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ABSTRACT

Despite increased interest in and acceptance of the concept and mandate of providing adaptive instruction to ensure schooling success for each student, a sizable gap exists between identification of specific educational practices and application of such practices in schools. The work described in this paper is aimed at examining the feasibility and practicability of widespread implementation of an adaptive instruction approach. Discussion focuses on four areas: (1) the conceptual and practical implications of the adaptive instruction approach and the effective allocation and use of school time; (2) the rationale and design of an adaptive instruction program that includes features thought to be particularly effective in enhancing student learning; (3) the results of a descriptive study of the program's impact on classroom processes, student achievement, and the allocation and use of school time; and (4) the comparability of the study's findings with recent literature on effective classroom instruction in general and investigations of the use of school time and student learning in particular. The descriptive study was conducted in 156 kindergarten through third-grade classrooms where the Adaptive Learning Environments Model was implemented as the core educational program. It is concluded that it is unnecessary to trade off achievement in basic skills for student growth in areas such as independence, self-responsibility, and social cooperation. (Author/RH)

PROVISION OF ADAPTIVE INSTRUCTION: IMPLEMENTATION AND EFFECTS

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Abstract

The work described in this paper is aimed at examining the feasibility and practicability of widespread implementation of an adaptive instruction approach. Discussion focuses on four major areas: the concept and practice of adaptive instruction; the rationale and design of an adaptive instruction program; results of a study conducted in 156 classrooms in school sites with widely varying characteristics, in terms of the program's overall impacts on classroom processes, allocation and use of school time, and student achievement; and comparability of the findings with the extant literature on effective classroom instruction.

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Provision of Adaptive Instruction: Implementation and Effects

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Throughout the history of formal schooling, use of alternative instructional strategies and school resources to provide learning experiences that are adaptive to student differences has been the object of educators' continuing interest. Particularly during the past 15 years, the implementation and effects of adaptive instruction programs have become associated with school improvement efforts and federal legislation aimed at ensuring effective schooling for all children and young adults.

Improving schools' capabilities to provide equal and quality educational opportunities for an increasingly diverse student population has been singled out as one of the most critical tasks facing educators and researchers today. Public sentiment, economic realities, and recent federal and state legislation have created mandates for change in areas such as school desegregation and the provision of equal and appropriate educational experiences for children of all races, language groups, social classes, and unique educational characteristics. Schools at every level are asked to integrate children with a wide range of educational, physical, and emotional conditions into regular classrooms. As a result, teachers are faced with the task of finding alternate ways and additional time to meet disparate student needs within the constraints of schools' present organizational systems and resources. Thus, research on ways to accommodate diverse student needs through maximal use of resources such as school time has been given high priority.

Despite this increased interest and widespread acceptance of the concept and mandate of providing adaptive instruction that ensures schooling success for each student, there continues to be a sizable gap between the identification of specific educational practices and the operationalization of such practices in actual school settings. It was in this context that the work described in this paper was initiated. The specific goal of this work has been to increase understanding of the basics of adaptive instruction as well as its implications for effectively reducing the amount of time needed by each student for learning while increasing the allocation and effective use of school time for instruction and learning. The paper includes discussions in four areas: the conceptual and practical implications of the adaptive instruction approach and the effective allocation and use of school time; the rationale and design of an adaptive instruction program that includes features thought to be particularly effective in enhancing student learning by decreasing the amount of time needed to learn and increasing the amount of time students actively spend on learning; the results of a descriptive study of the program's impact on classroom processes, student achievement, and the allocation and use of school time; and the comparability of the study's findings with recent literature on effective classroom instruction in general and investigations of the use of school time and student learning in particular.

The Concept and Practice of Adaptive Instruction

Adaptive instruction is defined here as the use of alternative instructional strategies and school resources to provide learning experiences that are effective in meeting the learning needs of individual students. The adaptive instruction approach has become widely recognized as viable for ensuring quality education for all students (e.g., Consilio, 1974; Gordon, 1979; Reynolds & Birch, 1977). This recognition has resulted, in part, from technical advances during the past decade in the development of relevant theories and instructional practices (e.g., Glaser, 1977; Henry, 1962; Snow, 1977; Weisberger, 1977) and growing "consumer" interest in educational programs and instructional technology that adapt schooling to the different experiences, interests, abilities, and socioeconomic backgrounds of individual students (Reynolds & Wang, 1981; Wang, 1980; Wendel, 1977).

The underlying assumption of the adaptive instruction approach is that students learn in different ways and at different rates. These differences require the provision of a variety of instructional techniques and learning experiences that match the needs of each student as well as the allocation of adequate amounts of time for all students to learn. As pointed out by Glaser (1977), the match between learning experiences and student needs in effective adaptive instruction programs is based on knowledge about each student's learning characteristics, his or her past performance and present level of competence, and the nature and type of learning tasks to be performed. Essentially, the objective is to bring students' abilities into a range of competence that enhances their capabilities to profit from available learning alternatives.

Thus, it is expected that by improving schools' adaptability and students' capabilities, every student will be provided with increased opportunities to experience success in school learning (Glaser, 1977).

As with all innovative concepts, there has been some difference of opinion regarding the operational definition of adaptive instruction. It is important to note several distinctions. First, contrary to frequent portrayals in the recent effective teaching literature, adaptive instruction (sometimes referred to by researchers and practitioners as individualized instruction) is not an educational approach that is the direct opposite of the group-based, direct instruction approach (e.g., Brophy, 1979; Rosenshine, 1976). Nor is it synonymous with the open education approach (e.g., Peterson, 1979). It is, instead, an educational approach aimed at providing learning experiences that effectively meet the needs of each student. As such, its operationalization incorporates a wide range of alternative techniques and practices that could indeed include those associated with direct instruction and/or open education.

The second important distinction is that the adoption of alternative instructional approaches (e.g., teacher-directed lessons in groups or with individual students, student-initiated exploratory activities, and individual and/or group projects) is a "must" in the design of adaptive instruction. A basic requirement for learning environments aimed at effectively providing educational experiences that are adaptive to student differences is the incorporation of a variety of alternative educational objectives and learning experiences. In turn, different educational objectives and differences in the nature of the tasks to be learned require a variety of alternative teaching and learning techniques. (For example, objectives related to oral communication and social cooperation require instruction in interactive group settings, while practicing computation skills might be done more effectively if designed as independent seat work.)

The final distinguishing feature of the adaptive instruction approach is that, although individualized planning is included, each student's educational plan need not be, and in many cases should not be, carried out entirely on an individual basis. The inclusion of group lessons in individual students' learning plans is assumed, from the perspectives of effective instructional management and the pedagogical requirements for meeting a certain set of objectives.

Two major design considerations are integral to the conceptualization and operationalization of adaptive instruction discussed in this paper. They are (a) accommodation of individual differences and effective schooling, and (b) effective allocation and use of school time and provision of adaptive instruction.

Individual Differences and Effective Schooling

The basic notion that students differ as individuals, particularly in terms of their levels of school achievement and their manners and rates of learning, has long been widely accepted. However, a gradual change has occurred in the interpretation of information on learning differences. Individual differences no longer are viewed as "static." As pointed out by Bloom (1981), they can be altered either before the instructional-learning process begins or as part of the process. This change in the view of individual differences has had profound implications for instruction and learning during the past decade.

Students' success or failure in school learning has come to be recognized as the responsibility of the schools rather than simply the result of differences in learning characteristics and students' basic capabilities to learn.

In contrasting the predominant traditional approach of the selective education mode with that of the adaptive education mode, Glaser (1977) has suggested that individual differences in students traditionally were accepted as "givens," serving as a basis for classifying groups of students and differentially predicting their probable future achievement. The selective mode has come to be displaced, however, by the view of individual differences as the basis for effective instructional planning. Thus, the operational goal of the adaptive instruction approach is to adjust to students' current level of functioning and/or alter their functioning by using special instructional and learning processes to teach prerequisite skills.

Changes in the conceptualization of individual differences dictate an approach to schooling that involves the identification of effective processes for providing equal and quality educational opportunities for every student. In this context, equal and quality educational opportunities refer to the provision of conditions that are equally effective in ensuring each student's success in learning. Instructional planning that incorporates a wide range of educational opportunities and resources, such as school time and personnel deployment, is seen as the primary task in improving schools' capabilities to provide effective schooling for each student.

School Time and Adaptive Instruction

Many problems have been encountered in efforts to establish educational programs whereby all students receive instruction that effectively meets their individual learning needs. Among the problems cited most frequently are the sometimes intractable demands on teachers' time and the lack of instructional supports that would enable teachers to spend more time on instruction-related than management-related tasks (Bennett, 1976; Rosenshine, 1979; Wang, 1979a; McPartland & Epstein, Note 1).

The amount of school time available to teachers and students is constrained by both the lengths of the school day and year and each student's required amount of teacher instruction and learning time. Since the total amount of school time is relatively fixed under the present system, an alternative for increasing the amount of time available for instruction and learning is the development of ways to make effective use of school time. In the context of adaptive instruction, "effective use of school time" can be defined as a reduction of the time needed by each student to learn and an increase in the time spent by each student on learning. Thus, school learning is seen as involving both "time needed" and "time spent" in a very dynamic way.

Programs aimed at adapting school learning experiences to student differences attribute considerable importance to the interactive effects of time and student achievement. In conventional programs, students are required to learn particular lessons in a specified interval of time, and all students are expected to proceed with their learning at essentially the same pace. Each student's progress is judged in terms of the amount or degree of learning he or she achieves within a constant amount of time. The adaptive instruction approach, on the other hand, permits students to progress through a given set of learning tasks at individual rates. In programs based on this approach, the level or degree of mastery is held constant, rather than the amount of learning time. Each student's performance or progress is assessed in terms of the rate at which program objectives are mastered (Wang, 1979b). Thus, the task of improving schools' capabilities to provide adaptive instruction is twofold. It involves identifying ways to provide the amount of time needed by each student for learning and designing learning experiences that are likely to reduce the amount of time each student needs for learning. It should be pointed out that these two major considerations formed the basis for the design and implementation of the Adaptive Learning Environments Model, the subject of investigation in the work described in this paper.

The Adaptive Learning Environments Model

The Adaptive Learning Environments Model (ALEM) is an instructional program which has been designed and studied at the Learning Research and Development Center of the University of Pittsburgh over the past 10 years. The overall goal of the ALEM is to create school environments in which each student can succeed in acquiring basic academic skills while becoming confident in his or her ability to learn and to cope with the social and physical classroom surroundings (Wang, 1980). One of the program's design objectives is to make optimal use of school resources, including student and teacher time, in order to provide the programming and classroom organizational supports required to effectively maximize each student's learning. Essentially, the ALEM's design combines aspects of prescriptive instruction that have been shown to be effective in ensuring basic skills mastery and aspects of informal education that are considered to be conducive to generating attitudes and processes of inquiry, independence, and social cooperation.

