit from the CAI program, but we do not schedule anyone for an excessive amount of time in any one day. We have also assumed that five hours of a school day are available for regularly scheduled CAI lessons and one hour is available for extra or make-up lessons.

In addition to constraints, however, any allocation of time among students must use some objective – either implicitly or explicitly. We will try to give a sense of the variety of plausible achievement objectives and the range of time-allocation strategies they imply by discussing six different objectives and the corresponding allocation strategies. We will see that some of the objectives that seem quite reasonable require allocation strategies that are not particularly appealing. Table I summarizes the objectives and strategies. We assume that when students spend time in CAI, they make progress, but some at faster rates than others. In the appendix, we present a more explicit formulation of these assumptions and show how the optimal strate-