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A MULTIFACETED COMPUTER-BASED COURSE MANAGEMENT SYSTEM

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A MULTIFACETED COMPUTER-BASED COURSE MANAGEMENT SYSTEM¹

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progress monitored by a previously developed Computer-Assisted Instruction Study-Management System. Lectures and standard quiz sections are little used. The time of instructors is invested in remediation for students having trouble mastering the core curriculum and in teaching seminars. The role of the computer is to manage study behavior, administer on-line achievement tests, and schedule group tutorial and seminar sessions. The system has been tried out with generally favorable results in an introductory college economics course having an enrollment of 360 students.

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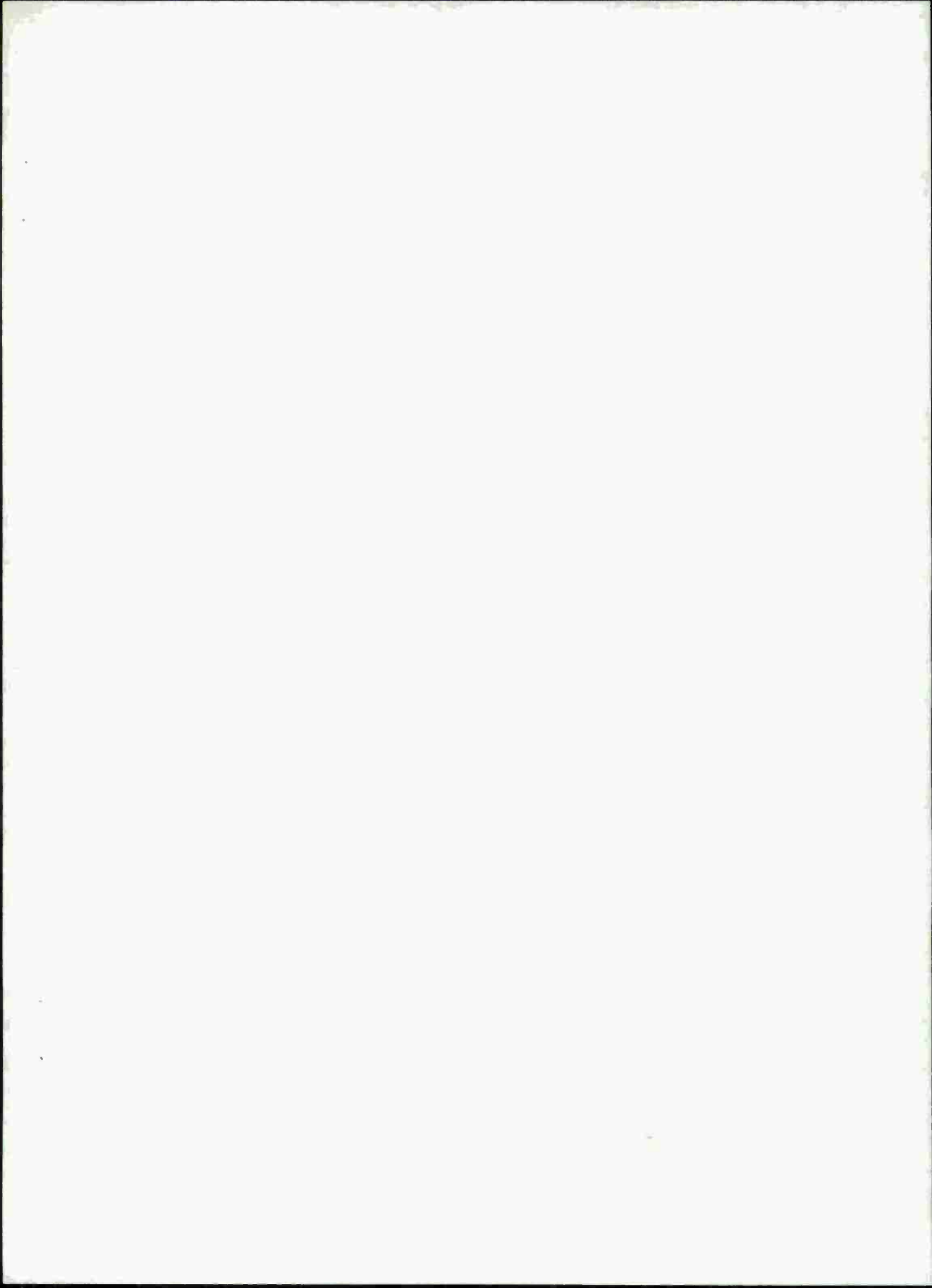
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FOREWORD

This research was supported via contract with the University of Illinois under Exploratory Development Task Area PF55.522.002 (Methodology for Developing/Evaluating Navy Training Programs) Work Unit Number PF55.522.002.01.60 (Advanced Computer Based Research). This work unit is jointly funded by the Advanced Research Projects Agency (Account Symbol 9740400.1311) and the Navy Personnel Research and Development Center. This research was initiated in response to the requirement for "improvements in training methodologies, measurement techniques, management and administration, including decision criteria required for their rapid implementation" (GOR 43, Rev 10/71).

Dr. William E. Montague was the technical contract monitor for NPRDC on this research effort. The basic rationale for the research was developed in a proposal submitted by Dr. R. C. Anderson during the Fall of 1973.

J. J. CLARKIN
Commanding Officer



SUMMARY

Problem

The major purpose of this project is to apply modern instructional and computer technology to the management of large-scale instruction, while minimizing in-line computer and material-preparation costs. A Computer-Assisted Instruction Study-Management System designed under a previous project used computer-programmed questions to maintain student attention. This project is an expansion of that earlier work to integrate books, computers, and live instructors in a Course-Management System (CMS). CMS is intended for use in courses with a large number of students and instructors.

Approach

The logistic problems associated with multifaceted instructional programs, large enrollments, and many instructors were solved, in part, by using PLATO, a computer-assisted instruction system developed by the University of Illinois. Students in the computer-managed system acquire basic information primarily from reading. Their attention to the course material is maintained and their progress through the material is monitored by a previously developed Computer-Assisted Instruction Study-Management System. Lectures and standard quiz sections are little used. The time of instructors is vested in remediation for students having trouble mastering the core curriculum and in teaching seminars and special projects. The computer is used to manage study behavior by administering on-line achievement tests, scheduling group tutorial and seminar sessions, and making lesson assignments. The course-management system features mastery learning, and permits able, hardworking students to complete the course in much less than the usual time period.

