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THE UNIVERSITY OF ALBERTA

SAFETY IN INDUSTRIAL ARTS EDUCATION

A PILOT STUDY USING

COMPUTER-MANAGED INSTRUCTION

BY

(C) DAVID IVOR STEVENS

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

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ABSTRACT

In order to reduce school shop accidents and foster safe working habits, the industrial arts teacher must have a thorough working knowledge of the equipment and/or processes he is demonstrating and subsequently having his students practice.

In order to develop this thorough working knowledge and foster working habits the student teacher must in his laboratory training be made aware of the many contingencies both he and his students will encounter in their various activities. The student teacher must develop an awareness of the knowledge he has to possess in order to function at an optimum level in the industrial arts laboratory. There is also need to develop in those same student teachers an awareness of the responsibility they will face to conduct their classes in as safe an environment as is possible and at the same time instill in their own students that same awareness of safety that will continue from the school laboratory into their lives beyond the school.

The purpose of this study was to develop and explore the feasibility of a computer managed instruction system to deliver a series of safety tests: tests that would provide the instructor with an indication of student strengths, give the student specific remediation when required and provide for that student an inventory of learnings to maintain an awareness of personal achievement.

The system was also designed to try to develop a safety knowledge that would foster safe working habits and develop safety awareness and responsibility that would be carried from the university laboratory into the school shop.

The procedures used for this study were divided into five stages. Stage 1, the development of the test material which concentrated on the development of specific test objectives, test topics and the writing of suitable test items. Stage 2 saw a review of the safety tests to make sure they conformed to the objectives, and in stage 3 the safety tests were authored into the PLATO Learning Management System. In stage 4 an analysis of results was carried out and finally stage 5 concentrated on an assessment of the suitability of the PLATO Learning Management System to deliver and manage the safety tests.

The research indicated that the use of the computer managed instruction in safety education was viable in that it provided for the instructor sufficient feedback regarding student progress, strengths and difficulties. Secondly the research indicated that the system was able to provide feedback to the student regarding personal achievement. The third and final part of this research, that of an analysis of results, was unable to be carried out completely as a number of data set translation problems arose that were unable to be resolved at the time of writing. The partial analysis that was undertaken did not indicate that the PLATO Learning Management System was, through its data gathering capability able to provide an indication of overly difficult, overly easy or ambiguous test items.

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"Life is intrinsically dangerous. Life is partly routine, to be sure, but more fundamentally it is an experience of the unknown and hence based on adventure ... The prime quality in safety, therefore, is not the removal of danger but an improvement in the quality of adventure"

(Whitney, A.W., Safety for Greater Adventure, in Stack, H.J., and J.D. Elkow, Education for Safe Living, 1966, p.13)

CHAPTER 1

INTRODUCTION

ORIENTATION TO THE PROBLEM

The human element is the most significant factor related to accident causation. The correction of such human failing is dependent upon a number of factors, Frenze (1973) notes:

> "One of the principal reasons why unsafe acts are committed... is that those who commit them don't know what they do is unsafe or incorrect" (p.33)

Frenze further notes that the correction of the unsafe act depends upon training, education and motivation to ensure procedures are followed. (ibid)

In a school laboratory environment the student is faced with a series of decisions regarding the task he is to perform and the machine or process he is to use to complete the task. In order for the student to move towards his objective a number of processes have to take place. First the student must make decisions and based on those decisions take certain risks. To do this, the student first needs information upon which to base his decisions; the better the information the better the decision, and subsequently the more calculable the risk. If the student's information is poor or insufficient there is greater chance for a poor decision being made and hence a greater risk. Secondly, if the student's task involves the use of a machine, that machine must function without failure: poorly maintained machines or those misused due to lack of safety knowledge could themselves be the cause of an accident. The reduction and/or elimation of school shop accidents then becomes dependent in large measure on the ability of the teacher to anticipate unsafe acts and recognize the steps that should be taken to ensure proper behavior. A superficial knowledge of operational procedures is not enough to ensure safety; therefore the teacher must become familiar with each piece of equipment, its parts, the correct handling procedure, the hazards involved and the precautions necessary to guard against those hazards, (Florio and Stafford, 1969, p.303)

The development of knowledge and its subsequent evaluation in the area of safe operational procedures then becomes a very important factor in the training of industrial arts teachers.

This study tested the feasibility of a computer managed instruction (CMI) system, specifically the PLATO Learning Management System (PLM) to deliver a series of safety tests for various pieces of equipment and processes used in the industrial arts metalworking laboratories at the University of Alberta. The safety tests were directed toward those prospective industrial arts teachers enrolled in EDIND 211 (Metals and Materials 1) and EDIND 412 (Metals and Materials 1A) to provide, for the instructor, a systematic check of student readiness to perform in a safe manner.

The use of the computer managed instruction system was based on its perceived role in education and its potential for use in the delivery of the safety tests. Baker, F.B.

(1978), notes that with the use of CMI the teacher is freed from many clerical-level tasks through the automation of diagnosis and prescription at the unit-of-instruction level, which allows more time to be put to instructional-related tasks. Baker also notes a shift by the teacher towards a more managerial role, one endorsed by Ziel (1971, p.95) in his description of the industrial arts teacher. With the use of CMI "the teacher-manager is now in a position to manage on a basis of data rather than intuition and judgement". (Baker, F.B., 1978, p.386), an important consideration in the area of safety.

NEED FOR THE STUDY

In 1976, the last year for which figures are available, there were more than 1,071,000 work related injuries and illnesses among a total of 8,500,000 workers employed in Canada. (Workers Compensation Board, cited Clark, 1979, p.2) These figures do not include those injuries not claimed or not covered by the Workers Compensation Board. Clark also notes that approximately 54 percent of these injuries and illnesses involved no loss of time except on the day of the injury, however the remaining 46 percent accounted for the loss of almost 12.3 million work days, each injury involving a loss of approximately 25 work days. This loss is estimated to be equivalent to the loss of production for one full year of 49,000 full-time workers. Over the nine year period 1969-1978 work related injuries and illnesses increased 35 percent overall, disabling injuries increased 69 percent and non-disabling injuries 15 percent. It should be noted however that in this nine year period employment increased 29 percent causing the accident incidence rate (the number of injuries and illnesses per one hundred workers) to increase only marginally from 12.1 to 12.6. This figure is however disputed by Clark (1979) who suggests that it could be as much as 20 percent higher due to statistical error. (p.2) The cost in medical benefits of these work-related injuries went up from $274 million in 1969 to $976 million in 1978. In terms of total industrial cost however the figure was in fact a great deal higher, using the ratio developed by Heinrich (1959) of 4:1, (the total loss concept) that is, indirect costs, which include pecuniary-measures for failure of business to meet customer demand, lowered employee morale, decreased efficiency and lost supervisory time, to direct costs such as medical aid and compensation for lost earnings, the industrial costs amounted to $3.5 billion. (Work Injury Experience and Costs in Canadian Industry. (1969-1978)

In the Province of Alberta, the number of work-related accidents and illnesses in 1973 (the first year of available figures) totalled 79,895 for a total working population of approximately 549,000. These accidents accounted for 1.9 million work days lost at an incidence rate of 14.5 work days per one hundred workers. By 1977, the last year for which figures are available, the number had risen to 109,131 work related injuries and accidents in a working population of 710,000. Days lost had increased to 2.7 million and the incidence rate to 15.3 work days per one hundred workers. (Alberta Workers Compensation Board Estimates of Employees by Province and Industry, nd.)

The report of the Industrial Health and Safety Commission of Alberta, 1976 (The Gale Commission) notes that the paramount cause of accidents is the indifferent attitude of those involved (p.38). Furthermore, the commission also noted that attitudes towards safety are most easily developed in individuals in their formative years and once established in mature individuals are difficult to influence. (pp. 84-85) The commission report recommended therefore that:

> "the basic goal (of education) must be to raise the overall level of awareness towards all matters relating to ...safety" (p.96)

The commission also recommended that the government play a vital leadership role through the Department of Worker's Health Safety and Compensation to co-ordinate all the educational processes in this field:

> "It (the department) should support, guide and direct these (the educational processes) toward the ultimate goal, the worker at the work site and stimulate the various professional organizations to establish standards of competence...We also suggest that greater emphasis be placed on safety...education in the school system" (p.97)

During February 1979 a meeting on industrial education, occupational health and safety chaired by Professor A.K. Deane of the Department of Industrial and Vocational Education at the University of Alberta was attended by industrial education representatives from the Edmonton Separate School Board, the Provincial Department of Education and the Department of Occupational Health and Safety. The following areas of concern were identified:

1 There is need for greater awareness of safety by teachers at all levels of education. Specifically, teachers should be made aware of the 1976 legislation on occupational health as it applies to the school situation.

2 There is an urgent societal need for a change of attitude towards safety.

and

3 Schools need to meet minimum standards for safety as required by the 1976 provincial occupational health and safety legislation. (personal correspondence, A.K. Deane, February, 1981)

A 1979 discussion paper emanating from the Research and Education Branch of the Occupational Health and Safety Division of the Alberta Department of Labour concludes that safety training in Alberta schools is generally inadequate.

(personal correspondence, A.K. Deane, February, 1981)

SUMMARY

An industrial arts teacher working in a student laboratory environment is faced with potentially hazardous conditions that require knowledge of the many contingencies both he and his students will encounter in their various activities.