The ALEM includes five major program components. They are (a) a basic skills component made up of a variety of highly structured and hierarchically organized prescriptive curricula, as well as a wide range of more open-ended exploratory learning activities designed to increase schools' capabilities to adapt to individual students' learning needs and interests; (b) an instructional-learning management system designed to increase teacher instructional time and foster student self-responsibility; (c) a family involvement component aimed at optimizing student learning through increased communication and integration of school and home learning experiences; (d) a multi-age grouping and instructional-teaming classroom organizational support system designed to increase the flexible use of teacher and student talents, time, and other school resources; and (e) a systematic approach to staff development that enhances the capability of school staff to effectively implement the ALEM in school settings.

A basic principle underlying the development of the ALEM's components is the importance of increasing the capability of the learning environment to adapt to the learning needs of individual students while, at the same time, maximizing each student's capability to benefit from the environment. (More detailed descriptions of the program and its components can be found in a number of documents, including Wang, 1980 and Wang and Catalano, Note 2).

Although each of the ALEM's major components listed above can be traced as having either a direct or indirect relationship to the allocation and use of school time, four program design features have been included in the design of the ALEM specifically to enhance the use of time by teachers and students. They are (a) an integrated diagnostic-prescriptive process; (b) inclusion of a wide range of learning options; (c) an instructional-learning management support system; and (d) an organizational support system that includes multi-age grouping and instructional teaming. These features are discussed below in connection with three of the ALEM's program design objectives which are related directly to the allocation and use of school time. These objectives are to reduce the amount of student time needed for learning, to increase the amount of student time available for learning, and to increase the amount of allocated time students and teachers actually spend on instruction and learning. The hypothesized relationships between the program's time-related features and design objectives are indicated in Table 1.

Integrated Diagnostic-Prescriptive Process

An integrated diagnostic-prescriptive process has become an operating feature of educational programs aimed at adapting instruction to student differences. Such processes provide for the assessment of each student's entering learning behaviors, the development of individualized instructional programming, and the continuous monitoring and assessment of students' learning progress. They are seen as program design supports that are particularly effective in reducing the amount of time needed by individual students to learn and increasing the amount of allocated learning time students actually spend on learning.

Table 1
Design Features of the Adaptive Learning Environments Model and Their Relationship to the Program's Time-Related Objectives

Design Features	Time-Related Objectives		
	Reduce Time Needed for Learning	Increase Time Available for Instruction and Learning	Increase Time Spent on Instruction and Learning
Integrated diagnostic-prescriptive process	X		X
Wide range of learning options	X		X
Instructional-learning management support system		X	X
Classroom organizational support system (multi-age grouping and instructional teaming)		X	

A major design task in the development of programs that incorporate a diagnostic-prescriptive process is the development and sequencing of psychologically and pedagogically meaningful learning hierarchies (Resnick, 1973; Wang & Resnick, 1978; Wang, Resnick, & Boozer, 1971). In the ALEM, such learning hierarchies form the basis for a criterion-referenced testing system that provides teachers with information on the presence or absence of specific competencies, thereby ensuring each student's placement at an appropriate point in the learning sequence. In addition, learning hierarchies provide teachers with the programming support for structuring learning experiences so that mastery of initial curricular objectives provides the prerequisite learning skills for mastering later objectives. In this way, students neither repeat tasks they already have mastered nor work on objectives for which they lack critical prerequisite skills. The fine-grained steps in its learning hierarchies form the natural checkpoints in the ALEM's curricular continuum, permitting those students who acquire certain skills before entering the program, or who acquire them quickly, to move ahead to more complex tasks. Thus, it becomes possible to reduce the amount of time needed by each student for learning.

The diagnostic-prescriptive process described above essentially is an intervention strategy designed to ensure predominantly successful experiences in learning, even for those students who initially are the least able. The contentions are that success in school learning is likely to lead to the development of students' sense of competence, and that this sense of competence results in the development of self-confidence and a sense of self-efficacy. Furthermore, students' perceptions of self-efficacy are related closely to their sense of personal control which, in turn, is assumed to be related closely to the amount of time students actually spend on learning or their motivation to learn (Wang, 1982).

Many have reported evidence of the close relationship between skills acquisition and an increased sense of personal control over the school learning environment (e.g., Bandura, 1977; Bloom, 1976, 1980; Covington & Beery, 1976; Covington & Omelich, 1979). According to Bandura (1981), for example, a student's perception of self-efficacy is reflected in his or her ability to assess all elements of a situation and organize and carry out the necessary actions to deal with that situation. Seen in this context, self-efficacy can be said to influence a student's choice of activities as well as the amount of effort, vigor, and persistence with which he or she carries out learning tasks. Therefore, it is hypothesized that if school learning environments place continuous emphasis on providing opportunities for skills acquisition, students will gain an increased sense of competence which will lead to the development of a sense of self-efficacy and personal control. As the result of students' sense of personal control over their learning, it is expected that they will be more likely to view momentary conflicts and failures as challenges or signals to modify their behavior, and that they will persist in spending the time needed to learn.

<u>Wide Range of Instructional-Learning Options</u>

The inclusion of a wide range of learning options in the ALEM's curricula is another design feature intended to enhance the program's capability to minimize the amount of time needed by students to learn and increase the amount of time spent on learning. The ALEM's prescriptive and exploratory curricula include a variety of paper-and-pencil and manipulative materials for use by students in their independent work and by teachers in individual or group instruction. It is anticipated that a wide range of learning options can provide a greater number of opportunities to learn in ways that best suit each student's unique learning characteristics as well as the nature and types of skills to be mastered. As a result, the amount of time needed by students to acquire mastery of the skills is likely to be reduced.

The provision of a wide range of learning options also is viewed as a factor that contributes to increases in the amount of time students are willing to spend on learning. It is anticipated that if students are provided with frequent opportunities to successfully acquire basic academic skills through a variety of alternative individualized learning experiences, they will develop greater motivation to persist in spending the time needed to learn.

Instructional-Learning Management System

One of the primary objectives of the ALEM's instructional-learning management system, known as the Self-Schedule System, is to support teachers and students in making maximal use of their instructional and learning time and other school resources. The Self-Schedule System is a programming device that allows for the most flexible allocation and use of school time by providing teachers with the support to free up more of their routine classroom management time for instruction and providing students with increased opportunities to plan and carry out their own tasks.

Scheduling learning activities and instructional time has been a major implementation problem for programs aimed at adapting instruction to individual differences. Typically, scheduling choices have been limited to group instruction versus individual instruction, free-choice versus teacher-prescribed activities, or teacher instruction versus independent student work. Effective implementation of adaptive instruction programs, however, requires the inclusion of all these alternatives within the context of a flexible school day (Wang, 1974a). It is assumed that, under the Self-Schedule System, students are likely to choose to work on a variety of tasks, resulting in a flexible distribution of teacher time to accommodate the different instructional demands associated with the abilities of individual students.

Results from a number of studies (e.g., Brown, 1978; Phares, 1968) suggest the close relationship between academic performance and self-management. Pines and Julian (1972) found, for example, that students who were high in self-management appeared to make much more use of previously learned concepts and principles in problem solving than those who were low in this trait. When such prerequisite skills had not been acquired, students with self-management skills were found to display greater persistence in actively seeking the necessary information for solving problems. Students who were low in self-management skills, on the other hand, tended to adopt and stick with a given problem-solving strategy, regardless of its appropriateness. The performance of these students improved only when they knew they would be provided with evaluative feedback by the teacher. These results suggest that one effective way of helping students succeed in school learning is to create an environment which facilitates their ability to manage their own learning behavior.

Effective implementation of the Self-Schedule System can be expected to increase students' motivation and reduce the amount of system-imposed distraction in the learning environment. As noted earlier, the development of students' basic academic and self-management skills is viewed as a way of increasing their sense of self-efficacy or personal control over their learning, thereby increasing their willingness to spend the amount of time needed to learn. Under the Self-Schedule System, students' willingness to spend the time required to learn is further increased by the kind of classroom management that results in minimal interference or distraction. Thus, students are provided with a chance to actually spend the time they are willing to spend on learning.

Teaching students to become effective classroom managers also has been found to enable teachers to devote more of their time to instructional matters (Smith, 1976; Stone & Vaughn, 1976) than to managing students (Kounin, 1970; Evertson & Anderson, Note 3). Results from a recent study of the effects of the Self-Schedule System in a mainstreaming program for low and high achievers (Weisstein & Wang, Note 4) showed that, in general, teachers' interactions with all students were more instruction-related than management-related. Furthermore, the low-achieving students initiated more contacts with teachers for instructional than management purposes. In addition, no significant differences were observed in the on-task behavior of high achievers and low achievers. Each group completed the same number of tasks. Results such as these seem to support the advisability of teaching self-management skills as a way of maximizing both the amount of time students spend on learning and the amount of time teachers spend providing instruction. The Self-Schedule System is postulated on the assumption that increases in teacher time for instructional purposes are likely to increase the quality of instruction and, thereby, reduce the amount of time students need for learning (Wang, 1979a).

Classroom Organizational Support System

One of the most frequently cited causes of the unsuccessful implementation of innovative practices in schools is the lack of well-defined organizational supports (Anderson, 1973; Conner, 1976; Decker & Decker, 1977). In particular, the adaptive instruction approach challenges teachers to identify available resources (e.g., school time and teachers' and students' talents) and manage them in ways that create a variety of learning alternatives for meeting students' individual learning needs. Instructional teaming and multi-age grouping are programming features included in the design of the ALEM to increase both the amount of school time available for learning and the amount of time students actually spend on learning.

Instructional teaming plays an important role in increasing teachers' flexibility to allocate and use their school time. Students in classrooms where instructional teaming is implemented have been found to spend more of their school time receiving instruction than do students in self-contained classrooms (e.g., Schmuck, Paddock, & Packard, 1977; Cohen, Note 5). By working together in a team for instructional purposes and sharing their talents and school resources (e.g., instructional materials and time), teachers can provide a wider variety of instructional alternatives (Adams, 1962; Arikado, 1975; Wang, 1976) and teaching styles (Dawson & Linstrom, 1974). For example, instead of one teacher being able to provide reading instruction to only four groups of students at different reading levels, two teachers in instructional-teaming situations can jointly service twice as many different reading groups. In such ways, the amount of time students need for learning is likely to be reduced and the amount of time actually spent on learning increased. Many studies have found significant differences in student achievement, as well as in students' self-concepts and attitudes toward school (e.g., Klausmeier & Quilling, 1967; Pribble & Stephens, Note 6), in classrooms where some form of instructional teaming was implemented.