Conclusion

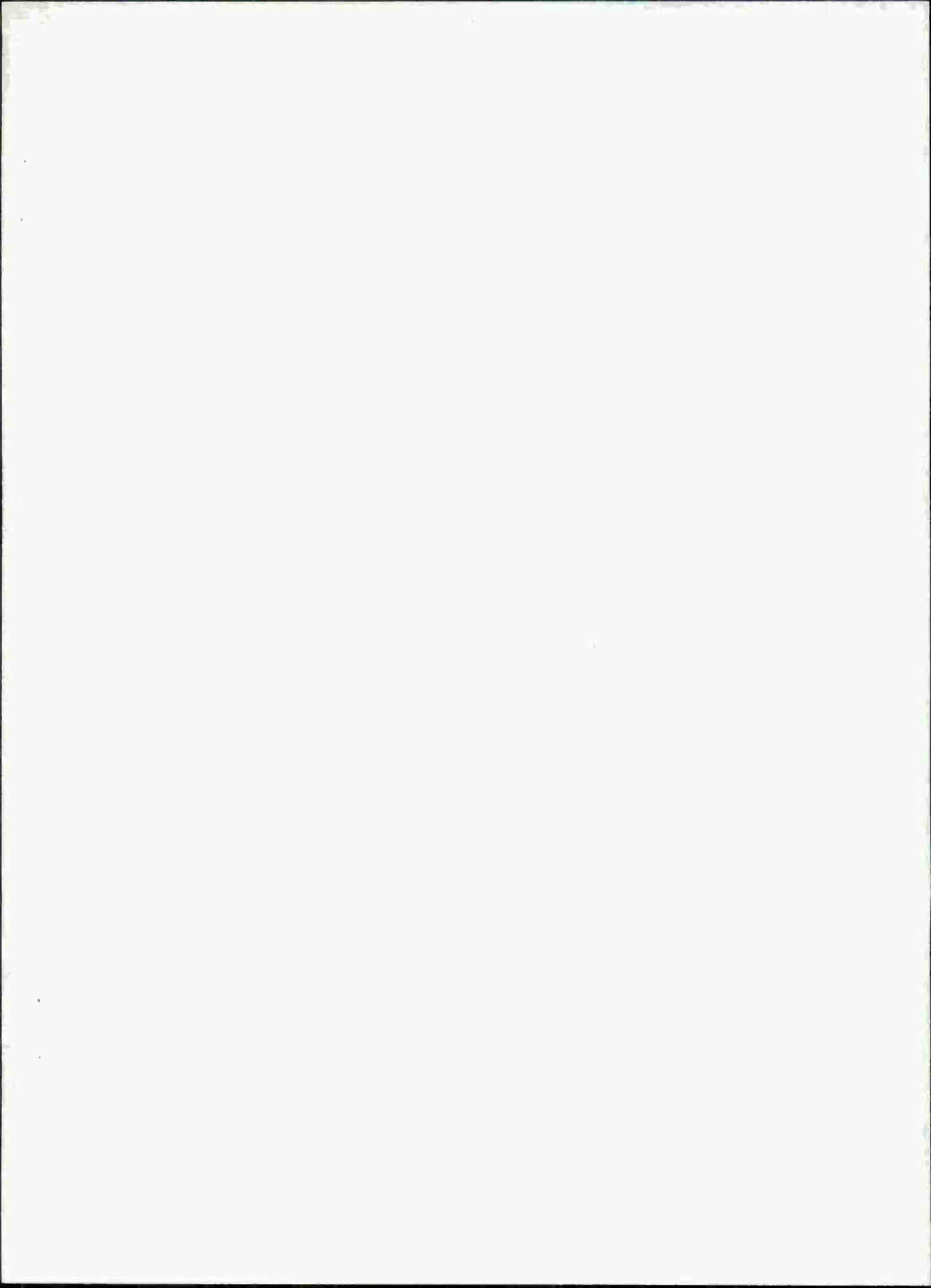
The Course-Management System was developed and tried out in an introductory college economics course with an enrollment of 360 students. A comparison with student performance data from prior years shows that present students have learned as well and are favorably disposed toward the CMS.

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INTRODUCTION

The Course Management System (CMS) was designed to integrate books, computers, and live teachers in an effective manner. The system is intended for courses with large numbers of students and instructors, such as introductory courses in community colleges, universities or military settings. The logistic problems associated with multifaceted instructional programs and large numbers of students and faculty were solved, in part, by using PLATO--a computer-assisted instruction system centered at the University of Illinois.

In CMS, students are expected to acquire basic information and concepts primarily from individual reading. Their attention to the material is maintained and their progress monitored by a previously developed and evaluated Computer-Assisted Instruction Study-Management System (T. Anderson *et al.*, 1974a, 1974b). Lectures and standard quiz sections are little used. The time instructors normally spend on routine lectures and reviews is invested in remediation for students having trouble mastering the core curriculum, and in teaching a variety of topical, high-interest, activity-oriented seminars, and special projects. The role of the computer is to manage study behavior, administer on-line achievement tests, schedule group tutorial and seminar sessions, and conduct other functions. CMS features mastery learning, and permits able, hard-working students either to complete the course in as little as 12 weeks, or to gain extra credit by taking additional seminars.

DESCRIPTION OF THE COURSE-MANAGEMENT SYSTEM

Role of the Computer-Assisted Instruction Study-Management System

The core of the Course Management System is the Computer-Assisted Instruction Study-Management System (CAISMS). Students often fail to learn from text because they do not study it thoroughly enough, and CAISMS is designed to increase attention. A range of evidence shows that procedures that induce meaningful processing of text facilitate learning (e.g., Barclay, 1973), and 75 years of research indicate that an effective way of managing processing activities is to ask questions about what has been read (R. Anderson & Biddle, 1975). This is the technique used in CAISMS.

Under CAISMS, the student signs in at a PLATO terminal and receives a brief study assignment. Upon completing the assignment in a nearby work space, the student again signs onto the terminal. This time he receives a short quiz on the assignment just completed. If the quiz performance is below 75% correct, he reviews the same study assignment. If performance is above 75% correct, he receives a new assignment. The quizzes are not graded, but the student must pass a quota of them to become eligible for graded examinations.