The preparation at the university level, of these same Industrial Arts teachers, in Metals and Materials requires therefore that their safe working knowledge of metalworking equipment and processes be assessed and evaluated and specific remediation be given when required.

This process of knowledge assessment and remediation however, becomes especially difficult in the industrial arts laboratory because of the many and varied routes chosen by the student to complete the metalworking course. In the laboratory area the instructor is faced with the task of providing and assessing specific safety knowledge on a variety of processes and/or procedures to individual students throughout each laboratory hour. While this methodology is in itself a valid and often necessary one it does however lack uniformity and consistency, a serious omission in safety education. Secondly, and just as importantly, the methodology does not provide an assessment of student knowledge except through detailed observation, a luxury unable to be afforded by the instructor when surrounded with other potentially hazardous conditions. Finally, due to lack of feedback, little or no remediation can be given to the student to correct the decision making process he is using to complete the task and so lower the potential risk involved.

There is therefore no systematic methodology devised for use in the industrial arts laboratory to determine student safety knowledge.

This pilot study has been carried out on the premise that there is need for improvement in the knowledge component of Industrial Arts safety curricula. Secondly the study seeks to define a methodology of safety education, using computer managed instruction, for Industrial Arts teachers that is viable in a teaching laboratory or work shop.

STATEMENT OF THE PROBLEM

At the university level there is no systematic method of measuring industrial arts student teacher knowledge of safe conditions and procedures that works within the usual constraints of an industrial arts laboratory. Furthermore, even when a deficiency in knowledge does exist or is thought to exist, no convenient means of remediation of the deficiency is readily available.

PURPOSE OF THE STUDY

The purpose of this study was to develop and explore the feasibility of a computer managed instructional system to deliver a series of safety tests, tests that would provide the instructor with an indication of student strengths, give the student specific remediation when required and provide for that student an inventory of learnings to maintain an awareness of personal achievement.

The study sought answers, based on the development and implementation of that system to the following questions:

- given the need for instructor feedback will the computer managed instruction system, specifically the PLATO Learning Management System, provide an indication of student strengths, difficulties and progress?
- given the need for student feedback, is the system able to provide an inventory of learnings that maintain an awareness of personal achievement?
- given the need for item (question) feedback, is the system able, through its data gathering capability, to provide an indication of overly difficult or ambiguous items?

Finally, the study, given its exploratory nature, sought to describe the overall suitability and ease of use of the system for users specific to this study.

SCOPE OF THE STUDY

This study was delimited to the development and initial assessment of feasibility of a computer managed instruction system used to deliver several specific safety tests for a number of different pieces of laboratory equipment or processes used in EDIND 211, Metals and Materials and in EDIND 412 Metals and Materials, 1A, at the University of Alberta.

Furthermore, the trial and initial assessment of the system was delimited to a small sample of EDIND 412 students.

ROLE OF THE INVESTIGATOR

The role of the investigator in this study was as follows; under the direction of a senior instructor, the investigator was responsible for teaching course EDIND 412, Metals and Materials 1A at the University of Alberta Term 2, 1982. He was also solely responsible for the initial selection or writing and editing of all test items, and for development of the strategy used to carry out the data analysis using the Statistical Package for the Social Sciences (SPSS). The variable management strategy (VMS) was developed by the investigator after discussions with a senior instructor and with the Instructional Systems Group (Computing Services, University of Alberta).

PROCEDURES

The data used in this study were collected from those students enrolled in EDIND 412, Term II, 1982.

The procedures used in this study were divided into five stages:

1 the development of test material.

2 a review of the safety tests.

3 the authoring of the safety test material onto the PLATO Learning Management System.

4 an analysis of the results.

5 an assessment of suitability of the PLATO Learning

Management System and its ability to deliver and manage the safety tests.

The development of the test material concentrated on the development of specific test objectives, determination of suitable test topics and construction or selection of suitable test items. The safety tests were then checked for face validity and correctness of information. Authoring of the PLATO Learning Management System (PLM) included the development of appropriate PLM templates, entering of testing strategies, and test items, item feedback and specific remediation for each topic. Finally through the gathering of basic and summary PLM data an analysis of results was performed. This analysis was carried out to determine if overly difficult, overly easy or ambiguous items could be isolated. Lastly an assessment of suitability of the PLM system as a vehicle for managing the safety tests was determined.

SIGNIFICANCE OF THE STUDY

Attitude, environment, inadequate supervision and inadequate knowledge are, it is noted, the major contributing factors relating to the accident (Florio and Stafford, 1969, DeReamer, 1968 Heinrich, 1959, Stack, 1960, Strasser, Aaron, Bohn and Eales, 1973). Strasser et al, (1973), suggest that the "elimination of ... mishaps is based on learning and applying fundamental safety practices for each activity" (p.302). DeReamer, (1958) notes that group or mass training of people in the area of safety education holds an important place in that training; however he feels an individual approach should be effected to: compensate for; individual differences, differing rates of learning and interests, differing abilities and physical limitations. (p.47) The significance of this study was that it focused its attention on the feasibility of using a computer managed instruction, PLATO Learning Management System, approach to deliver a series of safety tests in an individualized instructional mode. A system that could provide, to the instructor, an assessment of the students' safety knowledge for the various metalworking equipment and processes used in the metalworking laboratory and correct inadequate knowledge through prescription for remediation when required.

DEFINITION OF TERMS

The following are definitions of terms used throughout this document.

SAFETY EDUCATION TERMS

Accident:

"An incident due to error in performance by man and/or machine in a particular environment ... and observable in the form of symptoms such as pain, injury, damage and/or destruction"

(Professional Preparation in Safety Education and School Health Education, p.2)

Safety:

"A system of science-based action-oriented components designed to affect optimal achievement of error-free and, therefore, accident-free task performances which involve man-machine environment relationships"

(Professional Preparation in Safety Education and School Health Education, p.2)

Safety Education:

"The process and methodology employed in conveying safety science subject matter ... designed to favorably influence decision making competencies ... demanded for accident-free performance in tasks involving man-machine-environment relationships"

(Professional Preparation in Safety Education and School Health Education, p.2)

GENERAL TERMS

Industrial Arts Teacher:

"A teacher-manager representing a dynamic technological society, possessing the requisite skills current in society and cognizant of the rapid changes taking place in technology"

(Ziel, H.R., Man Science Technology, p.95)

Computer Managed Instruction:

"A total education approach in which a computer based management information system is used to support the management functions performed by the teacher. This totality encompasses the educational goals, the curriculum, the instructional model, the teacher, and a management information system"

(Baker, F.B., Computer Managed Instruction, p.14)

Lesson:

A PLATO type file that holds author language code for a CAI activity. A PLATO lesson may replace a module, a test, introduce a course, or be a learning resource within the PLATO CMI system.

Test:

A series of questions (items) that include text and/or graphic material for querying the student and for judging student response.

PLATO Aids:

Those items available on the PLATO system and accessible to any user after sign-on to facilitate Instructional Systems Terminal (IST) usage.

Statistical Package for the Social Sciences (SPSS):

"A packaged program ...that will perform a specified set of operations, usually under the control of a simplified 'language' or set of instructions ...specifically designed to compute those statistics typically used by social scientists"

(Kecka, W.R., Nie, N.H. & Hadlai Hull, C., SPSS Primer, p.2)

SPSS File:

"A distinct group of information separated from another by magnetic code and containing a series of contiguous magnetically stored items of information" (records).

(Kecka, W.R., Nie, N.H., & Hadlia Hull, C.,

SPSS Primer, P.9)

PLATO CMI TERMS

The following terms are reproduced from: Control Data Corporation, PLATO Learning Management Authors Guide, Publication Numbers 97406200 and 97406300B, St. Paul Minnesota, 1982

PLATO Learning Management (PLM):

"(A) computer managed instruction system (that) manages testing, learning aid selection, and record keeping for individualized instruction as part of a PLATO system"

Author:

"A user who creates PLATO CMI modules and specifies their learning resources"

Course:

"A file containing a collection of modules, variable management strategies, feedback messages, and test controls"

Courseware:

"PLATO CMI courses and their component modules and learning resource files"

Data Collection:

"The recording by the PLATO system of student responses and other related data"

Feedback:

"Messages shown to the student in response to mastery or non-mastery of a question (item), instructional unit or module"

File:

"A collection of data stored within the computer system", (such as module files, learning resource files, course files and section roster files)

Function Keys:

"The keys provided on the right hand side of the PLATO keyboard that provide access to special functions"

Gradebook:

"A program that stores and retrieves student performance data"

Instructor:

"As used in the PLATO CMI system: a user who constructs a PLATO CMI course and supervises its use"

Instructional Unit (IU):

"The main component of a CMI module containing questions, a testing strategy, and a scoring procedure used to test mastery of a single educational objective"

Learning Resource (LR):

"Instructional materials accessible to students taking a PLATO CMI course and listed in the course for selection by the study prescription generator"

Module:

"A CMI file containing IU's, a testing strategy, a scoring procedure, feedback, and learning resources"

Objective:

"The statement describing what a student is expected to learn and how well he will be asked to demonstrate his learning"

On-Line:

"The state of being properly signed on to the system through a PLATO terminal"

Prescription:

"A list of learning activities selected on the basis of the objectives not mastered in a diagnostic test"

Question/Item:

"The parts of an IU that include text and/or graphic material for querying a student and for judging student responses"

Section Roster:

"The list of students registered in a course section"

Sign-On/Sign-In:

"A PLATO name registered in a PLATO user group roster and the user-selected password associated with that name. Also the act of typing that name, user group, and password to gain entry to the system"

Student:

"A user that is capable of interacting with certain prescribed PLATO CMI modules. He can take tests, review past performance, receive study prescriptions and read and write notes"

Student records:

"The performance records, statistics, and learning resource assignments for each student"

User:

"A person signed-on to the PLATO system. His sign-on can be that of an instructor, an author, (or) a student"

Variable Management Strategy (VMS):

"The controls given the instructor for governing student interraction with the system and its courseware. The VMS is designed to provide the student with a number of alternative routes through the curriculum and can be set to present items sequentially or at random".