In addition to instructional teaming, the ALEM's design incorporates a multi-age (ungraded) classroom organizational pattern as a way of facilitating the effective allocation and use of school time. Essentially, multi-age grouping provides the necessary flexibility to accommodate the differences of individual students, particularly those who tend to make unusually slow or fast progress. From the teacher's perspective, multi-age grouping under the ALEM facilitates the more selective and, therefore more effective, use of instructional time, according to the varying instructional needs of individuals and/or groups of students. A less obvious benefit of multi-age grouping is the opportunity it provides for both spontaneous and planned peer modeling and peer tutoring as the result of the integration of students who are at different developmental and academic achievement levels (Allen, 1976; Wang & Weisstein, 1980). Aside from the socialization functions that have been attributed to peer groups in the literature (e.g., Allen, 1976; Demos & Demos, 1969; Erikson, 1963; Lippitt, 1976), cross-age peer tutoring situations provide additional instructional resources and time. These, in turn, have been found to contribute to the school achievement and motivation of both those being tutored and the tutors themselves (Fogarty & Wang, 1982; Lohman, 1970; Peifer, 1972). The common occurrence of peer tutoring in multi-age grouped classrooms also enables teachers to spend a greater amount of instructional time with those students who require more teacher assistance. Although some spontaneous peer tutoring and modeling might occur in graded classrooms, the greater age span in multi-age grouped classrooms generally tends to result in a wider range of student talents, skills, and interests. When viewed as instructional resources, these student characteristics are a source of additional time for instruction and learning.

Documentation and Analysis of the Implementation and Effects of the ALEM

To investigate the nature and patterns of the ALEM's implementation in school settings and the program's effects, a descriptive study was carried out during the 1980-81 school year. The study had two major goals. The first was to investigate the extent to which critical dimensions (operating features) of the program were in place in selected classrooms and the extent to which a high degree of implementation of the ALEM was attained in a variety of school sites. The dual focus was on documenting the characteristics of the classroom environments (context variables) under which students and teachers functioned and testing the generalizability of the program. The study's second major goal was to document the patterns of classroom processes and student learning outcomes, as well as the allocation and use of school time, in classrooms where the ALEM's critical dimensions were in place.

Setting

The study was conducted during the 1980-81 school year in 156 kindergarten through third-grade classrooms (including a total of 138 teachers) where the ALEM was implemented as the core educational program. The classrooms were spread across 10 school districts located in communities with varying ethno-cultural, socioeconomic, and geographic characteristics (e.g., inner-city, suburban, rural, and Appalachian communities). Each of the school district sites in the study implements the ALEM either as a basic education program in conjunction with participation in the National Follow Through Program, a compensatory education program sponsored by the U. S. Department of Education; or as a mainstreaming program for mildly handicapped and gifted students in conjunction with participation in a project sponsored by the Handicapped Children's Model Program of the Department of Education's Special Education Program. Table 2 provides a summary description of the participating school sites.

Measures and Procedures

Three types of measures were used to obtain data for the study: degree of implementation measures, classroom process measures, and student learning outcome measures.

Degree of implementation. The degree of implementation measures utilized in the study serve two functions: They assess the presence and absence of critical program features in classrooms where the ALEM is implemented, and they provide a description of the context in which teachers and students in ALEM classrooms function. The measures were based on a series of 96 performance indicators for assessing the presence and/or absence of the program's 12 critical dimensions of the

Table 2
Characteristics of Participating School Sites
1980-81 School Year

Site	Community	Title I-Eligible Students In District	Population	Number of Participating Schools	K	1	1–2	2	2–3	1-2-3	3	3–4
					Number of ALEM Classes at Each Grade Level							
Follow Through Sites												
School District A	Urban Industrial Community	40%	250,000	2	6	6		5			5	
School District B	Rural Native American Community	52%	8,731	1	6	6		6			5	
School District C	Semi-rural Community	20%	37,791	3	5	4		4			4	
School District D	Rural Community	22%	7,000	3	6	5		5	1		5	
School District E	Rural Appalachian Community	28%	28,762	3	4			3	2		3	
School District F	Urban/Rural Community	24%	80,000	3	9	6	1	6	1		6	
Mainstreaming Sites												
School District G	Suburban Working Class Community	11%	11,901	1	4	1	2				1	2
School District H	Large Suburban Low SES Community	13%	33,185	1	2					3		
School District I	Large Suburban Mixed Low to Middle SES Community	5%	33,172	1	2		4					
School District J	Small-Town Suburban Low SES Community	19%	10,250	1	2		4					4
Total for 10 Sites				19	46	28	11	29	4	3	29	6
											(156 total Classes)*	

Note. *Because kindergarten classes in some districts were only for half a day (AM/PM sessions), the total number of different teachers for the classes included in the study was 138.

ALEM. The performance indicators were derived from an analysis of the program's structural and action domains. The structural domain consists of the resources (e.g., materials, space, facilities, time, and personnel) required to create the conditions under which program activities can be implemented effectively. The action domain consists of the role behaviors of instructional staff and students (Wang, Note 7).

Based on the performance indicators, the Implementation Assessment Battery for Adaptive Instruction has been developed and empirically validated (Strom & Wang, Note 8). This battery, which consists of six components, generally takes about two hours to administer. It was used during regularly scheduled assessment periods to gather degree of implementation data for the study. A more detailed description of the instrumentation and procedures for collecting and analyzing degree of implementation data is provided in the appendix of this paper.

Classroom processes. A series of observations was carried out to systematically obtain descriptive information on classroom processes under the ALEM at the participating sites. The Student Behavior Observation Schedule (Wang, 1974b) was used to obtain information on the nature and patterns of interactions between teachers and students, the settings in which learning activities occurred, the types of tasks on which students worked, and the manner in which classroom time was spent by students. The Student Behavior Observation Schedule (SBOS) has been utilized in a number of investigations of classroom processes under the ALEM; inter-observer agreement consistently has been found to be above 85% (Wang, 1976).

During the first two weeks of May, 1981, classroom process information was collected for all first-grade and second-grade classrooms in the 10 school districts included in the study (N = 72 classrooms). The decision to collect classroom process data only from these classes was based primarily on considerations of cost and time constraints. Using the SBOS, every student in each of the 72 classrooms was observed for five consecutive one-minute intervals. A total of 1,426 students was observed. The total observation time included 7,130 one-minute intervals, or approximately 120 hours of observations. The mean total observations per classroom was about 100 one-minute intervals. All of the observations were conducted by trained observers who were randomly assigned, in pairs, to the classrooms. Each observer was responsible for completing the SBOS on a specific list of students within each classroom. The students were randomly assigned to the observers, and they were observed in the order in which their names appeared on the lists. For any given classroom, all of the observations were made in one day. The time of day when the observations occurred was not found to be significant. Average inter-observer agreement of 95.5% was obtained in this study.

Student learning outcomes. Two types of information on student learning outcomes were included in the data base for the study: students' progress in the ALEM's math and reading curricula, and standardized achievement test scores. Data on students' progress in math and reading were collected from teachers' records of the skills mastered by each student in each curricular area throughout the year. Data on students' achievement in math and reading consisted of the percentile scores from the standardized achievement tests routinely administered by the participating school districts at the end of each school year. It is important to point out that because different tests were used by the districts included in the study, cross-district comparisons of achievement test results could have been problematic. However, the achievement test scores were used in the present study to investigate the relationship between degree of implementation and student achievement, and not for comparison of student achievement among the different school districts. Therefore, it was reasoned that use of the scores to provide a gross indicator of student achievement, based on the national norms provided by the tests, was justifiable.

Results of the Study

Analyses of the data focused on addressing the following major questions.

1. Could a high degree of implementation of the ALEM's 12 critical dimensions be attained in classroom settings across a variety of school sites with differing needs and contextual characteristics?

2. When the ALEM's critical dimensions were in place, did the hypothesized patterns of classroom processes occur? To what extent did the classroom process patterns differ from or concur with the predicted trends? Were findings on the classroom process patterns in the ALEM classrooms compatible with findings in the recent research literature on effective teaching?

3. Did the ALEM (as characterized by the degree of implementation data) and its resulting classroom process patterns lead to expected student achievement outcomes?

4. What are the implications of the study's findings for the effective allocation and use of school time?

Patterns of Degree of Implementation

The first step in evaluating the effects of an innovative school program like the ALEM is establishment of the presence or absence of the critical dimensions of the program's design. The twofold purpose is to ensure that observed program effects can be attributed to the implementation of specific design features and to test the "generalizability" of the program. In this context, "generalizability" is defined as the extent to which critical program dimensions can be implemented effectively in a variety of classroom settings.

The spring degree of implementation data for all the classrooms included in the study were analyzed to determine (a) the extent to which the ALEM's 12 critical dimensions were in place at the 10 sites; (b) the extent to which the distribution of classrooms with overall high, average, and low degrees of implementation varied among the sites; and (c) the extent of the different patterns of implementation (of specific critical dimensions) among classrooms with overall high, average, and low degrees of implementation.

Degree of implementation across all sites. To investigate the extent to which the ALEM's critical dimensions were in place at the 10 sites at the end of the school year (1980-81), several analyses of the degree of implementation data were performed. A summary of the mean degree of implementation scores for each site across all 12 critical dimensions is provided in Table 3. The table shows that, while some significant variations were noted across dimensions, an overall high degree of implementation (i.e., scores at or above 85%) was obtained; the overall average degree of implementation score for each site (last row of Table 3) was 85% or above. Furthermore, the cross-site average scores (last column of Table 3) for all but two of the critical dimensions were above the 85% criterion level. In fact, even the mean scores for these two dimensions (Creating and Maintaining Instructional Materials and Student Planning) were within a close range (four percentage points) of the 85% criterion level.

The overall results of the analysis suggest that all of the critical dimensions of the ALEM were in place in the majority of the participating classrooms when the degree of implementation data were collected in Spring, 1981. In direct contrast to findings in the current literature on effective schooling, this evidence of a high degree of program implementation in a large number of classrooms indicates the possibility of large-scale implementation of adaptive education programs like the ALEM.