The quiz items require comprehension of the important concepts in the text as judged by economists on the project team. Each item either paraphrases the language in the text, or calls for application of concepts and principles to examples different from any appearing in the text. These types of items increase the probability that the student will engage in meaningful cognitive processing (cf. Watts & R. Anderson, 1971; Felker, 1974).

The CAISMS was evaluated in an experimental study in which a randomly selected group of students used it for a semester and a randomly selected control group did not. Both groups used the same text, had the same instructors, and took the same hourly and final examinations. Results indicated that the CAISMS significantly improved student achievement and attitudes. It should be emphasized that this study did not investigate the effects of replacing lectures, but rather of complementing lectures with CAISMS. Even in an adjunct role, CAISMS was powerful enough to increase achievement.

Currently, 300 students at the University of Illinois are using CAISMS as a part of the Course-Management System. Data from the first achievement test support the contention that students do as well using CAISMS as when they are required to attend lectures and to read the text. Test means show that students using CAISMS this semester are performing approximately as well as students did in previous semesters where the lecture-discussion method was used.

CAISMS does not only manage the students' independent study of the text in the Course-Management System, but it also replaces traditional lectures and routine review sessions. These lectures and reviews are typically dull, ineffective, and inefficient (cf. Lloyd et al., 1972). They squander human resources. It has been clearly established that a course can be successful without lectures. For example, the June 1972 issue of the Personalized System of Instruction Newsletter reported a questionnaire study of 190 courses using self-instructional materials. Most of the course plans had entirely eliminated lectures. The disciplines most heavily represented were psychology, physics, engineering, mathematics, chemistry, and biology, with a smattering of courses from such fields as Spanish, English, and sociology. Almost all respondents claimed they learned more from personalized (i.e., individualized) instruction. Further, it was reported that students heavily favored the self-instruction to the lecture mode. Only three of 190 courses were said to have been failures on balance.

Experimental comparisons have also consistently shown higher student achievement under individualized instruction than under traditional lecture or lecture-discussion methods, according to a recent comprehensive review of the literature by Parsons (undated). Moreover, the experimental literature indicates that individualized, nonlecture courses are very popular with students, even though usually rated as more work than conventional courses.

The advantages of individualized instruction over the conventional lecture-discussion method are detailed in two studies. Witters and Kent (1972) compared traditional and individualized introductory psychology and cultural anthropology courses. Students in the experimental section of the psychology course had no lectures indeed, no formal class meetings of any kind. Students participating in the individualized anthropology course met as a group once a week to view movies. Results showed significantly higher achievement, especially for students with low cumulative grade-point averages, in the nonlecture sections of both courses in each of two semesters. Students in experimental sections consistently reported greater confidence in their mastery of course material. In both semesters of the psychology course and in one semester of the anthropology course, students whose instruction was personalized rated the course as significantly more enjoyable than their counterparts in the lecture-discussion sections. Paden and Moyer (1972) compared several different methods for teaching the first course in economics. Most noteworthy was the fact that students who received the standard course minus the lectures achieved as much as those required to attend lectures.

Miniseminars

It is perhaps a portent that Fred Keller's (1968) seminal paper on personalized instruction was entitled "Goodbye, Teacher. . .". For now, in a personalized course, the professor is no longer a lecturer. He is no longer a teacher of any kind. He is called a manager. And that he is, not only in the Skinnerian sense, as the arranger of reinforcement, but in the ordinary sense as well.

The CMS employs teachers as teachers, under conditions that make scholarly insight and human qualities relevant. Seminars are offered in which class size is kept low (less than 20 students). Only students who have mastered required background work are allowed to register, so the discussion is informed.

An important point is that seminars would not be economically feasible within traditional introductory courses at American universities. The CMS makes them possible because the teacher is saved from lecturing, routine review, and most of the clerical and management tasks involved in giving and grading examinations, keeping records, and scheduling tutorial and group activities.

Seminars meet two hours a week for four weeks. To be eligible to enroll in a seminar, the student must have mastered a specific amount of core curriculum by a predetermined registration date. The seminars are scheduled in three waves to accommodate variations in student work rate.

The CMS handles student registration for seminars. As soon as a student becomes eligible, he can sign up for a seminar. Each seminar has an enrollment limit and positions are filled on a first come, first served basis.

Currently seminars on the following ten topics are being offered under the CMS program:

1. Public Policy Toward Big Business
2. Poverty and Welfare Reform
3. Manpower Policy in the U. S.
4. Economic Analysis of Inflation
5. Causes of the Industrial Revolution
6. Nixonomics and the Aftermath
7. Consumerism
8. Unionism
9. Economics of Transportation
10. Taxation

To date, seven seminars have been completed and the student ratings are encouraging. On a six-point scale ranging from "excellent" to "very poor," the modal value for four of the seminars was "very good," and for the other three, "good." Five of the seven seminars were rated "more interesting" than other full-semester courses that the students had taken, and two seminars were rated "as interesting" as other courses. The work load in all seminars was rated "reasonable," the midpoint of a five-point scale between "excessively heavy" and "very light."

Remedial and Tutorial Instruction

Absolutely essential for an individualized, self-paced instructional system is effective back-up instruction when the student achieves poorly and fails to earn a good grade. Students receive grades on three hourly examinations, on seminar performance, and the final examination. Students can retake alternate forms of the hourly examinations and seminars if their performance was below their expectations. Permission to retake the test must be given by a teaching assistant (who prescribes work to remedy deficiencies) if the student scored below a C on the exam. It must be emphasized that reference here is to remedial procedures to be provided after poor performance on a graded examination. The study-management component also provides simple contingencies when a student does not pass the ungraded quiz over a short reading assignment. In other words, CMS has components to deal with poor performance on both micro- and macroscales.

The CMS provides diagnostic information which is essential for remediation. Good diagnoses depend upon information about difficult aspects of the subject matter and about the misconceptions of individual students. With respect to the former, item analyses of the data collected in the initial runs of CAISMS have provided a virtual blueprint of the difficult sections of the textbook. Six special adjunct lectures with supporting worksheets are being used this semester to help students learn those

difficult sections in the text. In addition, reviews are being developed which entail quizzing the student over difficult sections in the text. If a student misses an item, he will be redirected to the text and provided with a clue to the correct answer. He will then be tested again, using a parallel form of the item.