ORGANIZATION OF THE REMAINDER OF THE STUDY

Chapter 2 is divided into three major parts; the first deals with a review of current literature regarding the usage of computers in education, computer managed instruction and three related studies describing the uses of computer managed instruction. The second section concentrates on safety education and the relationship between a person's attitude and safety. The final section is a review of the literature dealing with criterion referenced testing.

Chapter 3 details the methodology used in this pilot study with emphasis on the PLATO system, module design and development, instructional design and item analysis.

Chapter 4 lists the findings of the study.

Chapter 5 summarizes the conduct of the study and presents the conclusions. The findings and conclusions are then discussed and suggestions for further study made.

CHAPTER 2

REVIEW OF LITERATURE

COMPUTER BASED EDUCATION

The process by which a person learns can be divided into three distinct steps. First the student must be exposed to some material or stimuli, next he must interact with that material in an active manner such as writing, talking, thinking or reasoning, and finally that interaction must be evaluated and reinforced. (Holland, 1976, p.189, cited Eisele, p.2, 1980). Gagne and Briggs (1974) also outline similar criteria in their theory of the instructional process, and while Holland's view is considered by some (Eisele, 1980) to be superficial it does serve as a model from which technology can be devised.

Such technology has been devised in the form of the computer which over the ensuing years has developed from the teaching machine, which by todays standards should not be considered a computer, and in which the "dynamic component of the programs was largely illusory" (Evans, 1979, p.117) to responsive delivery systems which allow for input via a keyboard and/or a touch panel. While these systems may never become highly sophisticated mediums for allowing complex learner response, they do provide a judgement of the adequacy of the response similar to that used in the teaching act. (Eisele, 1980, p.6) Whatever that judgement is however, is of course dependent upon the nature of the lesson design.

Computer applications in education cover many areas, such as school administration, planning, record keeping, preparation of reports and class programs or schedules, all of which can be taken care of both efficiently and dependably using the computer. However through the use of interactive systems the computer is more and more being used as:

> "an instructional vehicle when some sort of adaption in the mode or context of instruction must take place between the learner and the instructional program"
>
> (Dyer, 1972, p.35)

Dyer (1972) also notes two major applications in the context of the computer as an instructional vehicle:

> - applications that include programs that provide drill in various subject matter skills, and programmed assistance for teachers in lesson planning or course development.
>
> - applications that permit completely individualized pupil placement, scheduling, testing and evaluation.
>
> (p.35)

Two major advantages of the computer in the classroom are again noted by Dyer:

> - programmed machinery can 'know' everything possible about a pupil, yet retain objectivity needed in order to make a decision based only on the criteria which are significant to the pupil's progress.
>
> - teaching programs will not 'get frustrated or tired'
>
> (pp.34-35)

Caldwell (1980) writes that computer technology and its related instructional capabilities have an ability to:

> - provide interactive instruction where learners become active participants in the learning process.
>
> - provide alternative learning paths within lessons or courses

- offer independent pacing for individuals so progress can be affected at a rate suited to their learning style.

- control reinforcement

- evaluate performance quickly and accurately and provide data on achievement that helps improve the effectiveness of the course.

- store information in massive amounts for use by the teacher and the students themselves in self-evaluation.

(p.41)

The use of the computer in the educational setting becomes then a total educational environment that offers an extensive array of learning alternatives not possible in conventional teaching environments. The capabilities of the computer have been applied to that same educational environment in a number of distinct ways such as computer assisted instruction (CAI) where direct interaction with the computer may take the form of a drill-practice routine for one student, or a simulation for a group of students, or computer managed instruction (CMI) which uses the computer as a means of assistance in classroom management. This latter computer function often includes the administration of tests, the scoring and diagnosing of student abilities, as well as the monitoring of the learning sequence so as to provide the student with a formative evaluation and a record of progress. Whatever support the computer lends however, the primary purpose is to assist in the individualization of instruction. (Caldwell, 1980, p.141)

Some misgivings regarding computer based education are however being expressed. Avner (1978, p.24) notes that like any other medium, computer based education uses certain techniques which may be of instructional value in some situations but not effective in others or conversely, where potentially effective, they are not being used at all. Avner also stresses that how the medium is used is more important than the fact the medium is used at all. (p.24) Caldwell (1980, p.143) notes similar caution, in that with the use of the computer in education the student has been placed into a passive role with the teacher operating under the assumption that knowledge must be inserted into the heads of the learners. Programs must be developed, Caldwell writes, that "allow students to access information in a meaningfull way and one that contributes to meaningfull learning patterns." (p.143)

COMPUTER-MANAGED INSTRUCTION

Computer managed instruction (CMI) is one computer development devised from a myriad of 'modern' technology and technical expertise. Allen (1980, p.33) defines such computer developments as "the use of the computer to solve instructional management problems". Allen further suggests that the emphasis of CMI should be placed on the management aspects of the classroom and not on the delivery of instruction as is computer assisted instruction. He further notes that CMI has come to mean computer based assistance in the management of individualized instruction, which in turn, involves the generation of study prescriptions as well as the keeping of student records. (p.34) Allen divides CMI into three basic components, that of a testing component, a record keeping and record generation component and a study prescription generation component. Baker (1978, p.14) defines CMI as a "management information system used to support the management functions performed by the teacher". He sees CMI as being used within the context of a total educational program rather than as a learner-oriented system, and like Allen divides CMI into a number of specific components: a curricular plan, an instructional model, diagnosis and prescription management and reporting and the computer. (p.21) The following comparison can be made to those components described by Allen. (figure 1 below)

Figure 1

Components of CMI

BAKER		ALLEN
curricular plan testing component	————	testing component
management reporting	————	record keeping record generation
diagnosis and prescription management	————	study generation

THE TESTING COMPONENT OF CMI

The testing component of CMI is the computer equivalent used to meet the needs of many human measurement operations, and is also adaptable to the support of the many facets of test preparation. Lippey (1974, p.4) notes that "self paced learning ...requires frequent use of diagnostic and evaluative instruments". Lippey further notes that assistance by the computer in test construction can be interrelated with a number of sub-systems each reinforcing the other, such as item statistics and directions to students toward specific sources for remedial study. (p.22) Allen notes (p.35) that CMI uses "testing for the purpose of determing which learning activities would be most beneficial and whether the student is ready for more advanced material". The major decisions CMI makes are based on mastery of the learning experiences in accordance with the principles of learning, therefore implicit in the testing component is the concept of behavioral objectives, as these provide the explicitly-written criteria for mastery of a subject. In this regard Allen notes:

> "Since it is impractical and wasteful of student time to ask every question which would assess mastery of a defined behavior stratified random sampling of a ...question pool is both ...real and ...practical"
> (p.36)

One consequence of behavioral objectives is that the learning task is broken down into a number of elements which can then be rearranged into different sequences dependent upon the material being presented, for example, social studies might use a chronological order; industrial arts and science a major topic order; and mathematics a building block sequence. Baker (1978, p.24) identifies five such sequences: linear, strand, block, tree, and menu. Generally speaking these sequences, with the exception of the menu plan, are used at the elementary and secondary school level in various forms and degrees of complexity. The post-secondary level tends to favor the menu plan. Baker writes:

> "Under this (the menu) plan the total course is divided into modules or units that are unstructured. The student is free to select any module to study. When it (the module) is completed, he is free to select from the 'menus' of remaining modules"
> (p.24)

It should be noted however, that the degree of differentation afforded to a student within any of the curricular plans is quite low. Kearsly (1978, p.7) notes that from an instructional design perspective, there are of course optimal ways to organize and present a subject, however allowing a student to alter this design structure would result in a less than optimal product. Kearsly concludes therefore that little or no acknowledgement of individual student differences exists in any curricular plan without some form of learner control.

THE RECORDKEEPING AND RECORD GENERATION COMPONENT OF CMI

The recordkeeping and record generation component of CMI is perhaps the most important function of this type of individualized instruction. Baker (1978, p.35) suggests that one of the primary causes of the emergence of CMI was "a recognition of the unmanageability of highly unitized, rate of progress, individualized instructional schemes". In this instructional mode the students naturally spread themselves over the range of the curriculum each requiring instructionally relevant data and each demanding considerable managerial attention from the teacher.