Distribution of classrooms with overall high, average, and low degrees of implementation. To further investigate the extent to which the degree of implementation of the ALEM was site-specific, the percentages of classrooms in each site with high, average, and low

Table 3

Mean Degree of Implementation Scores for Each of the ALEM's Critical Dimensions

Critical Dimension	Follow Through Classrooms: Site A (N = 22)	Site B (N = 22)	Site C (N = 17)	Site D (N = 19)	Site E (N = 11)	Site F (N = 26)	Mainstreaming Classrooms: Site G (N = 4)	Site H (N = 3)	Site I (N = 5)	Site J (N = 9)	Average Scores Across All Sites
Arranging Space and Facilities (.84)*	97	92	95	94	98	92	100	97	91	96	95
Creating & Maintaining Ins. Mat. (.83)	85	89	74	80	97	87	71	88	64	76	81
Estab/Comm. Rules/Procedures (.69)	86	92	90	93	94	89	97	89	91	84	91
Managing Aides (.83)	98	98	100	100	100	99	100	100	93	100	99
Testing (.48)	100	99	87	100	100	100	100	100	100	100	99
Record Keeping (.50)	100	100	100	95	100	96	100	89	100	100	98
Monitoring and Diagnosing (.71)	93	98	95	93	93	91	94	100	88	93	94
Prescribing (.67)	99	97	99	92	100	96	100	100	100	100	98
Traveling (.91)	76	93	94	95	100	88	75	100	80	94	89
Instructing (.74)	92	91	93	97	92	87	86	86	76	76	88
Motivating (.74)	90	92	93	99	98	88	100	87	80	96	92
Student Planning (.66)	88	82	88	84	86	90	58	100	60	96	83
Overall Scores Per Site	92	94	92	94	96	92	90	95	85	93	92

Note. *Inter-observer generalizability coefficients are given in parentheses.

overall degrees of implementation were examined. High degree of implementation classrooms were those identified as scoring at or above the 85% criterion level in 11 or 12 of the critical dimensions; average degree of implementation classrooms were those with scores at or above 85% in six through 10 of the critical dimensions; and low degree of implementation classrooms were those with scores at or above 85% in five or fewer of the critical dimensions. Table 4 shows the distribution of each site's classrooms among the three degree of implementation levels.

The patterns of the distribution of classrooms among the three degree of implementation levels provide evidence of a range of site-specific characteristics. For example, in Site E, 10 (90.9%) of the 11 ALEM classrooms were at the high degree of implementation level, and none of the classrooms had an overall low degree of implementation. In Sites G and J, on the other hand, all of the classrooms included in the study were at the average degree of implementation level. However, despite the site-specific differences, data on the cross-site distribution of classrooms at the high, average, and low degree of implementation levels suggest an overall high degree of implementation across sites and critical dimensions. As shown in the last row of Table 4, 39.9% of the classrooms were at the high degree of implementation level. In other words, 39.9% of the classrooms scored at or above 85% across 11 or 12 of the critical dimensions. At the same time, 56.5% of the classrooms were at the average degree of implementation level (i.e., scored at or above 85% in six through 10 of the critical dimensions), and only 3.6% of the classrooms were at the low degree of implementation level (i.e., scored at or above 85% in five or fewer of the critical dimensions). Furthermore, the fact that a total of 96.5% of the classrooms included in the study scored at either the high or average

Table 4
Percentages of Classrooms in Each Site at the High, Average, and Low Degree of Implementation Levels
Spring, 1981
(N = 138 classrooms)

Sites	Degree of Implementation Levels: High[1]	Average[2]	Low[3]
Site A (N = 22)	40.9	59.1	0
Site B (N = 22)	36.4	63.6	0
Site C (N = 17)	35.3	52.9	11.8
Site D (N = 19)	52.6	47.4	0
Site E (N = 11)	90.9	9.1	0
Site F (N = 26)	38.5	53.8	7.7
Site G (N = 4)	0	100.0	0
Site H (N = 3)	66.7	33.3	0
Site I (N = 5)	0	80.0	20.0
Site J (N = 9)	0	100.0	0
Cross-Site (N = 138)	39.9	56.5	3.6

Note. 1 = Classrooms with scores at or above the 85% criterion level for 11 or 12 of the critical program dimensions.
2 = Classrooms with scores at or above the 85% criterion level for 6 - 10 of the critical program dimensions.
3 = Classrooms with scores at or above the 85% criterion level for 5 or fewer critical program dimensions.

degree of implementation levels suggests the "implementability" of the ALEM; that is, it suggests the strong possibility of effectively implementing the ALEM on a large-scale basis in a variety of school sites.

Differences in the patterns of implementation among classrooms at the high, average, and low degree of implementation levels. From both the program design and teacher training perspectives, it was of interest to investigate whether classrooms categorized under the three degree of implementation levels showed consistent patterns of significant differences in their implementation of the ALEM's 12 critical dimensions. In other words, the question was whether classrooms at the high, average, or low degree of implementation levels tended to have implementation problems that were similar to those in classrooms at the other degree of implementation levels. A series of analyses of variance were performed to test the extent of such patterns of differences. The results of the analyses are reported in Table 5.

As shown in Table 5, the overall degrees of implementation (mean scores in last row of the table) across all 12 critical dimensions were found to differ among the three groups. In addition, significant differences were noted among the groups in all but three of the critical dimensions. It should be noted that consistent patterns of comparatively higher mean percentage scores for the high than average degree of implementation levels and for the average than low degree of implementation levels were found in all dimensions.

Table 5

Differences in Patterns of Mean Degree of Implementation Scores Among Classrooms at the High, Average, and Low Degree of Implementation Levels

	Mean Percentage Scores			
Critical Dimensions	High	Average	Low	F-Test
Record Keeping	99	98	87	2.13
Prescribing	100	96	96	3.78
Testing	100	98	95	5.89
Managing Aides	100	98	100	1.83
Arranging Space and Facilities	98	93	77	6.84*
Establishing and Communicating Rules and Procedures	93	87	79	7.48*
Monitoring and Diagnosing	95	93	83	6.43
Instructing	96	87	77	8.34
Motivating	99	89	80	10.11
Creating and Maintaining Instructional Materials	92	78	62	9.39
Traveling	100	84	70	7.13*
Student Planning	93	81	74	9.17*
Mean Across All Dimensions	97	90	81	7.35*

Note. *$p < .01$

[dashed box] Dimensions for which mean scores above the 85% criterion level were achieved by all three levels of degree of implementation classrooms.

[dotted box] Dimensions for which mean scores above the 85% criterion level were achieved by the high and average degree of implementation classrooms, but not by the low degree of implementation classrooms.

[solid box] Dimensions for which mean scores above the 85% criterion level were achieved by the high degree of implementation classrooms, but not by the average and low degree of implementation classrooms.

Some interesting patterns of differences in the implementation of particular dimensions are reflected in the data. The mean scores for all three groups were above the 85% criterion level in four of the critical dimensions (those scores boxed in broken lines in Table 5). They are Record Keeping, Prescribing, Testing, and Managing Aides. The nature of these dimensions suggests that all of the teachers in the ALEM classrooms included in the study were able to achieve high performance in the basic mechanics of providing individualized instruction (i.e., testing, record keeping, prescribing, and making effective use of paraprofessionals to assist in program implementation).

The major differences between teachers in classrooms at the average and high degree of implementation levels and those in classrooms at the low degree of implementation level were related to classroom instruction and management. This comparison is illustrated in Table 5 by the dotted lines boxing in the scores for Arranging Space and Facilities, Establishing and Communicating Rules and Procedures, Monitoring and Diagnosing, Instructing, and Motivating. Finally, major differences between the classrooms at the high degree of implementation level and those at the average and low degree of implementation levels were found in three dimensions (scores boxed in solid lines in Table 5): Creating and Maintaining Instructional Materials; Traveling (circulating among students to instruct, assist, evaluate, and answer questions); and Student Planning. These dimensions require skills in simultaneous analyses of individual students' needs, accurate assessment of the nature of the tasks to be learned, and effective identification and allocation of specific instructional and learning resources that can be used to make instruction more adaptive to individual students' needs. It is expected that application of these skills by teachers will ensure that appropriate instructional decisions are made.

It is noteworthy that the differences in the patterns of degree of implementation found in this study replicate the findings of a previous study (Wang, Note 9). The same hierarchy of teacher competencies differentiating high, average, and low implementation of adaptive instruction was suggested by the degree of implementation data from the earlier study.

Degree of Implementation and Classroom Processes

A central issue in the investigation of the ALEM's effects was the extent to which implementation of the program's critical dimensions resulted in classroom processes identified as "desirable" (e.g., high rates of on-task behavior and greater frequencies of instruction-related than management-related interactions between teachers and students), in terms of both the program's goals and the findings in the research literature on effective teaching (e.g., Brophy, 1979; Rosenshine, 1980). Results from analyses of the data from these two perspectives are discussed here.

To investigate the extent to which the degree of program implementation was related to those classroom processes which the ALEM's program features were designed to achieve, canonical correlation analyses and analyses of variance techniques were used to examine the classroom process and degree of implementation data for Spring, 1981. A statistically significant canonical correlation (canonical $R = .36$, $p < .01$) was found, suggesting a positive relationship between degree of implementation and classroom processes.

In addition, some distinct patterns were noted in the SBOS data among classrooms at the high, average, and low degree of implementation levels. Table 6 provides a summary of the mean percentages of observed frequencies of the classroom process variables for the three groups of classrooms and the probability levels for the obtained F's from ANOVA analyses. As noted earlier, SBOS data were collected only for the first-grade and second-grade classrooms in the study (N = 72).

As shown in Table 6, the differences among the three groups of classrooms in the frequency of instruction-related interactions between teachers and students were found to be statistically significant. Furthermore, the data also suggest a progression from classrooms at the low degree of implementation level to those at the high degree of implementation level. This finding lends support to the hypothesis that the higher the degree of implementation, the greater the frequency of observed instructional interactions between teachers and students. Also of interest are the findings which suggest that the interactions among students were significantly more disruptive in classrooms at the low degree of implementation level (10% vs. 5.6% in classrooms at the average degree of implementation level and .2% in classrooms at the high degree of implementation level), and that students in classrooms at the high degree of implementation level spent significantly less time in individual settings (89.8%) than students in classrooms at the average (95%) and low (97%) degree of implementation levels.