With respect to the diagnosis of the difficulties encountered by an individual student, useful diagnostic information is a by-product of the SMS and the on-line examinations. All items presented to the students are coded according to the content assessed. Since a topic-by-topic profile of the student's performance can be displayed at a PLATO terminal, the student and his teacher can see where the problems are. The ability to pinpoint problem areas and retrieve the specific items that the student missed on an examination is a useful tutoring aid, since "a few minutes of instruction which gets precisely at the student's difficulty can be worth more than hours of general review" (R. Anderson & Faust, 1973). The teaching staff has signed on at terminals 118 times per week, and has averaged 12 terminal hours per week in remedial work.

On-Line Mastery Achievement Testing

After the student has made himself eligible for taking an on-line test, he may reserve a time for testing by using a reservation routine. The CMS keeps track of a student's eligibility and will not allow him to reserve a terminal until he has completed the proper reading assignments. The exams are offered Sunday afternoons and three evenings during the week. The original intention was to have a completely free access testing facility. However, this plan was modified because the terminals were inaccessible during the day. Also, it was discovered that students needed an economics proctor to clarify test items and deal with hardware malfunctions.

Test items are displayed to the students in a random order. There is a spacer page between items that tells how many items remain in the test and how much time is left to complete them. The student cannot go back to a previous item to change an answer once he has seen a new one. At the end of the test, performance is judged and test statistics are displayed. The student is shown the number of items correct, percent correct, his letter grade, and a profile of performance across textbook chapters. He is also shown his cumulative grade in the course, which includes the results of the just-completed test. If the test performance is not satisfactory to the student, he can choose to retake it, using a different form.

To date, approximately 500 examinations have been administered. Test data are very encouraging. Students as a group are doing as well on these tests as students who took them in previous years under conventional lecture procedures.

When students choose to retake a test (an alternate form), their performance increases. About 25% elect to retake. Two procedures are

thought to reduce the number of retakes. First, students cannot continue their CAISMS work while waiting to take a test, and, second, the most recent test grade is the one that counts. If a student fails to prepare adequately for a test retake, he may have to live with a lower grade than he received the first time.

Examination Review Items

To assist the student in preparing for the graded exams, a large pool of review items has been prepared. The items are similar in format and language to those on the test. The student has free access to this pool after he has become eligible to take the exam. A random sample of ten items is displayed. Feedback is given following each answer, and performance is summarized after all ten items have been completed. Students may try as many samples of items as they wish. Most students make extensive use of this review facility. (Neither the CAISMS items nor the review items appear on the graded exams.)

Message Exchange

Another valuable feature of CMS is the communication network. The students were assembled only once as a group (on the first day of class). However, as the semester progressed, they required general interest information on such matters as changes in course procedures and reminders about deadline dates, and special interest information such as the reason why a student missed a particular item. An on-line message system was evolved in which students could direct questions to the staff by typing them on the terminal keyboard. The staff reviews the messages during office hours and directs responses to individual students, or, occasionally, to all students. A student receives both individual and the "all-student" messages when he signs on the system again. Students leave approximately eight messages during each 24-hour period.

IMPLEMENTATION OF THE COURSE-MANAGEMENT SYSTEM

During the first class session of the economics course, 360 students received instructions on how the Course-Management System works, how and where to sign onto the PLATO system, and specific topical content areas covered in the course. Specific questions about the course were referred to discussion sessions of 35 students, each conducted for the first two weeks by the teaching assistants. Meanwhile, students began within a few hours after the initial meeting to sign onto the system and start the self-paced study. Figure 1 shows the rate at which students began working.