Records must be kept on students during the instruction process so that subsequent decisions made by either the student or the teacher can be made in light of more than just the immediate past. (Eisele, 1980, p.3) Baker (1978, p.41) writes that the recordkeeping and record generation functions of CMI can and should be divided into cycles that reflect the teacher management functions within the educational setting. These are: instructional, course and program. At the instructional level the teacher is concerned with the unit-of-instruction cycle, that is the assigning of a unit of instruction to a student after determining the prerequisites, administering a pre-test, scoring the test and making a mastery or non-mastery decision, deciding on remediation in the case of non-mastery and the administration and scoring of a post-test. Once the student has completed the task the cycle will begin over again. The course level of management concerns itself with the responsibility of the teacher to have a student finish a unit of instruction at a reasonable rate in terms of the type of instructional unit being employed. This function would then be concerned with scheduling, pacing and educational expectations. Finally at the program level the teacher is concerned with the educational program of a student, attainment of educational goals, curricular improvement, instruction of courses and the quality of educational programs. Eisele (1980, p.3) notes that the most important of these functions is the desirability of providing an inventory of learnings and experience to individuals to maintain an awareness of their own status. Allen (1980, p.34) writes that CMI generates large volumes of data which must be manipulated and stored in such a way as to serve two primary functions, that of indicating student strength, difficulties and progress and validating test items, objectives, and instructional materials. Hazen (1980, p.281) noted that the recordkeeping function of the CMI system is also useful as a research tool in terms of CMI evaluation. Data collection is, she writes, "relatively easy, inobtrusive and has the added advantage of being collected over a long period of time". The major problem however with the recordkeeping and record generation component of CMI is as Baker notes (1978, p.303) its limitation to symptomatic diagnosis. The information given is at a basic level of management and consists of objectives passed or failed, test scores and dates on which tests were given or assigned. None of this information is integrated in a diagnosis and therefore the teacher is left to interpret the data on a judgemental basis for his students.

THE STUDY GENERATION COMPONENT OF CMI

Kalisch (1978, p.37) writes that the purpose of the CMI study generation or prescription component is to direct the student to areas that only require his or her attention or to areas of the students' interest.

> "prescription frequently direct individuals to specific pages or chapters of books, to video, or audio tapes or to other instructional materials"

Allen (1980, p.37) notes that the computer reading the data generated by the tests given, as well as any additional data provided by the instructor, can compare diagnosed needs with a list of instructional materials, then select and present a study prescription to the individual student. It is noted by both Allen (1980) and Baker (1978) that any system which does not generate study prescriptions is not CMI and that both diagnostic and prescription procedures should be an integral part of any CMI system. "The level of diagnostic information given by any CMI system is considered to be at a rather 'crude' level of detail" (Baker, p.31) The computer in no way, it is noted, Baker et al., makes a diagnosis of why the student has not mastered a given objective, it only indicates the status of the student relative to the curriculum.

Two types of prescription are generally used in most CMI systems, the forward and the remedial. The forward, based on the student's mastery of a given unit, will allow that student to select the next module on the menu. The remedial prescription is based on the student's non-mastery of a given unit and takes two forms, that of having the student re-study the material or assigning the student to some educational activity or resource. Baker (1978, p.32) has noted that most "CMI prescriptions tend to be remedial in nature" and most prescriptions, except those especially contrived to fit a single objective, cover several objectives. One extension of the concept of study prescriptions is noted by Allen (1980, p.38) and is used on the PLATO system. Here the percentage of times each available resource has been found to bring the student to a mastery status is recorded. The system then references this 'success' information in order to select the resources having the best potential for meeting a student's needs.

THREE RELATED STUDIES

The following three studies describe the different ways in which CAI and CMI have been used in education. The three studies are:

1 The Wisconsin System for Instructional Management (WIS-SIM)

2 A Computer Assisted Study Management System (CAISMS)

3 An Alternative Curriculum For Computer Literacy Development (ACCOLADE)

THE WISCONSIN SYSTEM FOR INSTRUCTIONAL MANAGEMENT

The Wisconsin Ssytem for Instructional Management (WIS-SIM) Spuck and Bozeman, 1978, became operational in 1974 using the Madison Academic Computing Center's UNIVAC 1108 computer. The system was pilot tested from 1975 through 1977 when the project was concluded, and served a total of 1350 students.

The WIS-SIM program was a computer-based management information system designed to aid teachers with record-keeping and the other clerical tasks involved with the individualization of instruction. The program, Spuck and Bozeman note, (p.33) was not curricular but had as its basic premise the collection and processing of student information that was "directly applicable to instructional decision making". The underlying assumption of the program was that when appropriate information was supplied to teachers, students and administration, the quality of decision making improves and can be evaluated. The WIS-SIM program supported a comprehensive system of education designed to produce higher educational achievement by providing an individual rate of learning and learning style.

The system was also an interactive one in that the user could communicate directly with the computer via terminals located in various schools. Operators could enter information such as student achievement data, new student enrollment, deletion of students from the school roster as well as comments regarding the students and their test scores. Reports from the system took the form of student performance profiles either individual or group, student listings, instructional grouping recommendations and a program of study recommendations.

In their evaluation of the system, Spuck and Bozeman, noted that the system rated quite highly in terms of usefulness. Also noted was teacher planning time. Actual time taken to complete a task did not change, however the process itself became more efficient and effective and more was accomplished. The use of the WIS-SIM program also indicated, during the evaluation period, a positive trend in student achievement. Spuck and Bozeman suggest however that this finding should be interpreted with some caution as a large number of other factors in the school environment may have contributed to the trend.

A COMPUTER BASED STUDY MANAGEMENT SYSTEM

The Computer Based Study Management System (CAISMS), Anderson, T.H., Anderson, R.C., Dalgaard, B.R., Wietecha, G.J., Biddle, W.B., Paden, D.W., Smock, H.R., Allessi, S.M., Surber, J.R., and Klemt, L.L., 1974, was designed to maintain attentive study of instructional materials in an introductory level, college economics course and served 70 students. CAISMS was delivered using a PLATO IV computer terminal. PLATO, Anderson et al. (p.38) note was chosen for the project for two reasons: first its capacity to present material in a pictorial, diagramatic and graphical format and second in a response mode, "PLATO ...permit(s) fairly sophisticated treatment of freely composed natural language answers".

The system itself was designed around existing materials which primarily consisted of the textbook being used in the economics course. A number of summarizing statements on the most important points presented in the text were prepared which then served as the basis for the generation of the test items. The test items were then formulated using either paraphrases of the language of the text or examples of the concepts different from any appearing in the text. By using this method it was felt that the student would have to have a more than superficial understanding of the text material to answer the questions correctly.

The system itself required that the student use it for only approximately a fifteen minute period per hour of studying, typically during this period the student would sign on to the PLATO terminal and be provided with a specific study assignment, the student then leaves the terminal to study the assignment given. As he signs-off, a seven minute delay is placed on the system, during which time he cannot sign back on. Once the student has completed the assignment he then goes back to the terminal signs-on and is given a test on the assigned material. No feedback is presented until all the items in the item pool have been presented and answered.

The criterion level for this program was set at 75 percent and if a student did not achieve this he was required to re-take the test. Prior to the re-take however a 'lockout' was again placed on the system during which time the student was to re-study the material he missed. If the student achieved mastery on the first test he was then routed through a pass routine to a new assignment.

Anderson et al. found in their evaluation of CAISMS that it functioned well in the structure of an ongoing college program. They also found that student study habits improved and that students using the system scored higher than those students not using the system. The authors do note however, that the evaluation information should be considered "only suggestive" and that several modifications to the system would have to take place to increase its impact.

AN ALTERNATIVE CURRICULUM FOR COMPUTER LITERACY DEVELOPMENT

An Alternative Curriculum for Computer Literacy Development (ACCOLADE), Denenberg, 1980, was implemented on a pilot study basis with ten learners and two teachers. The system was designed to offer a curriculum system that allowed students to educate themselves about computers. (p.56) To acquire the computer literacy knowledge the learner first had to use the computer to search through a number of literacy topics, then through the use of a number of responsive display devices the student was shown the structure of the topic:

> "to gain the skills of logical thinking, problem solving and learning confidence... During the learning session the learner works with the other learners ...using a programming language to solve case study problems associated with the learner's discipline and interests"
> (p.57)

If a learner wished to accredit the experience to his record he could self-administer a range of criterion referenced tests using a CMI PLATO system. The CMI system was set up to handle testing, grading recording, reporting, diagnosis and prescription, as well as monitoring test progress, learner-computer transactions, issuing management reports and performing continuous item analysis for each question so that poor questions could be improved or eliminated. The system was considered to be reasonably successful in that it demonstrated an alternative and quite effective teaching-learning device. (1977, p.72) Denenberg also noted that the PLATO terminal provided an excellent communication medium between the learner and the computer, affording the learner an easy-to-use, highly controlled search tool.

The CMI reports obtained from the PLATO system were quite comprehensive. The total number of visits to each of the components of the system was recorded as was the specific learner path through the program. The PLATO system also provided data upon which decision making could be based. Such decision making centered around the quality of the questions being answered: was the question too hard, tricky, ambiguous, highly positive or negative discriminating?

The system as a whole was noted (p.172) to have demonstrated a reasonably effective teaching machine that allowed the learner the educational alternative of taking responsibility for effecting his own education. The system was also noted to be moderately responsive to learner and teacher needs and their requirements.

SUMMARY

The use of computers in education points to computer usage serving two important functions in the total educational process: that of instruction and management. These functions allow the student to effect their own learning and allow teachers to collect data that provides viable decision making capabilities.