Significant differences in the types of learning activities and the manner in which learning tasks were carried out by students also are shown in Table 6. Students in classrooms at the high degree of implementation level were observed to spend less time on

Table 6

Mean Percentages of Observed Frequencies of Classroom Process Variables for Classrooms at the High, Average, and Low Overall Degree of Implementation Levels (in 72 first-grade and second-grade classrooms)

	Overall Implementation Levels						
	High (N = 29)		Average (N = 39)		Low (N = 4)		
Variables	Mean	S.D.	Mean	S.D.	Mean	S.D.	F-test
Interactions Between Teachers and Students							
Instruction	93.3	(.23)	91.7	(.20)	90.0	(.17)	4.83*
Management	6.7	(.06)	8.3	(.04)	10.0	(.04)	1.24
Interactions with Peers							
Sharing Ideas	99.8	(.23)	94.4	(.28)	90.0	(.18)	1.02
Disruptive	.2	(.02)	5.6	(.03)	10.0	(.03)	5.01*
Settings							
Group Interactive	5.1	(.21)	3.0	(.16)	3.0	(.18)	2.73
Group Parallel	5.1	(.20)	2.0	(.15)	0.0	(0)	6.13**
Individual	89.8	(.29)	95.0	(.24)	97.0	(.18)	4.98*
Activity Types							
Prescriptive	84.7	(.35)	96.0	(.21)	98.0	(.16)	8.94**
Exploratory	15.3	(.34)	4.0	(.19)	2.0	(.13)	6.37**
Manner							
On-Task	86.0	(.25)	81.0	(.37)	76.0	(.32)	4.92*
Waiting	8.0	(.19)	8.0	(.27)	10.0	(.23)	3.11*
Distracted	6.0	(.16)	11.0	(.22)	14.0	(.25)	7.49**

Note. $^{*}p < .05$
$^{**}p < .01$

teacher-assigned, prescriptive tasks (84.7%) than students in classrooms at the average (96%) and low (98%) degree of implementation levels. In addition, they were observed to spend significantly more time on student-selected, exploratory learning tasks (15.3%), compared to students in classrooms at the average (4%) and low (2%) degree of implementation levels. Furthermore, students in classrooms at the high degree of implementation level exhibited more on-task behavior (86%), compared to students in classrooms at the average (81%) and low (76%) degree of implementation levels, and they were less distracted (6% vs. 11% in classrooms at the average degree of implementation level and 14% in classrooms at the low degree of implementation level). It should be noted here that even the non-significant differences among the three groups of classrooms reflected trends in the hypothesized directions. For example, classrooms at higher degree of implementation levels were observed to have lesser frequencies of management-related interactions between teachers and students, greater frequencies of interactions among students for exchanging ideas, more student learning time spent in group interactive settings, and less student learning time spent waiting for teacher help.

The overall results of the analyses of the differences in classroom processes among classrooms at different degree of implementation levels support the general hypothesis that there is a significant relationship between the extent to which critical dimensions of the ALEM were in place and the nature and patterns of the resulting classroom processes. Students and teachers in classrooms at the high degree of implementation level seemed to exhibit more of the classroom processes the program is designed to achieve (e.g., instructional interactions between teachers and students, constructive interactions with peers, and on-task behavior), compared to students and teachers in classrooms at the low degree of implementation level.

Student Achievement

The end-of-year reading and math scores from standardized achievement tests administered by the school districts for the 1979-80 and 1980-81 school years were analyzed to investigate the overall impact of the ALEM on student achievement. The results are summarized in Figures 1, 2, and 3. (It should be noted that achievement data were available from four of the Follow Through sites only. These are sites where standardized achievement tests are given by the districts at the end of each school year.)

Figure 1 presents a summary of the standardized achievement test scores of kindergarten through third-grade students in the four sites. The mean percentile scores for each grade level in 1980 and 1981 are shown separately. Three types of comparisons were made: a comparison of the Spring, 1981 data with the national and estimated population norms; a comparison of the 1980 and 1981 scores within the same cohorts; and a comparison of the scores for each grade level across different cohorts of students.

As shown in Figure 1, the 1981 mean percentile scores in reading and math for the first, second, and third graders consistently were above the national norm (50th percentile). In all cases, for both 1980 and 1981, Follow Through students from the ALEM classrooms also scored well above the estimated population norms for students from low-income families. (Based on a national study of the standardized achievement test results for students from low-income families, Branden and Weis,

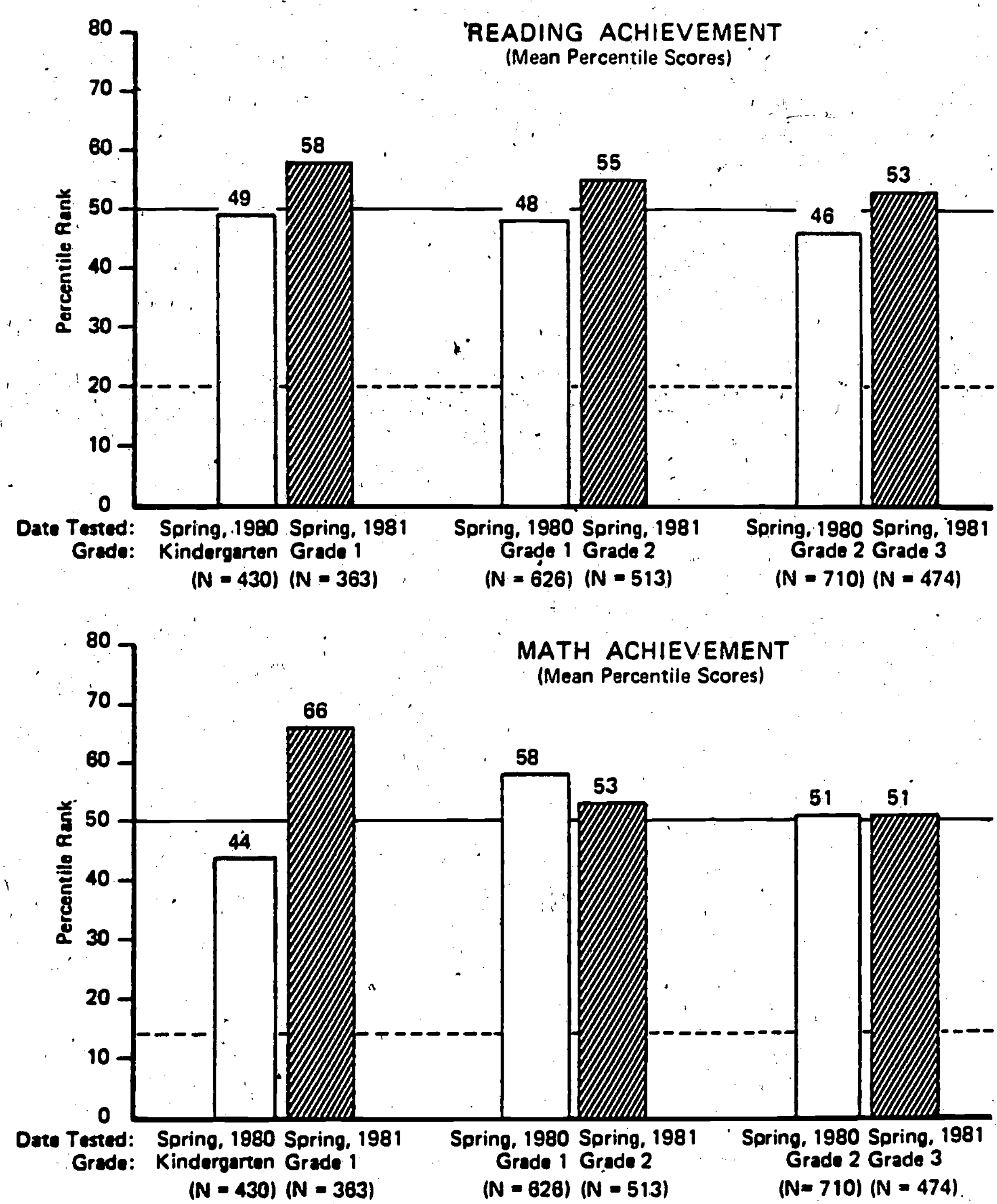


Figure 1. Mean Percentile scores from the end-of-year standardized achievement tests—cohort comparison.

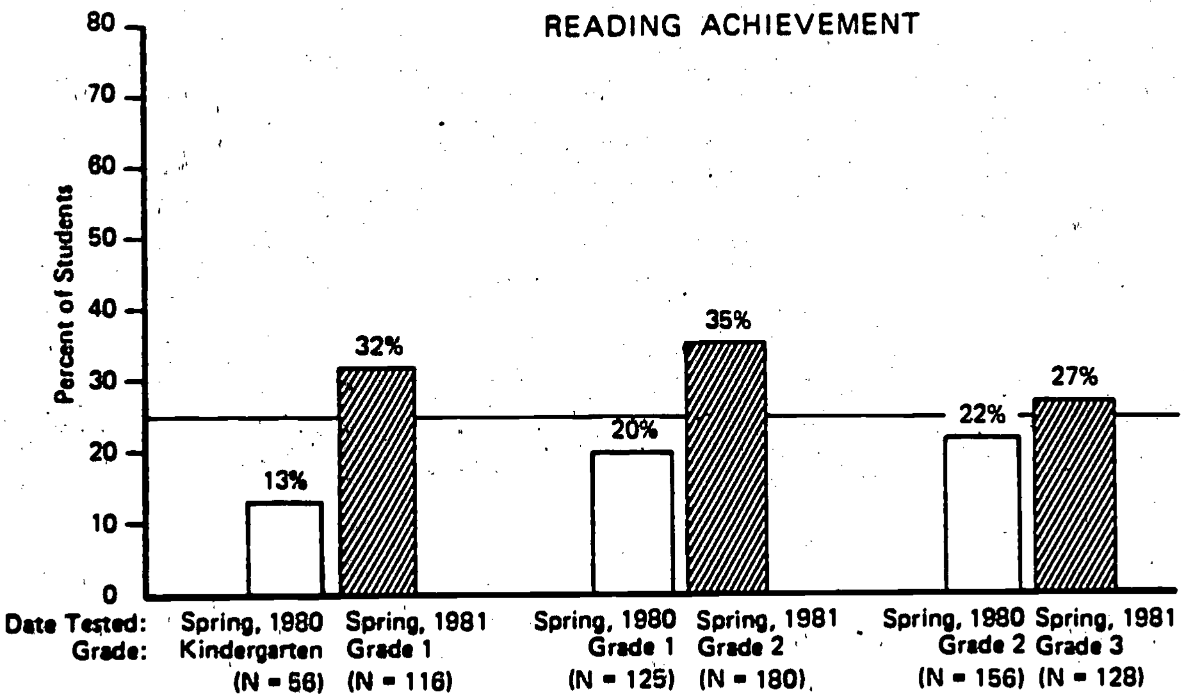
Note. The solid line represents the expected percentage based on the national norm. The dotted line represents the expected percentage based on the estimated population norm for children with similar SES backgrounds.

Note 10, have estimated that the expected average performance of students like those in the National Follow Through Program is at the 20th percentile in reading and the 13th percentile in math). The average reading achievement score for first-grade Follow Through students from the ALEM classrooms in 1981 was at the 58th percentile. In math, the first-grade students' mean percentile score was at the 66th percentile. In Spring, 1981, the average reading achievement score for second graders was at the 55th percentile; the average math achievement score, at the 53rd percentile. Third graders' average achievement score in reading for 1981 was at the 53rd percentile; their average math achievement score was at the 51st percentile.

It has been hypothesized that steady improvement in student achievement can be expected as students spend more time under the ALEM and program implementation improves. When the Spring, 1981 achievement test scores for each grade level were compared with the scores from the previous year for the same groups of students, improvements in student achievement were evident. Students in the first, second, and third grades showed an increase in their mean percentile ranks in reading. For example, first-grade students in 1981 scored higher in reading (58th percentile) than they did as kindergarteners in 1980 (49th percentile). Second-grade students in 1981 scored, on the average, at the 55th percentile in reading, whereas in 1980 the same students scored at the 48th percentile. Similarly, third graders in 1981 scored higher in reading (53rd percentile) than they did as second graders in 1980 (46th percentile).