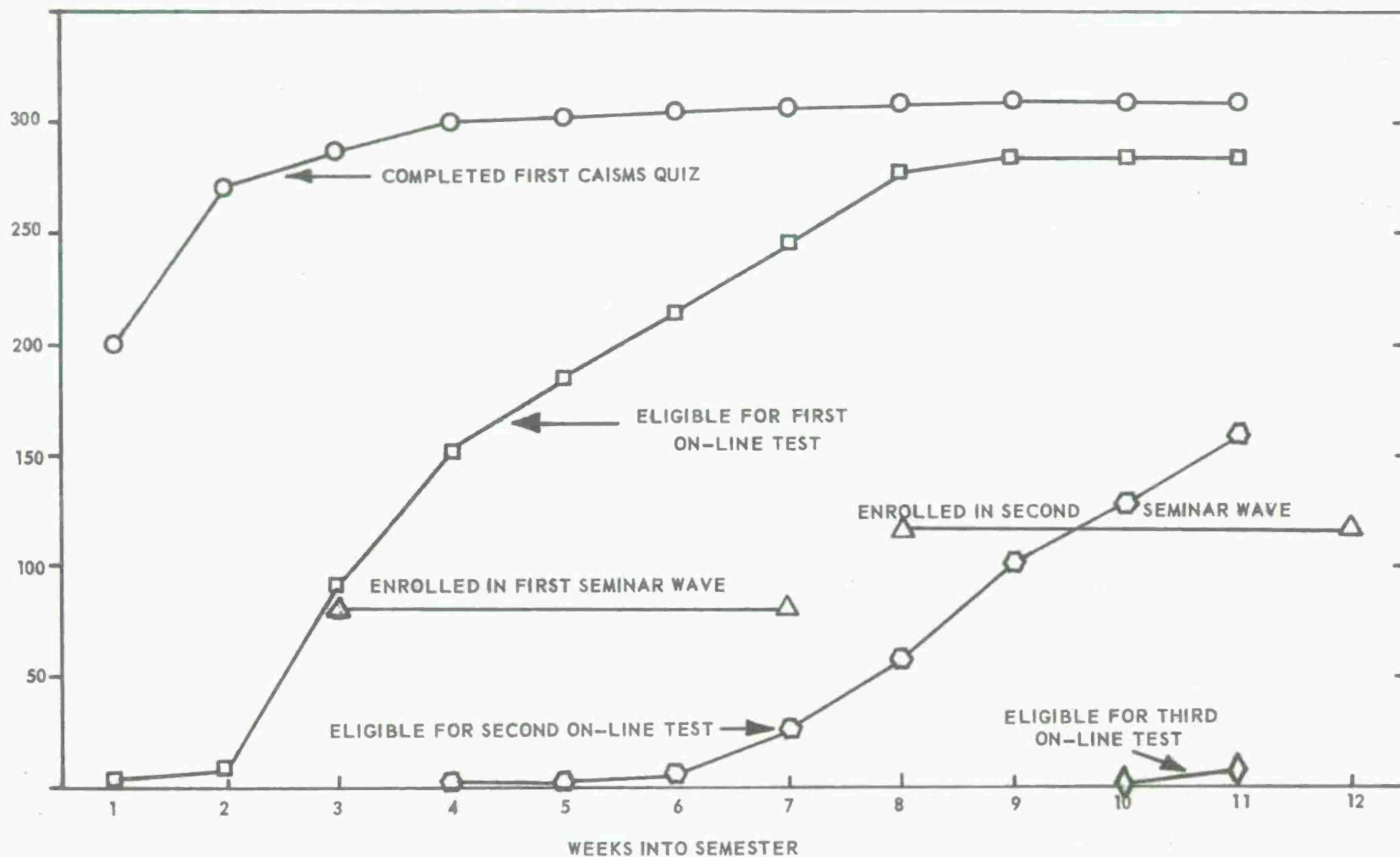


Figure 1. Student progress in computer-managed course

Approximately 200 students had taken the first Study-Management quiz by the end of the first week, and over 300 students had done so by the end of the fourth week. Previous studies on this population of students (T. Anderson, et al., 1974a, 1974b) show that approximately 25% of the students who appear for the first class session or who register for the class drop the course or change sections before the semester ends. Consequently, it is reasonable to expect 80 students to drop the course. To date approximately 50 students have not started the course, and many others who have started are not likely to complete it.

Followup interview data from 80 students who were well behind the course pace at the end of the third week indicate that approximately 15% had negative attitudes toward both the course and CMS, and planned to drop the course. Slightly more than 18% had neutral or positive attitudes toward CMS, but had to drop the course for other reasons. A large group, approximately 58%, had positive or neutral attitudes toward CMS and the course, but had chosen not to work on the course early in the semester.

Student Procedures for Using CMS

Students are required to spend a majority of their time studying the text in conjunction with the computer terminals. Consequently, they study in one of the two resource centers where terminals are available. One center has six terminals and is available from 0800 to midnight on weekdays, and from 1300 to midnight on Sundays. Another site with 30 terminals is available to students evenings and weekends to accommodate the large number who study at these times.

Students use a terminal for approximately 10 to 20 minutes during each hour of studying. Consequently, from three to six students can use one terminal in an hour. Most of their computer time is spent in the study-management phase of the course, although they are also involved in other computer-assisted activities. Figure 2 shows the typical pattern of the student-computer interaction. Options 1 through 8 are always available to the student, while others like 9 through 12 are contingent on successful progress in the course and are not available at all times. For example, a student cannot sign up for a seminar until he has passed an on-line test, which he cannot take until he has completed all of the study assignments required for the test and reserved a terminal for testing.

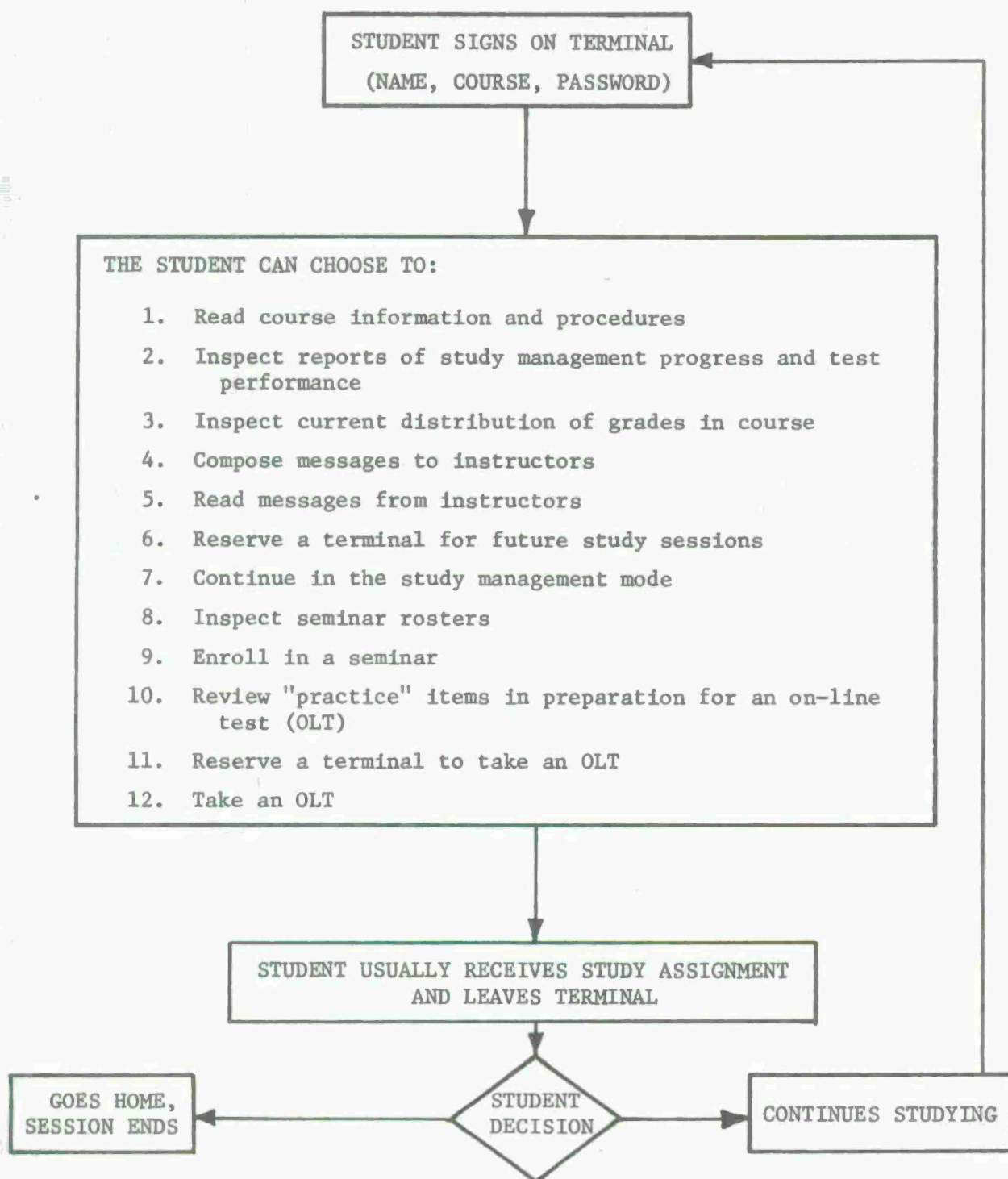


Figure 2. Index of student options in the Course-Management System

Staff Procedures for Using CMS

The system is managed by a teaching staff, and a technical staff. The teaching staff includes the lead professor, five graduate teaching assistants, and six undergraduate tutors. The technical staff consists of a project director, a project manager, and four graduate research assistants.