The Wisconsin program describes a CMI system using a UNIVAC 1108 computer that provided a management information system to support decision making on behalf of students, teachers and administrative staff. The system was found to be reasonably successful. The CAISMS program was designed around a totally different concept and interactive computer device. In this case a PLATO IV terminal was chosen to provide, through its CMI learning management system, a series of tests based on the students' text material as an aid to learning and improving student study habits.

The remaining study ACCOLADE, like the CAISMS system also used PLATO. However in this case a PLATO Learning Management (PLM) System was developed to allow the student to effect his own learning through a series of criterion referenced test.

SAFETY EDUCATION

> "In the development, of 'safety awareness' the aim is to condition a person's mind so that whenever there is one element of danger present, a sixth sense will cause him to react in the safe way"
>
> (DeReamer, 1958, p.16)

The conditioning of a person's mind to develop a 'safety awareness' is generally categorized into three areas of concern: accident prevention, safety programs and the fundamentals of safe living. Florio and Stafford (1956, p.11) note that in the area of accident causation the primary factors are, 1) unsafe behavior, 2) inadequate knowledge, 3) insufficient skill and 4) improper attitudes and habits. Florio and Stafford further note that several of these factors usually operate together and it is not always possible to isolate one particular attitude or characteristic responsible for the accident. Strasser, Aaron, Bohn and Eales (1964, p.302) feel the human element is the most significant factor related to accident causation and they like Florio and Stafford list four factors in that area. These are: 1) attitude, 2) environment, 3) inadequate knowledge and 4) inadequate supervision. They feel that the "elimination of such mishaps is based on learning and the application of fundamental safety practices for each activity". Safety programs they note (p.107) must be approached in a positive, business-like manner and a well balanced program should be developed to take advantage of all well known and proven principles and techniques of accident prevention. Among the basic elements they stress are: the keeping of accident records and reports, enforcement of safety rules and regulations, education, training incentives, evaluation and research. Heinrich (1956, p.113) feels safety programs must be based on all the "pertinent facts of accident causation" to which he suggests there are four types of action available: 1) engineering revision, such as the removing or guarding of a potential hazard, 2) persuasion and appeal, which includes instruction, 3) personal adjustment, and 4) discipline. Heinrich also notes that the individual person as a result of proper supervision, safety education and personal initiative can correct his own safety practices and can also maintain safely a good part of his physical environment. (p.45)

DeReamer (1956, p.47) notes that group or mass training of people in the area of safety education does in many cases hold an important place in that training, however he also feels an individual approach to instruction must be effected to facilitate individual differences, a person's rate of learning, his interests, abilities and physical limitations. "Personalized safety training can be specific, group training must be general".

Worick (1975, p.25) also notes criteria similar to those of Florio and Stafford. These are: 1) inadequate knowledge, 2) insufficient skill, 3) environmental hazards, 4) improper habits and attitudes, and 5) unsafe behavior. Proper knowledge, notes Worick, enables the individual to recognize and evaluate dangerous situations. This combined with their personal skill is an important determinant in accident prevention. Like Heinrich, Worick suggests the environmental hazards should be engineered out of society and a person be educated to rid him of faulty habits and attitudes which are prime accident producers. Unsafe behavior, he notes, is the end result of a person's failure to develop proper habits, attitudes and knowledge regarding safety. "Safe behavior entails responding correctly under all circumstances and avoiding ...high risk situations". (p.25) Worick further notes (p.45) that "teaching methods must be positive in nature with the constant reinforcement of safety knowledges being standard procedure".

For Worick, safe behavior is the optimum performance of a progression of seven processes which are as follows: 1) identification, the hazard is first identified, 2) assessment, the hazard is assessed in terms of risk, 3) decision, once the risk has been assessed the decision for safe performance is taken, 4) performance, safe performance takes place, 5) evaluation, after the performance has taken place, the action is evaluated, 6) modification, once the performance has taken place and been evaluated in terms of safe behavior the action might need modification to make it even safer, and 7) application, at this point in the process experience is applied to the task so as to reach the desired goal of safe behavior.

> "We know that behavior may be changed as a result of an increase in man's knowledge, improvement in his skills and modification of his attitudes" (Thyerson, 1976, p.97)

Thyerson further notes (p.97) that safety rules as such should not be emphasized as these lie at the lowest level of cognitive learning: a student may know the rules but never apply them. To influence safe behavior, concepts must be developed that lead to good 'safe' decisions being made. Safety concepts must "equal the major mediating variable in human decision making and purposive behavior" (Woodruff, cited Thygerson, 1976, p.113). It is therefore necessary to replace the safety rule with the conceptual statement.

Strasser et al. (1964) feel that only through safety education can a safety philosophy be developed in the student. Behavior they note:

> "is controlled by values, attitudes, and habits which in turn, are developed and modified by the acquisition of knowledge and experience"
>
> (p.55)

Florio and Stafford (1956, p.20) suggest a similar approach with emphasis being on the understanding of the many hazards one must encounter in daily life, the development of attitudes that predispose a person to adjust properly to his environment and mastering skills that enable a person to cope with potentially dangerous situations.

ATTITUDES AND SAFETY

The concept of an attitude is closely allied with that of emotion and is most often manifest when a person responds in a predictable manner.

"Attitude is generally conceptualized as a learned predisposition to respond in a consistent evaluative manner toward an object or a class of objects"
(Miller, 1969, p.3)

Many attitudes are latent; that is, the attitudinal response is dormant until required by that person, who, when given the appropriate stimulus, brings the attitude to the fore. The behavior exibited at this time is then in accordance with the feelings of that individual. Attitude is considered by many to be the most important concept of safe human behavior. Stack and Elkow (1966, p.39) note that many safety educators "consider them (attitudes) more important than either knowledge or skills". Brody (1962, cited Stack and Elkow, 1966, p.39) notes:

"I believe we can state that the relatively specific attitudes that need to be developed are those that convince the individual that accidents are hardly accidental ...that they are for the most part personally caused, and they they are controllable"

Florio and Stafford (1956, p.31) feel attitudes influence one's fundamental concept of honesty, work and personal responsibility. They feel that attitudes "determine the degree to which success is achieved in making adjustments to environmental conditions". Strasser et al. (1964) note that when safety is defined as a function of human behavior, the importance of controlling this behavior through the development and modification of attitude becomes very important. The role attitudes play however, becomes very complex and each situation brings many conflicting and supporting attitudes together which interact and determine behavioral response. Brody, et al. (1962) note that a number of suggestions have been put forward for the modification of attitudes toward safety and the determination of behavioral response. These suggestions include logical appeals to place safety education on the basis of reason, and the admonition and exhortation of the persons involved in the safety program to behave in a safe manner. However Strasser et al. (1964, p.188) suggest that little or no success has been achieved by any of these methods as they appear to inhibit rather than create any true behavioral change. They further note that "the principal aim of safety education ...centers around the modification and development ...of acceptable attitudes" (p.189) and like Stack and Elkow (1966, p.189) feel a problem solving technique should be developed to bring about that modification and development of acceptable attitudes. Also noted is that unlike other areas of education, safety education should be within the interest and capacity of the teacher as teacher enthusiasm is an essential part of the instructional process.

SUMMARY

It is now widely recognized that human traits are expressed in such terms as perseverance, curiosity and level of aspiration, as well as being a function of heredity and environment. Most writers in the field of safety education note that evidently accidents are multi-causal due to factors which are present at sometime in some people in certain settings. The concensus of opinion towards accident prevention points to a need to instill in people the concept that the development of protective skills rests with them, that human traits tend to increase human vulnerability to accidents which are centered around everyday environmental hazards, inadequate knowledge and insufficient skill to work at an optimum level in that environment, so creating improper attitudes and working habits. The authors feel that the elimination of the accident rests with the learning and application of fundamental safety practices for all human activity.

Attitude, it is noted, (Miller, et al.) is manifested by overt behavior and is often latent until recalled in response to the feelings of that person. Attitude modification is considered to be the most fundamental concept in safe behavior development. (Stack and Elkow, et al.) A number of methods have been suggested for modification purposes such as fear, humor and exortation. Most however, have been unsuccessful. What is suggested are the more standard teaching practices that allow a student to practice the safe ways demonstrated by the teacher, or a problem solving technique where the student moves through a set procedure identifying and assessing risk and making decisions on actions that must be taken to perform in a safe manner. (Strasser, et al., 1964, Worick, 1975)

CRITERION REFERENCED TESTING

Criterion referenced testing is used to "ascertain an individual's status" (Popham and Husek, 1979, p.133) with respect "to a well defined body of knowledge and behaviors" (Morgan, 1979, p.1). This standing:

> "is often represented in terms of a measure of performance (competency or functioning) based on the individual's test data, which is often, but not always independent of the performance of others that might be tested with that individual"
>
> (Ibid)

The individuality of the criterion referenced test then presents a number of problems in its analysis. Like the norm referenced test, items that do not discriminate between the knowledgeable and less knowledgeable learner must still be identified. However for the criterion referenced test the discrimination indices must be modified. Popham and Husek (1972, p.139) note:

> "an item which doesn't discriminate need not be eliminated. If it reflects an important attribute of the criterion such an item should remain in the test"

However they do caution that:

> "discriminating indices are little more than warning flags and one still must use common sense in weighing the worth of an item as a negative discriminator"
>
> (p.140)

Because of the criterion referenced tests concern with the relationship between a person and his own level of performance and not the performance level of others, traditional measurement practices to determine reliability and validity as well as interpret test results are not applicable.