To examine the specific effects of improved program implementation on student achievement from Spring, 1980 to Spring, 1981, the 1980 and 1981 achievement scores from the spring testing for each grade level were compared (Wang, Note 9). As shown in Figure 1, the 1981 scores seemed to be consistently higher than the 1980 scores. For example, the first graders' 1981 mean percentile score in reading was at the 58th percentile, whereas the mean score for first graders in 1980 was at the 48th percentile. In math, the first graders scored at the 66th percentile in 1981, an increase over the 1980 percentile rank of 58. Differences in the kindergarten, second-grade, and third-grade reading and math scores between 1980 and 1981 were equally noteworthy.

An alternative way of analyzing the ALEM's impact on student achievement is to compare the distribution of achievement scores within the top and bottom quartiles with the national norms published by the specific standardized tests. Figure 2 shows the percentages of students from the four sites who scored above the 75th percentile in 1980 and 1981. The solid line indicates that, based on the national norms for both reading and math, 25% of the students were expected to score above the 75th percentile. As shown in Figure 2, the achievement results from Spring, 1981 indicate that more students scored in the upper quartile in reading and math than expected, based on the national norm. For example, in 1981, 32% of the first graders scored in the upper quartile in reading, and 46% scored in the upper quartile in math. Examining cohorts, the number of first-, second-, and third-grade students who scored in the upper quartile in reading in 1981 increased significantly over 1980. Thirty-five percent of the second graders scored in the upper quartile in 1981, compared to only 20% of the same students in 1980. In math, a significant increase was seen for the first graders in



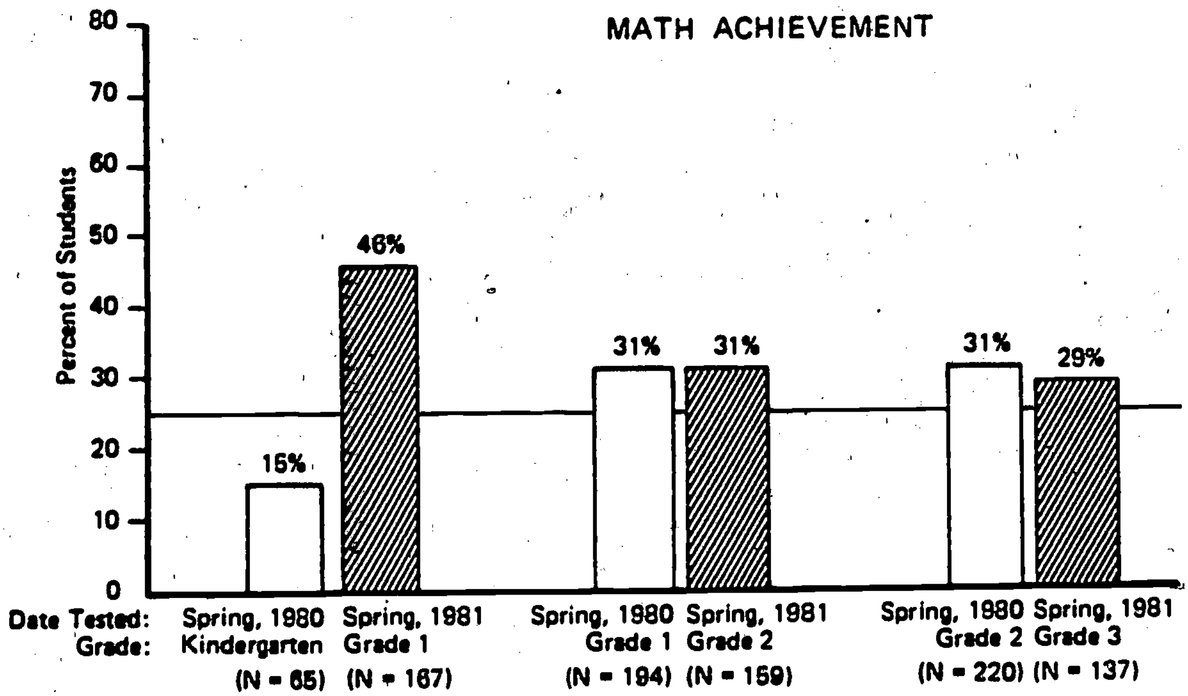
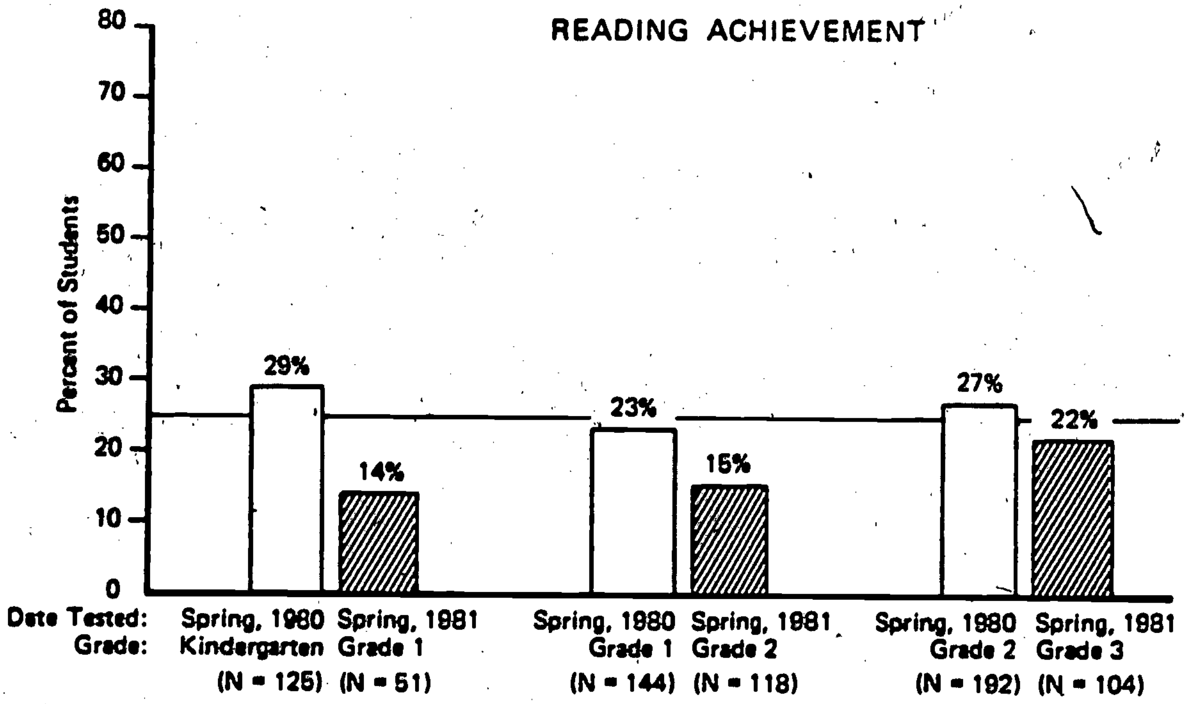


Figure 2. Percentages of students who scored above the 75th percentile based on the end-of-yea standardized achievement test results.

Note. The solid line indicates 25% of the students would be expected to score at or above the 75th percentile, based on the national norm.

1981, with 46% scoring in the upper quartile. On the other hand, the percentage of second graders in the upper quartile in math stayed the same in 1981, and the percentage of third graders in the upper quartile in math dropped slightly from 31% to 29%. Improvements across grade levels also are evident. For example, 20% of the first graders in 1980 scored in the upper quartile in reading. This increased to 32% in 1981. In math, 31% of the first graders scored in the upper quartile in 1980; 46% scored in the upper quartile in 1981.

Figure 3 summarizes the data on the percentages of students who scored in the lower quartile, based on the achievement tests' published norms. The solid lines indicate that 25% of the students were expected to score below the 25th percentile, according to the test norms. As shown in Figure 3, in both reading and math, and across all grade levels, there were substantially fewer students in the lower quartile than the national norm. Furthermore, when cohort comparisons of the 1980 and 1981 achievement scores were made, the data suggest a trend of decreasing percentages of students in the lower quartile. For example, a reduction was found for all grade levels in the percentages of students in the lower quartile in reading. In 1981, only 15% of the second graders scored in the lower quartile, compared to 23% of the same group of students in 1980. In math, the percentages of kindergarten, first-grade, and second-grade students scoring in the lower quartile decreased in 1981. It is also significant that across all grade levels in reading and math, the percentages of students scoring in the lower quartile decreased between Spring, 1980 and Spring, 1981.



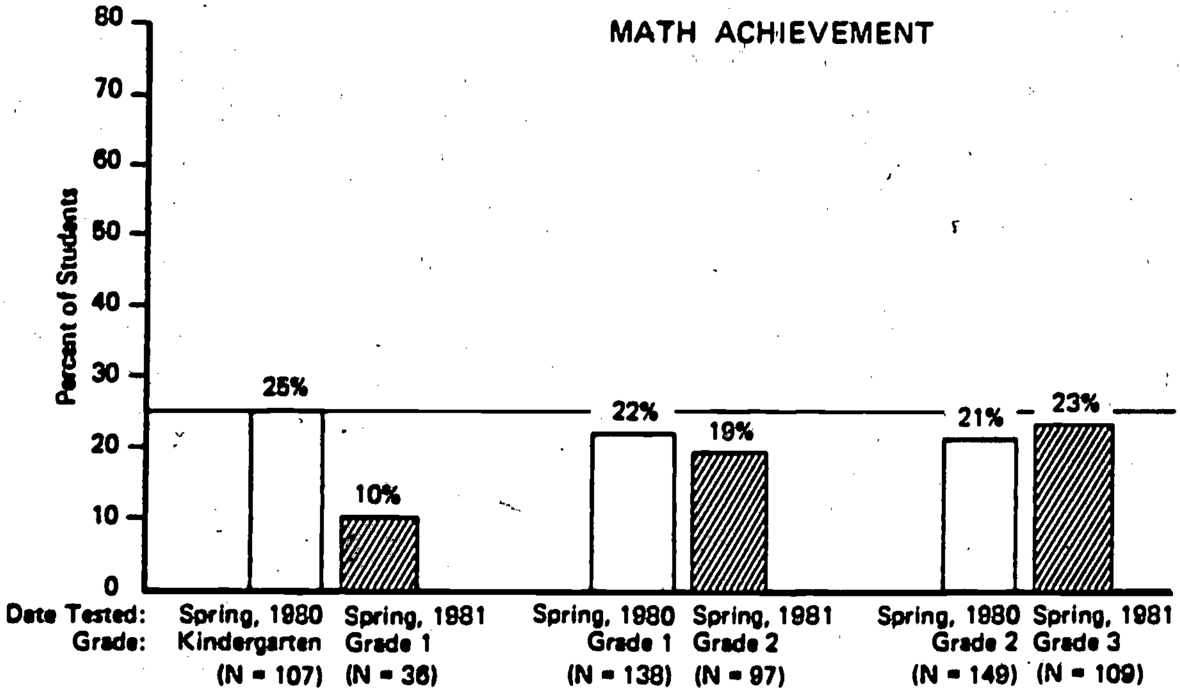


Figure 3. Percentages of students who scored below the 25th percentile based on the end-of-year standardized achievement test results.