The technical staff is large, since the system is still in a developmental phase. Evaluation and research data are being collected in conjunction with the on-going program. When the system reaches a stable state, the staff requirements can be reduced to five teaching and one technical member, plus the undergraduate tutors.

The staff can sign onto the system at any terminal. Figure 3 is a schematic of the staff-computer interaction, including three of the more important reasons for signing on. The staff has access to a large amount of current information, and the opportunity to intervene and alter procedural variables. Some course policies, (e.g., concerning when students are eligible to take on-line exams and seminars) cannot be changed via the staff program. These policies are implemented in software packages and only the programmers can change them. Also, all of the courseware (questions, answers, and assignments) are in computer language and cannot be altered via the staff program.

CONCLUSION

The Course-Management System was developed and tried out in an introductory economics course with an enrollment of 360 students. A comparison with student performance data from prior years shows that present students have learned as well and are favorably disposed toward the CMS.

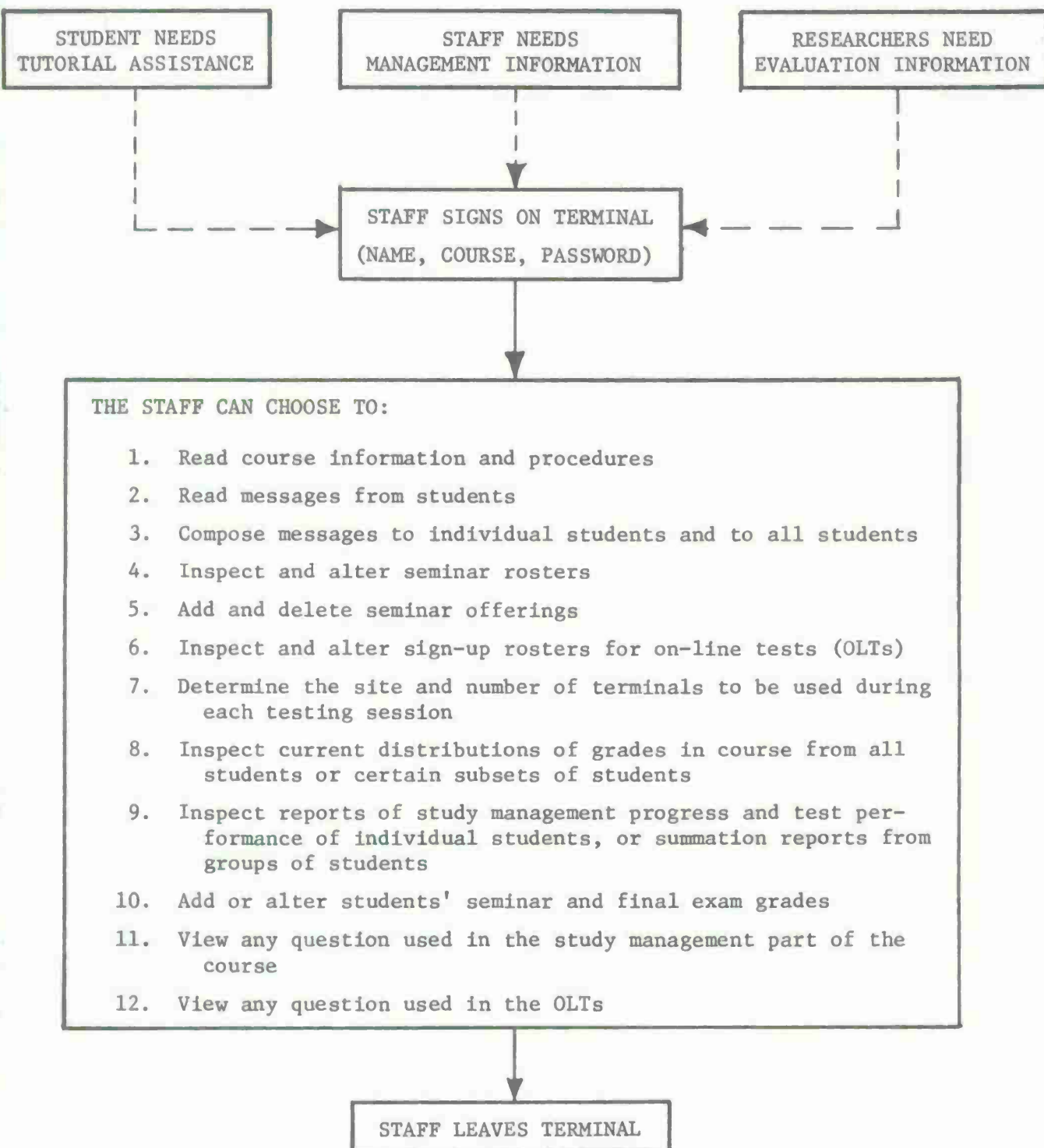
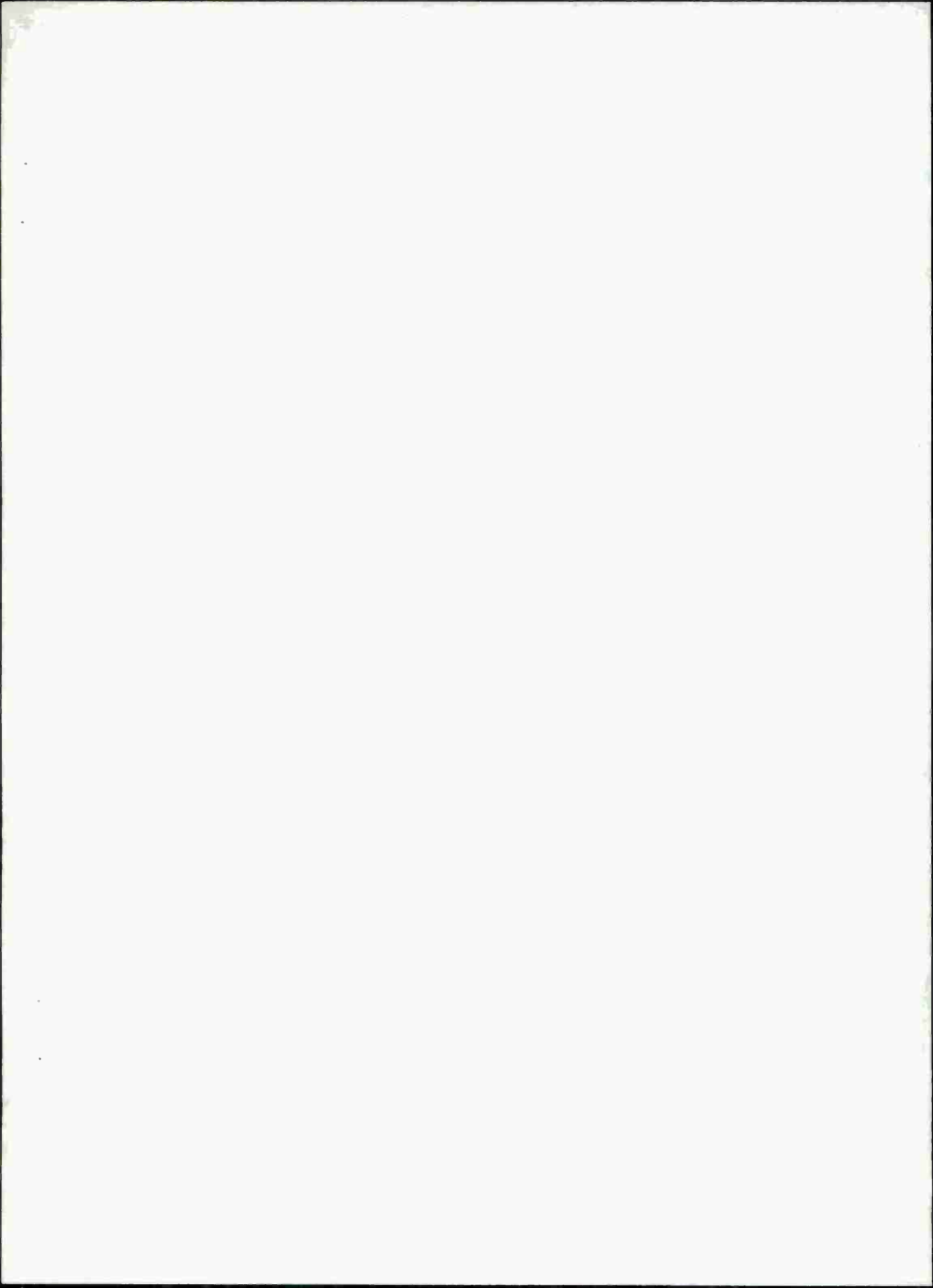
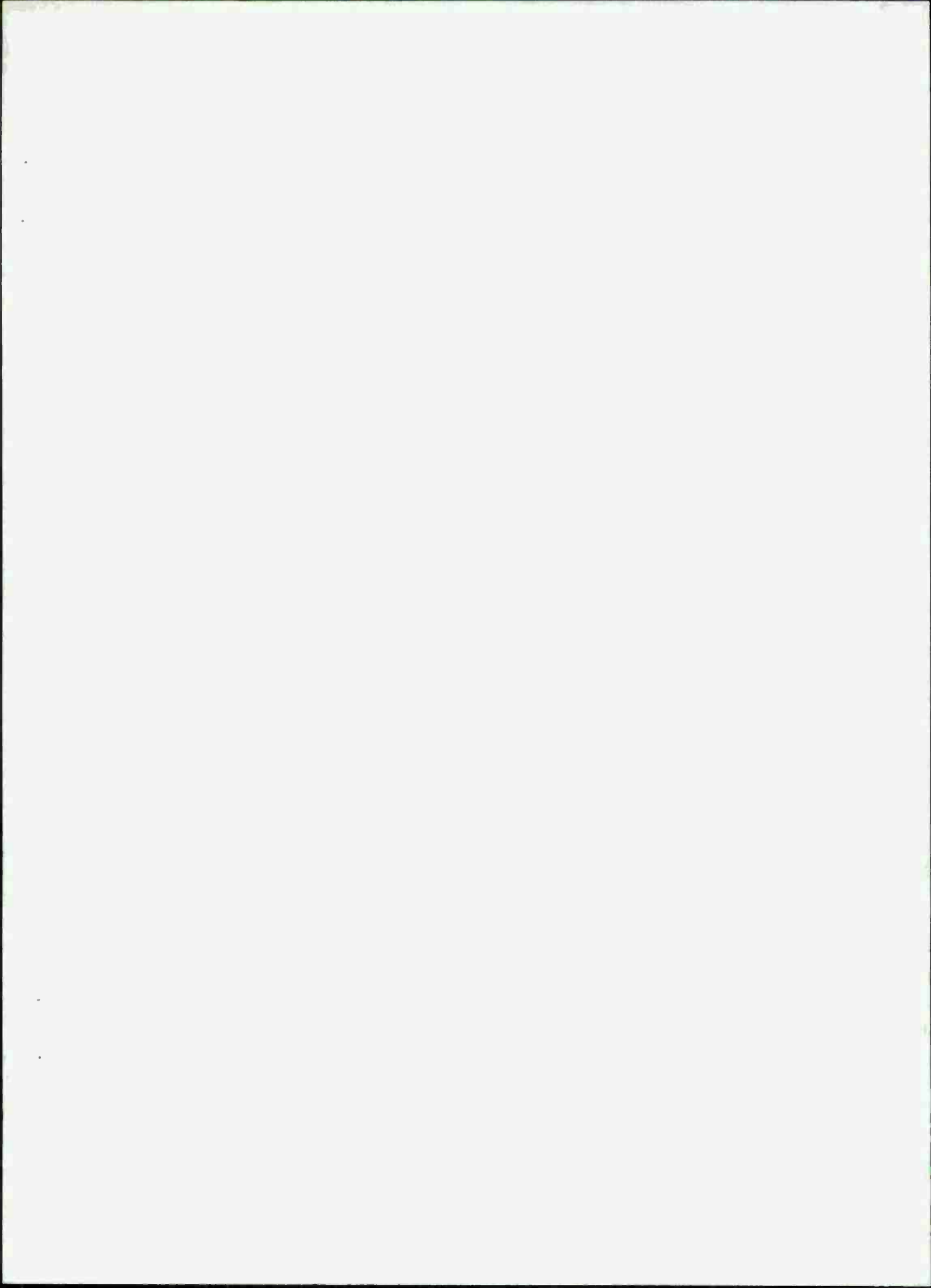