RELIABILITY

Reliability, defined by Stanley (1971, cited Thorndike, 1971, p.356) as the "tendency toward consistency from one set of measurements to another" is as necessary in the criterion referenced test as in the norm referenced test, however determining reliability in the criterion referenced test becomes a difficult process. Ferguson, (1976, p.413) notes that the purpose of any (norm referenced) test is differentiation of individuals, he further notes that:

> "clearly a test on which every individual made a ...perfect score ...would serve no useful purpose"

The construction therefore of a norm referenced test attempts to ensure that the test scores have a fairly large variance in relation to the number of items the test contains. However the criterion referenced test is not intended to differentiate between individuals, and a perfect score would serve a useful purpose. Using traditional measurement techniques however the test would have a zero internal consistency estimate. Popham and Husec (1972, p.137) note that it is not clear what should replace the traditional indicies of internal consistency, and suggest estimates comparable to the standard internal consistency formulas, such as that suggested by Husek and Sirotnik (1968) or ingenious indices to reflect the ability of a test to produce variation from pre to post instruction testing.

Hively (1974, p.8) suggests the notion of reliability:

> "has to do with the accuracy with which one can estimate the probabilities of correct performance within a concrete domain"

He further suggests that in order to be able to estimate the probabilities of correct performance the goal of domain referenced testing is to "create an extensive pool of items that represent in miniature the basic characteristics of some important part of the original universe of knowledge". (p.8) In this way a student who is able to respond correctly to these items will be able to generalize to the field. (p.6) Baker, (1974, p.11) concurs and notes that:

> "A domain consists of a subset of knowledge, skills, understandings or attitudes where the essential attributes of the context which the student is expected to acquire and the behavior through which he or she is expected to demonstrate such acquisition are carefully described"

Morgan (1979, p.5) notes however that "it may not be possible to determine with absolute certainty that the level of performance on the domain of tasks.

VALIDITY

"The most meaningful measures of the value of a test are its validities" (Lord and Novick, 1968). Validity is defined as "the capacity of a test to predict some specified behavioral measure (or set of measures) other than itself" (Cattell, 1964 p.338) or the "accuracy of a specified prediction or inference made from a test score" (Cronbach, 1971, p.443). Like reliability, the procedures for the assessment of validity are based on the variance between the test score and an observed criterion and are best applied to the norm referenced test. In the case of the criterion referenced test, Popham and Husek (1972, p.138) suggest validation be conducted in terms of the adequacy with which the criterion referenced measures represent the criterion and therefore a content validity approach is more suited to such tests. Content validity, Cronbach (1971, p.444) notes is evaluated by showing how well the content of the test samples the class of situations or subject matter about which conclusions are to be drawn. Hively notes (1974, p.8) that:

> "validity has to do with the success of generalization from performance on a concrete domain to performance in the larger universe of knowledge from which the domain was generated"

The determination of validity in the criterion referenced test becomes then a determination of how well the test produces a clarified description of what an examinee's performance signifies. (Popham, 1978, p.155) To do this, test items should be homogeneous, that is the items should all measure the same variable or objective. (Davis and Diamond, 1974, cited Morgan, 1974, p.5) Cronbach (1971, p.457) notes however that:

> "judgement is required in establishing the accuracy of items as well as their relevance to the universe specifications. Test items should stand up under criticism from experts in the subject matter tested"

He further notes that:

> "an item ...should be consistent with the latest literature on the subject known ... not just with some out-of-date superficial conclusion

presented in a textbook"
(Ibid)

Secondly the validity of the criterion referenced test can be determined by its functional validity or the accuracy with which the test satisfied the purpose to which it is being put. (Popham, 1978, p.159) A set of items or tests must, suggests Popham, make accurate predictions. Finally, validity of the criterion referenced test can be determined by:

> (the) "accuracy with which the evaluator selected a particular domain to serve as the indicator of learner status with respect to a more general dimension"
> (Popham, 1978, p.164)

Domain selection is, notes Popham (1978, p.164) similar to those procedures used in the construct-validation approaches employed by the norm-referenced test.

SUMMARY

Criterion referenced testing is used to determine a person's status and is represented as a measure of performance independent of the performance of others. Because of this independence traditional measurement indicies cannot be used. What should be used to replace the traditional techniques is not clear, ideas range from estimates comparable to the standard internal consistency formulas for use when determining reliability to estimating the probabilities of correct performance within a concrete domain.

The determination of validity in the criterion referenced test also presents a number of problems. Here it is suggested that validation be carried out to determine the adequacy of the criterion referenced measures representing the criterion, or an evaluation be conducted to see how well the content of the test samples the class of situations about which conclusions are to be drawn.

CHAPTER 3

METHODOLOGY

PLATO CMI INSTRUCTIONAL DESIGN

PLATO is an interactive computer-based educational (CBE) system developed to enable instructors and courseware designers to create and deliver instruction.

When this study was conducted, PLATO at the University Alberta was using a Cyber 170/720 computer having 98,000 words of 60 bits each of central memory and 1,000,000 words of extended semi-conductor memory. (PLATO Aids, The PLATO Information Systems Terminal, Control Data Corporation, n.d.)

The PLATO Information Systems Terminal (IST) provides interaction between users and the computer, it is also capable of displays, animation and selective erase. The terminal is the primary device by which students, instructors and authors interact with the computer.

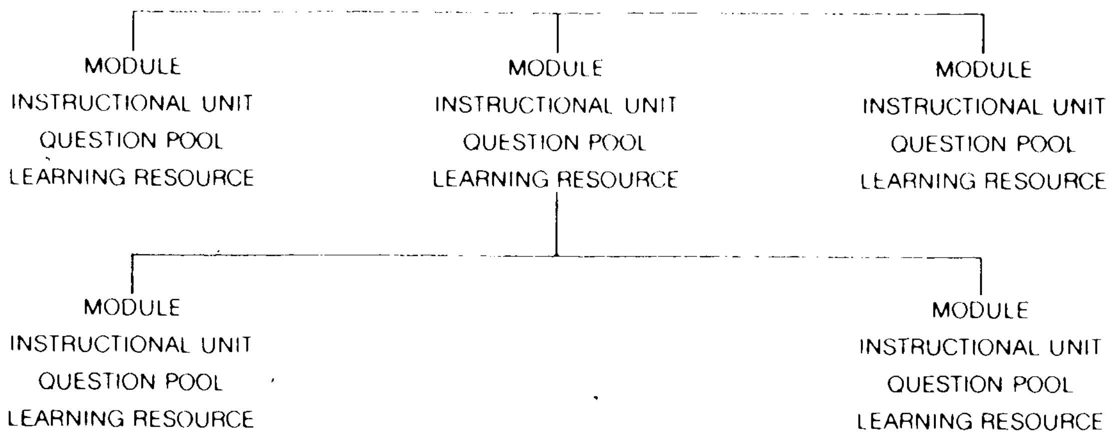
The primary means of input to the terminal is via the keyboard. However users can also enter information using a touch panel. The touch panel contains a 16 by 16 grid of electrodes defining 256 touch-sensitive areas. PLATO Demonstration and Evaluation, Computing Services, The University of Alberta, 1978)

PLATO LEARNING MANAGEMENT

The structure of the PLATO Learning Management System (PLM) is centered around the Group, a Curriculum, Modules, Instructional Units or Objectives, Question Pools and a set of Learning Resources or Remediation Prescriptions. (See Figure 2, PLM Structure, below).

Figure 2

PLM Structure



The PLM individualized instructional model is designed around a single module of which there are many within each course. After the student signs on to the system and is presented with a menu (of modules) or router lesson, he then selects the module he wishes to 'test out on'. Once that selection is made, the student is then presented with a series of questions (items) in the form of a test. If the test or module is not mastered, the student is given a selection of learning resources (LR's) particular to that module. (The LR's given the students in this study were in the form of page references taken from the textbooks used in the Metals and Materials courses. These assignments were not authored onto the PLATO system.) The studying of the LR's help the student continue toward mastery of that module and subsequently the course. After the student has studied the LR's and feels ready to demonstrate his learning, he can try the test again. (PLATO Learning Management Authors Guide, Control Data Corporation, 1982)

PLM DATA

The PLM system collects data into a student data file attached to a PLATO group. There are three types of data collection; basic, extended and summary. Basic and extended data are used to collect data from the test items presented to the student and only one or the other may be used at any one time. Test summary data gives overall test performance and can be used independently of, or with basic or extended data collection. Data collection can be turned off, set to collect data from each of the students first test, or set to collect data from every test. (PLATO Aids, The PLATO In Information Systems Terminal, Control Data Corporation, n.d.)

VARIABLE MANAGEMENT STRATEGY (VMS)

Variable Management Strategy (VMS) is designed to provide for the student a number of alternative routes through the curriculum. The VMS can be set to present sequentially or at random, both the Instructional Units (IU's) and/or the items in the item pool. (PLATO Learning Management, Authors Guide, Control Data Corporation, 1982)

PLATO PILOT STUDY INSTRUCTIONAL DESIGN

The CMI curriculum developed for this pilot study comprised twelve (12) safety modules each designed to complement the work being carried out by the instructor in the laboratory and each intended to expand student knowledge in the area of metalworking safety.