Note. The solid line indicates 25% of the students would be expected to score at or below the 25th percentile, based on the national norm.

In the investigation of the extent to which degree of implementation was related to student achievement, two specific questions were addressed: "To what extent were the degree of implementation measures related to students' learning progress in the ALEM's math and reading curricula (i.e., the number of curricular objectives mastered"?; and, "To what extent did the nature and patterns of student achievement differ among classrooms at different degree of implementation levels"?

To provide the data base for answering the first question, canonical correlations between degree of implementation scores and students' progress in the ALEM's reading and math curricula, and between degree of implementation scores and students' end-of-year achievement scores, were performed. Results from the analyses suggest that the degree of program implementation was significantly related to both the number of math and reading objectives mastered by the students across all the classrooms included in the study and the students' end-of-year achievement scores in these two basic skills subject areas (canonical R= .5998, $p < .01$).

Table 7 provides a summary of the results of the analysis of the differences in student achievement among classrooms at the high, average, and low degree of implementation levels. As shown in the table, a consistent pattern of higher degrees of implementation and greater student achievement is suggested, although the differences in student achievement among the three groups of classrooms were not statistically significant. There are at least two plausible explanations for the positive, yet non-significant, trend indicated by these results. First, the mismatch between the ALEM's curriculum and

Table 7

Summary of Student Achievement Outcomes for Classrooms at the High, Average, and Low Overall Degree of Implementation Levels

	Degree of Implementation Levels						
	High (N = 55)		Average (N = 78)		Low (N = 5)		
Variables	Mean	S.D.	Mean	S.D.	Mean	S.D.	F-test*
Student Learning Progress (Mean Objectives Mastered)							
Math Objectives	29.77	(17.4)	28.97	(17.6)	20.21	(15.8)	2.87
Reading Objectives	33.49	(20.6)	28.52	(19.4)	27.01	(20.1)	1.13
Standardized Achievement Scores (Percentile Rank)							
Math	53.49	(23.5)	52.16	(23.9)	48.00	(19.9)	2.10
Reading	53.59	(22.5)	52.57	(21.9)	51.02	(19.4)	1.92

Note. *None of the F-ratios is significant at or beyond the .05 level.

the test content, as well as the latitude provided under the ALEM for teachers and students to choose the amount and variety of task assignments (thereby directly affecting the number of curricular objectives mastered), both are likely to attenuate the implementation-outcome association. The second plausible explanation for the non-significant results has to do with the small variance in the degree of implementation among the different groups of classrooms that were compared. Due largely to intensive teacher-training efforts, the end-of-year mean degree of implementation scores across all the classrooms, including the scores for those classrooms at the low degree of implementation level, were quite high. For example, the overall score for classrooms at the low degree of implementation level was 81%. Although relatively uniform implementation is desirable from an educational standpoint, it diminishes the apparent implementation-outcome association, since there are few low degree of implementation classrooms to establish the trend.

Allocation and Use of School Time

The study's findings reported thus far suggest the relationship between the ALEM's design features (degree of implementation) and classroom processes and student learning outcomes. To examine further the implications of the program's design for the effective allocation and use of school time by teachers and students, additional analyses were conducted. The focus was on investigating the hypothesized relationship between the degree of implementation and the manner in which students in the study spent their learning time, as well as the relationship between the manner in which students spent their learning time and other classroom process variables.

Relationship between degree of implementation and the manner in which students spent their learning time. To investigate the extent to which the 12 critical dimensions of the ALEM were related to the manner in which student learning time was spent, correlation analyses between the mean degree of implementation score for each of the critical dimensions and the three classroom process variables related to the manner in which learning time is spent (i.e., on-task, distracted, and waiting) were performed. The results of the analyses are summarized in Table 8. Although the correlations were greatly attenuated by the uniformly high degree of on-task behavior (see Table 6) and, probably, by the small sample of behavior observed for each student (five consecutive 1-minute intervals for each of the 1,426 students), more than half the correlations were significant.

The overall correlation patterns shown in the table suggest that the extent to which the various critical dimensions were in place was positively related to students' on-task behavior and negatively related to their distracted behavior. Little relationship is suggested between the degree of implementation scores and student waiting time.

The patterns of relationship between each of the 12 critical dimensions and the "manner" variables are noteworthy. In general, they seem to be consistent with the predicted patterns. This consistency is illustrated by the fact that two of the critical dimensions under the ALEM's structural domain--Arranging Space and Facilities and Establishing and Communicating Rules and Procedures--correlated significantly with students' on-task behavior. In addition, on-task behavior was found to be significantly associated with instruction-related functions such as Monitoring and Diagnosing,

Table 8
Correlations Between Variables Related to the Manner in Which Student Learning Time Was Spent and the Degree of Implementation of the ALEM's Critical Dimensions (N = 72 classrooms)

	Manner in Which Time Was Spent		
Critical Dimensions	On-Task	Distracted	Waiting
Arranging Space and Facilities	.20*	−.18	.17
Creating and Maintaining Instructional Materials	−.19	.18	.17
Establishing and Communicating Rules and Procedures	.22*	.16	−.08
Managing Aides	.22*	−.20*	.20*
Testing	−.23**	.20*	.19
Record Keeping	−.23**	.19*	.19
Monitoring and Diagnosing	.22*	.18	.16
Prescribing	.23**	−.21*	.18
Traveling	.17	−.20*	.16
Instructing	.20*	−.17	.17
Motivating	.21*	−.06	.19
Student Planning	−.22*	.20*	.18
Total Mean Degree of Implementation	.40	.31	−.34

Note. * Correlations significant at or beyond the .10 level.
** Correlations significant at or beyond the .05 level.

Prescribing, Instructing, and Motivating. It is also noteworthy that distracted behavior was found to be negatively correlated with instruction-related dimensions such as Prescribing, Traveling, Instructing, and Motivating.

In general, results from the correlation analyses suggest that implementation "contexts" (i.e., the extent to which the ALEM's critical design features were in place) affected the manner in which students spent their learning time in school. Furthermore, this relationship was in keeping with the hypothesized relationship between the manner in which school time is spent by students and the implementation of specific program features. Of particular significance is the finding that teacher expertise in instruction-related functions involving active interactions with students tended to be positively associated with students' on-task behavior and negatively associated with their distracted behavior. It should be pointed out that, although this finding of a relationship between teachers' instruction-related behavior and students' time-on-task is quite consistent with recent reports in the effective teaching research (e.g., Brophy, 1979; National School Public Relations Association, 1981), the similar patterns of correlation were observed in two quite different types of classroom learning environments. The instruction-related teacher functions associated with on-task behavior under the ALEM were carried out in open and relatively informal environments where small-group and individualized instruction were the predominant instructional modes. On the other hand, data from the effective-teaching research primarily are from classrooms where conventional group-based instruction prevailed (e.g., Good & Grouws, 1979; Rosenshine, 1980).

Relationship between the manner in which learning time was spent and other classroom process variables. To examine the extent to which other classroom process variables (e.g., the nature and purpose of teacher-student interactions, the types of tasks on which students worked, and the settings in which students worked) were highly related to the manner in which students in the study spent their learning time, correlation analyses between the relevant classroom process data from the study and the three "manner" variables were performed. The results are reported in Table 9. (It is noted here that, as with the correlation patterns between degree of implementation and the manner in which students spent their learning time, the relatively small magnitudes of the significant correlations shown in Table 9 are the likely result of the small variance in the measures used in the analyses.)

Of particular interest in this series of analyses was the extent to which the ALEM's predicted classroom processes led to more effective use of student learning time. From the program design perspective, among the more interesting findings are those which suggest that student-initiated interactions were associated positively with distracted behavior and negatively with waiting behavior, while teacher-initiated interactions were related positively to on-task behavior and negatively to distracted behavior. Furthermore, instruction-related interactions between teachers and students correlated positively with on-task behavior and negatively with both waiting and management-related interactions between teachers and students. In addition, disruptive interactions among peers were associated with waiting.

Table 9
Significant Correlations Between Variables Related to the Manner in Which Student Learning Time Was Spent and Other Classroom Process Variables
(N = 1426 students)

Classroom Process Variables	Manner in Which Time Was Spent		
	On-Task	Distracted	Waiting
Interactions Between Teachers and Students			
Student-initiated Interactions	-.01	.08*	-.08*
Teacher-initiated Interactions	.08*	-.07*	-.03
Instructional Interactions with Teachers	.06**	-.02	-.11*
Management Interactions with Teachers	.01	.07*	-.07*
Sharing Ideas with Students	.01	-.03	.02
Disruptive Interactions	-.23*	.03	.27*
Activity Types			
Prescriptive	-.08*	.12*	.01
Exploratory	.13*	-.12*	-.06**
Settings			
Group Interactive	.09*	-.10*	-.04
Group Parallel	.04	-.03	-.02
Individual	-.10*	.10*	.01
Task Initiation			
Self-initiated	.07*	.01	-.01
Assigned	-.06**	.02	.01

Note. * Correlations significiant at or beyond the .01 level.
** Correlations significant at or beyond the .05 level.

In general, the results of these analyses reflect patterns consistent with those classroom process outcomes the ALEM is designed to achieve. These outcomes, in turn, seem to be associated, as predicted, with the manner in which students spent their learning time. For example, one of the unique design features of the ALEM is its instructional-learning management system, which is designed specifically to help students assume increased responsibility for managing their own learning and behaviors, thereby enabling teachers to devote more time to instruction and less time to routine classroom management. The contentions are that as students become more proficient in managing their learning behavior, they show a concomitant increase in the amount of time spent on-task, and that as students spend more time on-task, teachers are able to spend more time instructing. The correlation patterns reported in Table 8 seem to provide evidence in support of these contentions.

Comparability of the Findings with Recent Research

There are some interesting areas of agreement and contrast between the findings reported in this paper and those from the extant research literature on effective teaching. Perhaps the most controversial one is the challenge posed to the predominant data base on the efficacy of educational practices that attempt to accommodate the learning needs of individual students and the educational benefits of students' active role in the planning and management of their learning and behaviors. There is little evidence in the literature to support either the efficacy of the adaptive instruction approach or the practicability of implementing adaptive instruction programs in school settings.