Figure 3. Index of staff options in the Course-Management System



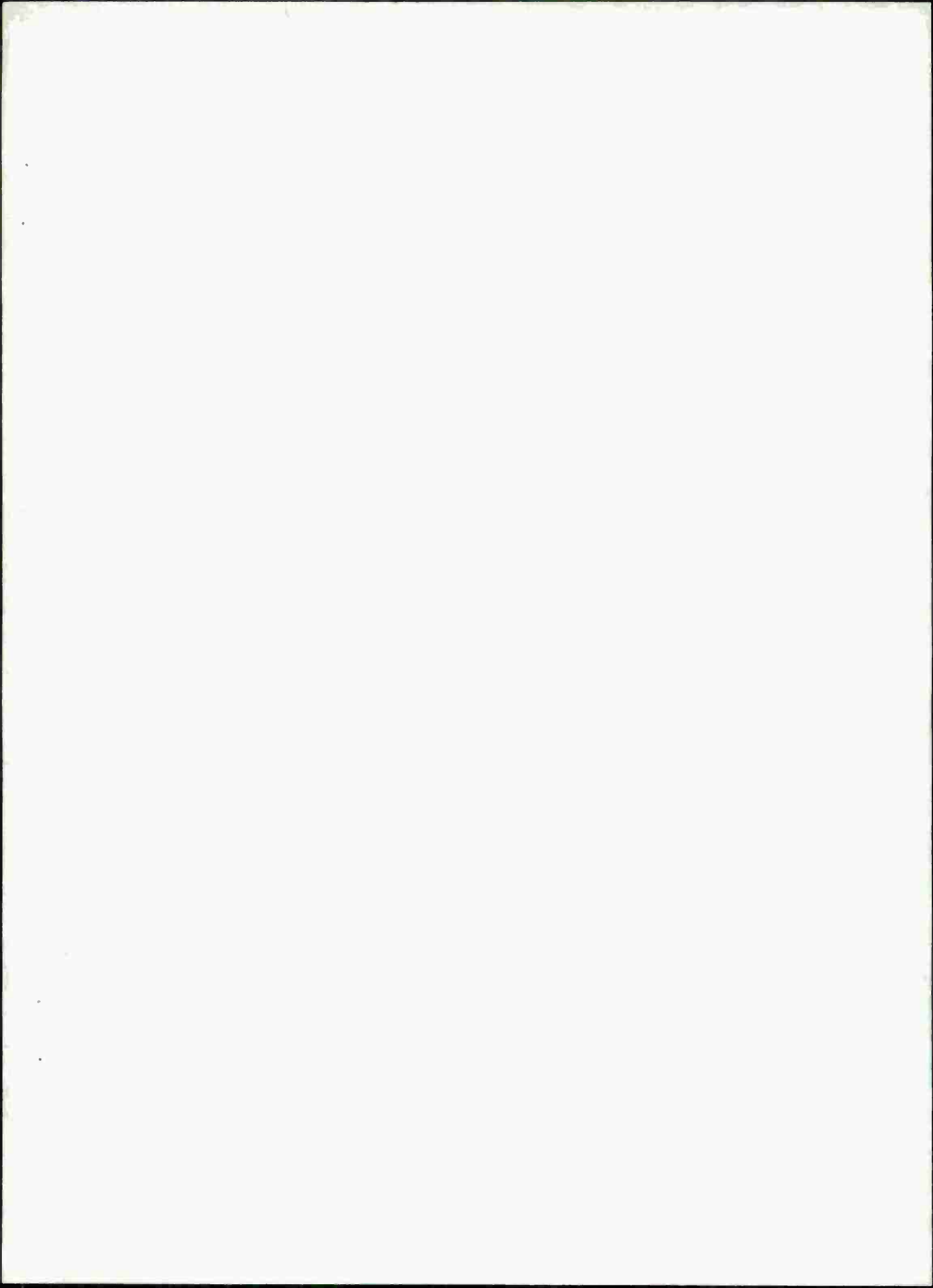
REFERENCES

- Anderson, R. C., & Biddle, W. B. On asking people questions about what they are reading. To appear in G. Bower (Ed.), Psychology of learning and motivation, New York: Academic Press, 1975, 9.
- Anderson, R. C., & Faust, G. W. Educational psychology: The science of instruction and learning. Dodd, Mead, & Company, 1973.
- Anderson, T. H., Anderson, R. C., Dalgaard, B. R., Paden, D. W., Biddle, W. B., Alessi, S. M., & Surber, J. R. An experimental evaluation of the Computer-Assisted Instructional Study-Management System. In preparation, 1974. (a)
- Anderson, T. H., Anderson, R. C., Dalgaard, B. R., Wietecha, E. J., Biddle, W. B., Paden, D. W., Smock, H. R., Alessi, S. M., Surber, J. R., & Klemt, L. L. A computer based study management system. Educational Psychologist, 1974, 11, 36-45. (b)
- Barclay, J. R. The role of comprehension in the remembering of sentences. Cognitive Psychology, 1973, 4, 229-254.
- Felker, D. B. The effects of question type and question placement on problem solving ability from prose material. Pittsburgh: American Institutes for Research, 1974.
- Keller, F. S. "Good-bye, Teacher..." Journal of Applied Behavior Analysis, 1968, 1, 79-89.
- Lloyd, K. E., Garlington, W. K., Lowry, D., Burgess, H., Evler, H. A., & Knowlton, W. R. A note on some reinforcing properties of university lectures. Journal of Applied Behavior Analysis, 1972, 5, 151-155.
- Paden, D. W., & Moyer, M. E. The teaching of the first course in economics. In A. L. Welsh (Ed.), Research papers in economic education. New York: Joint Council on Economic Education, 1972.
- Parsons, J. A. Personalized system of instruction: Theory, research and practice. Urbana: University of Illinois, undated.
- Watts, G. H., & Anderson, R. C. Effects of three types of inserted questions on learning from prose. Journal of Educational Psychology, 1971, 62, 387-394.
- Witters, D. R., & Kent, G. W. Teaching without lecturing: Evidence in the case for individualized instruction. The Psychological Record, 1972, 22, 169-175.



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