The modules themselves were delivered to the students via the PLATO Informational Systems Terminal. Each module was set up in the PLATO Learning Management Systems (PLM) by the Instructional Systems Group, Computing Services, at the University of Alberta. The Variable Management Strategy (VMS) within PLM selected for use in this study was to have the PLM system, after the student had selected a module, randomize the instructional units (objectives) within that module. The PLM system then selected one item from the pool within each instructional unit and presented that item to the student. The criterion level was set at 100 percent. The number of instructional units per module ranged from a low of ten (10) to a high of sixteen (16) with the average number of units being thirteen (13). The number of items in each item pool ranged from a low of two (2) to a high of seven (7). The pilot study used both basic and summary data collection which was set to collect data from every test the student took up to and including the first time he achieved mastery.

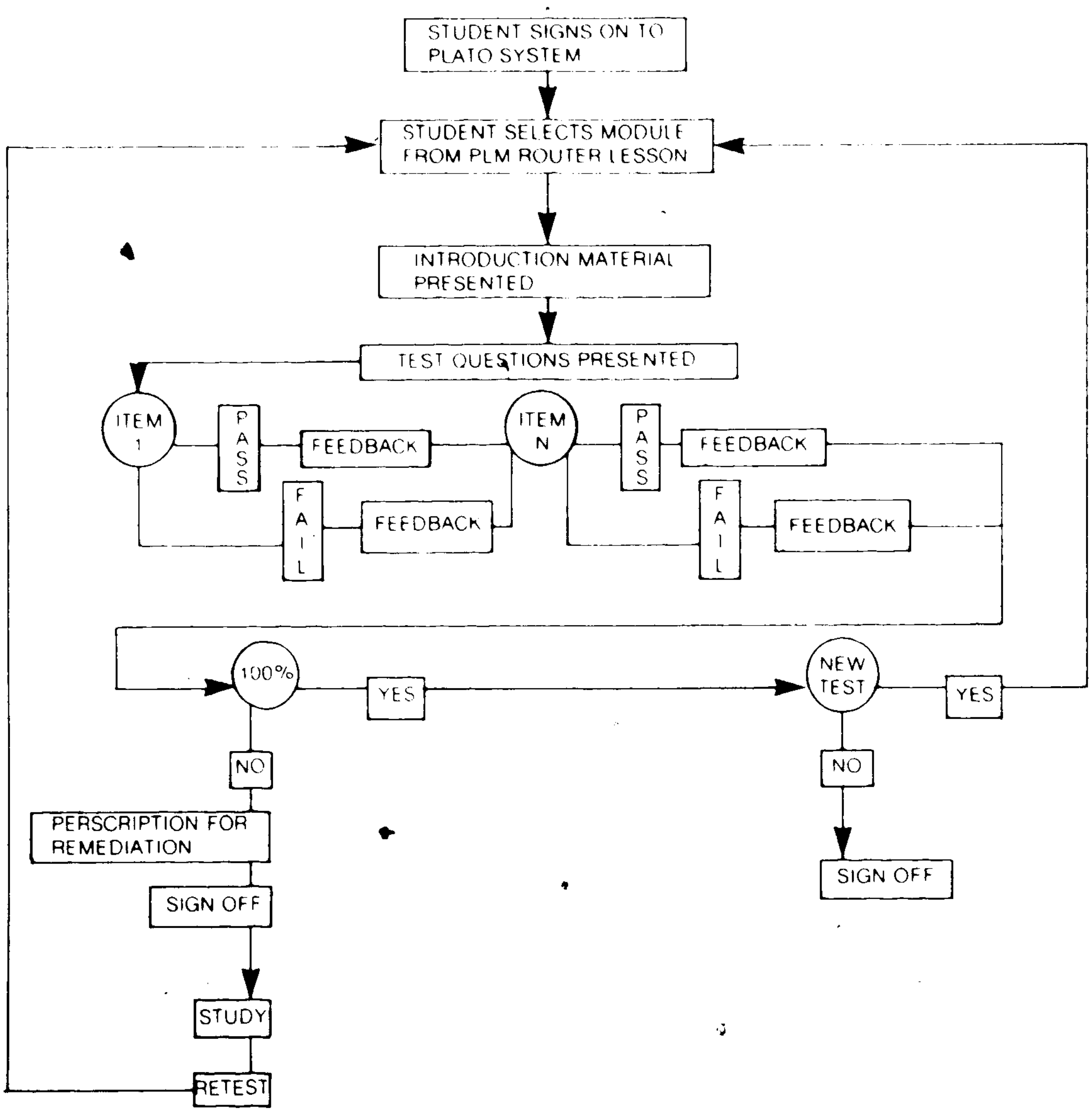
The student path through a PLM module is shown in Figure 3, page 55. The student would sign on to the PLATO system and would be presented with the router lesson or menu.

From this menu he would select the module he wished to take, and was reminded, as an introductory message, that the criterion level was set at 100 percent. If the 100 percent level was not achieved, remediation in the form of page references to the Metals and Materials course textbooks were presented at the end of each testing sequence. After the introduction the PLM system randomized the various Instructional Units, then selected one of the items from within each item pool for presentation to the student. When during the test the student answered the item correctly he was presented with the feedback message 'correct', if the item was answered incorrectly he was presented with a feedback message stating the reason the answer was considered incorrect. This procedure continued to the end of the test.

At the conclusion of the test the student was presented with either a mastery feedback message congratulating him on a perfect score and suggesting he go on to the next module, or a non-mastery message telling him he did not achieve what was expected and would now be expected to read the text remediation presented to him. At this point the student was locked out of the PLM module for a period of fifteen (15) minutes. The student now had a choice, he could continue on the system and work on another module or he could sign off the system, complete his assignment and retake the test at a later time. On test retake the student was compelled to take all of the test again, he could not answer just those objectives

Figure 3

Student path through a PLM module

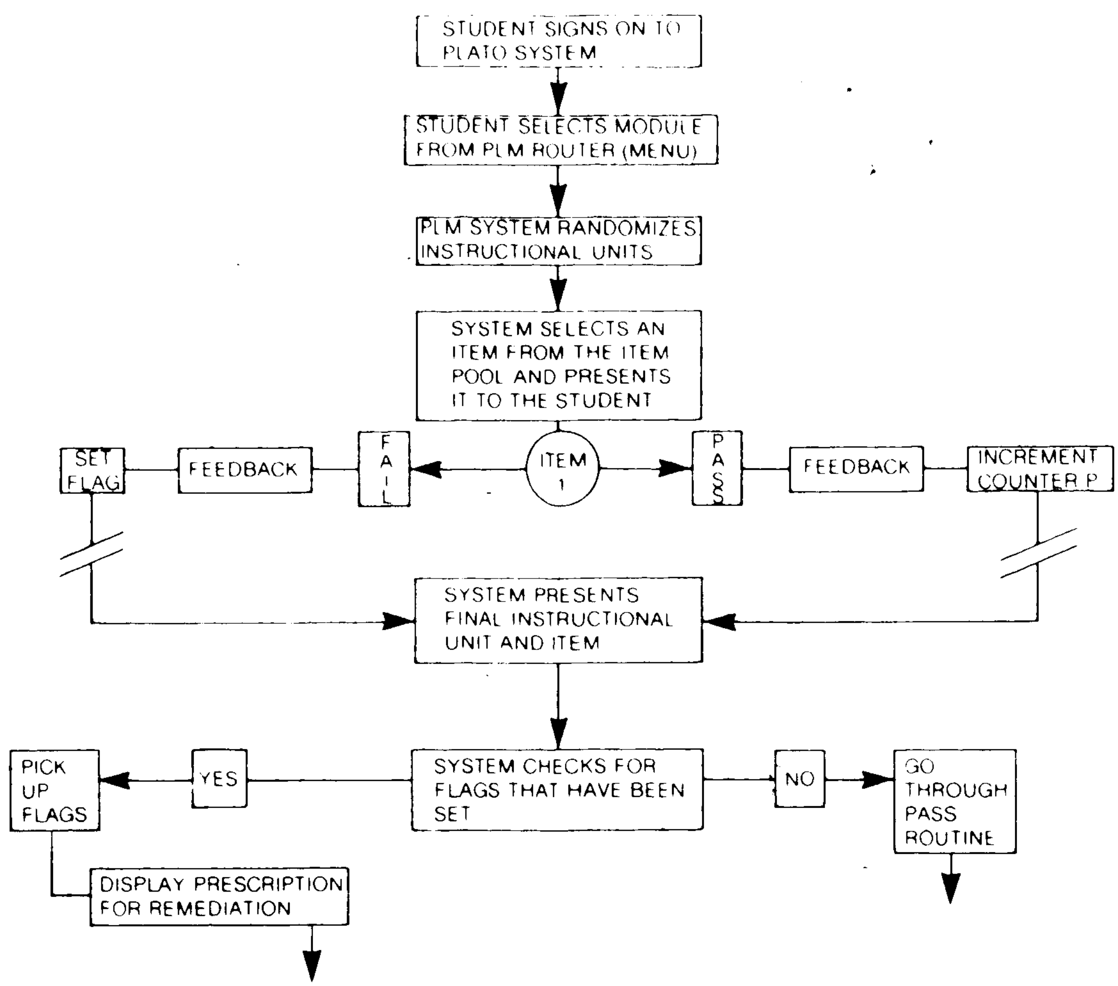


he failed to master. However because of the randomization of the IU's and the subsequent selection of one test item from each IU pool the student stood little chance of receiving the same test. Also available to the student after sign-on and during the test period (but not during the testing itself) was a router to the gradebook. The gradebook allowed the student to see his progress to date which included the number of times he had taken a particular module before mastery, each module he had taken, his test scores, the score for the test he was presently working on, if he signed off in the middle of a test and the module he should work on next.