Among the most frequent criticisms of adaptive instruction programs is that they result in ineffective utilization of teacher and student time as well as lower student achievement. It is argued by many that a major design flaw of such programs is the expectation that students work alone most of the time and, as a result, they tend to have fewer instruction-related interactions with teachers, lower rates of time-on-task, and lower rates of achievement than students in classrooms where more traditional programs are implemented. In this context, the present study's findings related to time-on-task and student achievement are of particular interest.

Findings from the present study also challenge current opinion on the "implementability" of adaptive instruction programs (i.e., the potential for widespread implementation of programs like the ALEM in school settings). The general consensus is that effective implementation of adaptive instruction requires considerable teacher expertise and resources. Many have come to the conclusion that even if adequate school organizational and resource supports could be provided, the knowledge base on how to develop the teacher expertise required to effectively implement the adaptive instruction approach is sorely lacking. Based on the assumption that it is extremely difficult to "reproduce" the special sort of teachers required by such programs, findings of successful demonstrations of adaptive instruction have been attributed to unusual teachers and/or students. However, in the ALEM classrooms where the present study was conducted, most of the teachers (more than 95%) were able to develop the expertise, or use the expertise they already possessed, to effectively provide adaptive instruction. These results clearly point to the feasibility and possibility that, with adequate training support, a large percentage of public school teachers can provide the kind of adaptive instruction that generally is believed to be a rare occurrence. (It is noteworthy that results from a study conducted concurrently show significant improvements in program implementation from fall to spring as the result of the utilization of a data-based, individualized staff development program [Gennari, Tomich, & Zajac, Note 11]).

Summary and Conclusion

The overall results from the study suggest two major findings. First, as critical features of the ALEM were established, so were classroom processes that are hypothesized to be facilitative in increasing the allocation and use of school time for student learning and teacher instruction. Classrooms at the high, average, and low degree of implementation levels were characterized by differences in classroom processes, particularly the manner in which students spent their school time and the nature and patterns of instructional interactions between teachers and students. Second, data from the study show that it was possible to establish and maintain implementation of the ALEM in a variety of school settings. As noted above, this finding is especially interesting in light of the research literature which suggests the difficulty, if not the impossibility, of wide-scale implementation of educational innovations (like the ALEM) that use an adaptive instruction approach to help students attain high levels of achievement in the basic skills, self-direction, independence, and social cooperation. Not only do the study's results support the practicability of implementing such innovative programs, but they also suggest a composite scenario of classroom environments that differ significantly from traditional classrooms.

The data from the 156 classrooms suggest that fundamental changes can occur in the design and delivery of adaptive instruction programs in a large number of classrooms, under the condition that program implementation closely approximates critical design features. The findings show that teachers were able to establish and maintain classroom learning environments where the emphasis is on development of self-reliance and perceptions of social and cognitive competence, as well as mastery of academic skills. Furthermore, there is evidence that desirable classroom processes (e.g., time-on-task and instructional interactions with teachers) identified in the research on effective teaching can indeed be attained under adaptive instruction programs like the ALEM.

Despite the limitations of attempting to generalize the implications of findings from a study of a single program, support is provided for the contention that it is unnecessary to trade off achievement in basic skills for student growth in dimensions such as independence, self-responsibility, and social cooperation. Attainment of both sets of educational skills is shown to be possible through the creation of learning environments where relatively structured teacher-directed experiences can be integrated in students' schooling process with more open-ended, student-initiated learning experiences.

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Appendix

Instrumentation and Procedures for Collecting and Analyzing Degree of Implementation Data Under the Adaptive Learning Environments Model

Margaret C. Wang

A systematic set of instruments and procedures has been developed to collect and analyze data on the degree of implementation of the Adaptive Learning Environments Model (ALEM) in school settings. Included are the Implementation Assessment Battery for Adaptive Instruction and a computer program for analyzing and displaying the data collected through the battery.

Implementation Assessment Battery for Adaptive Instruction

Development of the battery of degree of implementation instruments was based on the 12 critical dimensions (features) identified through analysis of the ALEM's structural and action domains. The 12 critical dimensions are Arranging Space and Facilities (AS&F); Creating and Maintaining Instructional Materials (CMIM); Establishing and Communicating Rules and Procedures (ECRP); Managing Aides (MA); Testing (TEST); Record Keeping (RCRD); Monitoring and Diagnosing (M&D); Prescribing (PRES); Traveling (TRAV); Instructing (INST); Motivating (MOTI); and Student Planning (SP). The critical dimensions incorporate 96 performance indicators for assessing the presence or absence of the critical dimensions in ALEM classrooms. The performance indicators, in turn, are grouped into the six instruments that comprise the Implementation Assessment Battery for Adaptive Instruction (Wang, Note 7).

Two of the instruments are used in observing dynamic aspects of program implementation--the Observation Checklist for Teacher Traveling Behavior and the Observation Checklist for Student Classroom Behavior. Both are administered during class time. Two instruments--the Checklist for Physical Design of the Classroom and the Checklist for Classroom Records--focus on non-dynamic observables and are administered when students and teachers are not present in the classroom. The final two instruments--the Student Interview and the Teacher Interview--are interview questionnaires designed to elicit comments from students and teachers on various aspects of program implementation. The Teacher Interview is administered before or after class time; the Student Interview, during class time.

The battery is used by school personnel on a regular basis to collect information for staff development purposes (i.e., the design of in-service training) and to monitor the overall degree of implementation of the ALEM in their classrooms. Degree of implementation data also are collected three times during the school year (usually in October, February, and April) specifically for program evaluation purposes. It generally takes about two hours per classroom to administer the entire battery.

Analysis and Reporting of the Degree of Implementation Data

A computer program has been developed to analyze and report degree of implementation data in a form that can be used by site personnel to design and monitor site-specific staff development plans for improving program implementation (Schmidhammer, Note 12). Figure A-1 illustrates

A-3

CRITICAL PROGRAM DIMENSION CODES

AS&F	ARRANGING SPACE & FACILITIES	M&D	MONITORING & DIAGNOSING
CMIM	CREATING & MAINTAINING INSTRUCTIONAL MATERIALS	PRES	PRESCRIBING
ECRP	ESTABLISHING & COMMUNICATING RULES & PROCEDURES	TRAV	TRAVELING
MA	MANAGING AIDES	INST	INSTRUCTING
TEST	TESTING	MOTI	MOTIVATING
RCRD	RECORD KEEPING	SP	STUDENT PLANNING

NUMBERS IN PARENTHESES INDICATE NUMBERS OF ITEMS (PERFORMANCE INDICATORS) INCLUDED IN THE DEGREE OF IMPLEMENTATION ASSESSMENT INSTRUMENTS

DISTRICT X
APRIL, 1981

		AS&F (11)	CMIM (11)	ECRP (27)	MA (3)	TEST (4)	RCRD (3)	M&D (8)	PRES (5)	TRAV (2)	INST (14)	MOTI (5)	SP (3)
School A													
Grade 1	Teacher A	100	82	93	100	75	100	100	100	100	100	100	100
Grade 2	Teacher B	100	91	93	100	100	100	88	100	100	79	100	100
Grade 3	Teacher C	100	46	85	100	50	100	100	80	100	86	60	100
Kindergarten	Teacher D	100	73	93	100	100	100	100	100	100	93	100	67
Average for School		100	73	91	100	81	100	97	95	100	89	90	92
School B													
Grade 1	Teacher E	91	73	100	100	75	100	100	100	100	100	100	100
	Teacher F	91	73	82	100	100	100	100	100	100	100	80	100
	Average	91	73	91	100	88	100	100	100	100	100	90	100
Grade 2	Teacher G	100	73	96	100	100	100	100	100	100	100	100	100
	Teacher H	91	73	96	100	100	100	100	100	100	100	100	100
	Average	95	73	96	100	100	100	100	100	100	100	100	100
Grade 3	Teacher I	91	73	78	100	100	100	100	100	100	79	80	67
	Teacher J	100	73	96	100	75	100	100	100	100	100	100	100
	Average	95	73	87	100	88	100	100	100	100	89	90	83
Kindergarten	Teacher K	100	73	100	100	75	100	100	100	100	100	100	100
	Teacher L	82	73	70	100	75	100	63	100	50	57	80	67
	Average	91	73	85	100	75	100	81	100	75	79	90	83
Average for School		93	73	90	100	88	100	95	100	94	92	93	92
School C													
Grade 1	Teacher M	100	73	85	100	100	100	100	100	100	100	100	67
Grade 2	Teacher N	91	73	93	100	100	100	100	100	100	100	100	100
Grade 3	Teacher O	100	73	96	100	100	100	100	100	100	100	100	100
Kindergarten	Teacher P	91	73	82	100	50	100	75	100	50	93	80	67
	Teacher Q	91	100	96	100	100	100	88	100	100	100	100	67
	Average	91	86	89	100	75	100	81	100	75	96	90	67
Average for School		95	78	90	100	90	100	93	100	90	99	96	80
Average for Site													
Grade Averages													
Grade 1		95	75	90	100	88	100	100	100	100	100	95	92
Grade 2		95	77	94	100	100	100	97	100	100	95	100	100
Grade 3		98	66	89	100	81	100	100	95	100	91	85	92
Kindergarten		93	78	88	100	80	100	85	100	80	89	92	73
Overall Average		95	74	90	100	87	100	95	99	94	93	93	88

Figure A-1 A sample computer printout of a summary of degree of implementation data.

the format for reporting the data. As shown in the figure, which simulates a computer printout of the results of the analysis of the April degree of implementation data from School District X, the data are analyzed in three different levels or units: school, grade level, and class (teacher). The mean scores for the critical dimensions of the ALEM are reported in 12 separate columns. The names and acronyms for the dimensions are listed at the top of the printout. The number in parentheses under the acronym for each dimension indicates the total number of performance indicators included in the six degree of implementation instruments for that dimension. For example, under CMIM (Creating and Maintaining Instructional Materials), shown in the second column of Figure A-1, 11 performance indicators are included in the instruments to assess the implementation of that aspect of the ALEM's design. The printout also includes information on each teacher's degree of implementation of the 12 critical dimensions, as well as mean percentages of the degree of implementation for each grade within a particular school, for a given school, and for specific grade levels across an entire school district.

The kind of summary analysis shown in Figure A-1 is used by school personnel to determine areas where improvements in program implementation or program refinement are needed. Analysis of changes in degree of implementation from one assessment period to the next, for example, provides information to teachers about their implementation progress, as well as the data base for designing and evaluating the effectiveness of schools' staff development efforts in improving and maintaining their degree of program implementation. In addition, the overall degree of implementation across a variety of schools for an extended period of time provides evidence of the program's "implementability." That is, the proportion of classrooms at an overall high degree of implementation level across a variety of schools and over a reasonable period of time serves as an index for assessing the extent to which program implementation can be established and maintained consistently by teachers with different characteristics, on a wide-scale basis, and in different school settings (Wang, Note 13).