Figure 4, PLM strategy for the student taking a test, following page describes the PLM strategy employed as the student was taking a test. The PLM system first presented the menu from which the student would select one module. The instructional units in each module were then randomized and one test item from each of the item pools within each IU was then selected and presented to the student. If the student failed to answer the test item correctly he was given feedback to that effect and a 'flag' was set. If the student 'mastered' the item he was presented with the appropriate feedback and the system would set an 'increment counter P'. At the end of the testing sequence the system would then check for the number of flags indicating non-mastery. If no flags were set, the student was routed through a pass routine, if flags had been set they were 'picked up', a non-mastery message was presented, followed by a prescription for remedia-

Figure 4

PLM strategy for the student taking a test



tion.

MODULE DESIGN AND DEVELOPMENT

The modules used in this pilot study were developed from two sources, one a series of safety tests designed and piloted by the Department of Industrial and Vocational Education at the University of Alberta, and two, a series of EDIND 412 class assignments in the writing of appropriate safety test items.

For the purpose of this study a list of twenty-one (21) metal-working subject areas such as the Drill Press and the Engine Lathe were drawn up then placed into the approximate order that the student in the University laboratory would be using them. Those tests designed and piloted at the University and those written by past EDIND 412 students were then fitted into the subject area list and developed first, then as time permitted, subsequent modules were developed up to the time of the actual pilot study. After fitting the already developed material into their various categories the next task was to devise a terminal objective and a number of instructional units for each module. Shown in figure 5, Terminal Objective and Instructional Units for the Drill Press Module, following page, is the terminal objective and list of instructional units developed for the Drill Press module.

Once the task of devising both the terminal objective and the instructional units was complete, a PLATO author

Figure 5

Terminal Objective and Instructional Units for the Drill Press Module

Upon completion of this module the student will be able to list the safety precautions and (demonstrate on the Drill Press) the safe working practice associated with:

- speed selection for drills
- chucks and chuck keys
- eye protection
- drilling small work
- confining long hair
- personal clothing
- drilling long pieces of material
- removing chips
- removing sleeves, sockets and drill chucks
- holding work
- using drills
- cutting fluids
- switching on the drill press

Note: Through the use of the PLM system the student was expected to gain knowledge regarding both the safety precautions and safe working practice associated with various machines and processes used in EDIND 412, Metals and Materials 1. It was not expected that the student would, through the PLM system, be able to develop his psychomotor skills.

information sheet was devised and printed (see Appendix VII). This sheet listed the information required by the PLM author which included the following: Module Title, Module Number, Instructional Unit Number, Item Mastery and Non-Mastery Feedback and Learning Resources. The information sheet also showed the space allotted by the PLM program for each of the items listed. In this way the size of the test item could be rigidly controlled and authored into the PLATO system by someone other than the principal author.

After the author information sheet was printed a minimum of two items, one true/false the other multiple choice, were devised for each instructional unit. Other test items were subsequently developed for each unit. PLM will allow up to sixty (60) items per IU. However for the purpose of this study the maximum number of items developed for any one IU was seven (7). Each test item was then checked for face validity and correctness of information. Having completed this, the test items and their non-mastery feedback was authored into the PLM system. In order to simplify the authoring procedure and the subsequent item analysis each Module was given a number, i.e. 1, each Instructional Unit a letter, i.e. A, and each Item a Module Number, Instructional Unit Letter and a number to denote its position in the item pool, i.e., 1A1. After finalizing the authoring procedure each Module, Instructional Unit, Item and Learning Resource was again checked for accuracy and typing errors. Finally five (5) modules were set up to check for viability in the PLM mode and conformity to their stated purpose. The Variable Management Strategy was also checked and initial student reaction guaged through the use of a pre-pilot study verification of the Modules and an initial data gathering session. Once the system had been checked seven (7) other Modules (for a total of twelve 12) were set up ready for the pilot study.

DATA COLLECTION

Data used in this study were obtained from the students of EDIND 412, Metals and Materials, 1A at the University of Alberta, during the months of January, 1982 (the pre-pilot study verification session) and March, 1982, (the pilot study session). The data were collected in two formats via the PLATO Learning Management System. Format 1, data collected for use by both the EDIND 412 students and the course instructor to evaluate student progress through each of the modules (see Appendices III and IV) and Format 2, data collected for use by the PLM author to evaluate the reliability and validity of the test items.

The data collected in Format 1 took the form of statistics describing the progress of an individual student in terms of the body of knowledge on which he was being tested. The data compared one test to another so as to provide a basis for judgement of the relative difficulty of each test. The factors used for this comparison were as follows:

1. time to complete each test
2. the number of tests taken before mastery
3. the number of students passing the test on the first, second and last try
4. the number of tests taken before test mastery was achieved by all students

The data collected in Format 2 took the form of detailed item statistics, labelled 'qubasic' in the PLM system. They were arranged into eight octal words for each test item, (see Figure 6, Qubasic Data, below) with each word containing a specific piece of information. The information labels for each of these words are listed in Figure 7, Basic Data Format, on the following page.

Figure 6

Qubasic Data

WORD	qubasic	plmtest		question
1	11260504153340000000	****	0.000	ivedm05
2	40700600000000000000	-***	*******	5F
3	40700635000000000000	-***	*******	5F2
4	55334050343650433555	-***	*******	05/13/82
5	55344573336573544457	-***	*******	11.03.29
6	06040032000000000202	-***	0.000	fdzbb
7	00000000000000000002	2	0.000	b
8	00000000000000000000	0	0.000	

(PLATO Aids, The PLATO IST,

Control Data Corporation, n.d.)

Figure 7

Basic Data Format

WORD

1--	module name
2--	IU name
3--	question name
4--	date question was presented
5--	time of day question was presented
6--	miscellaneous information
7--	answer given
8--	second answer word

(PLATO Aids, The PLATO IST, Control Data Corporation, n.d.)

Word six listed in the qubasic data format (above) as miscellaneous information contained in a 'packed' format other item and test information. This information was a follows:

1 number of tests taken, including current on this module by this student

2 question type, 1 = multiple choice, 2 = true/ false, 3 = matching, 4 = touch, 5 = numerical

3 off-line flag, 1 if test taken off-line, else 0 mastery flag, 1 if mastered, 0 if not mastered

4 time to answer question in seconds

5 question point value (signed)

6 points earned on this question (signed)

7 question number as presented to student

8 unused

9 physical course number

(PLATO Aids, The PLATO IST, Control Data Corporation, n.d.)

ITEM ANALYSIS

The methodology devised for item analysis in this study was based on that described by Denenberg (1977) and Husec and Sirotnik (1968). The analysis was divided into five steps as follows:

1 the translation of PLATO data into a format consistent with that able to be ready by the Statistical Package for the Social Science (SPSS) analysis program

2 the development of an SPSS file.

3 the development of an item frequency table

4 the grouping of students by their relative observed score

and

5 the development of an item analysis table

Step 1, the translation of PLATO data from the PLATO Cyber 170/720 computer to an Amdahl 470 V.8 computer operating under the Michigan Terminal Systems (MTS), was accomplished by the use of a Fortran program written by the Instructional Systems Group, Computing Services, University of Alberta.

This program was designed to place into a number of thirty-two bit words, on the Amdahl 470 computer, the following information derived from the PLATO data:

1 student name

2 Module name

3 Instructional Unit name

4 Item name

5 test date

6 test time

7 number of tests taken on that Module

8 item type

9 the off-line flag

10 mastery flag

11 time taken to answer the item

12 the item number

13 the course number

14 student item response

Step 2, the development of an SPSS command file (see Appendix VIII). This development took place by devising a series of two and three way crosstabulation tables. The SPSS subprogram crosstabs however has a number of limitations. These are:

> "the maximum number of dimensions available for any crosstabulation is ten. This means that control variables can be stacked eight deep but no more than eight control variables may be involved in any set of subtables"
>
> (Nie, N.H., Hadlia Hull, C., Jenkins, J.C., Steinbrenner, K. & Bent, D.H., SPSS Statistical Package for the Social Sciences. New York: McGraw-Hill Book Company, 1975, p.243)

Because of these limitations a number of 'select if' and '*select if' cards were then used for processing only those cases for which certain criteria were met, i.e. module number and the number of tests taken by all students on that module. Nie et al. write,

> "There may be times in dealing with large files when the researcher wishes to draw a ... sample of cases ...or to select some specified subgroup of the sample for analysis. The ... data selection card ...'select if' provide(s) the SPSS system with the capability ...of selecting ...cases from the users file. (The) card exists in both a permanent form and a temporary or starred form ...('*select if'). (This) provides the user with the ability to create permanent files of ...selected ...cases and to temporarily effect those changes for use with some particular subprogram within the system"
>
> (Ibid p.127)

Step 3, the development of an item frequency table devised after that developed by Denenberg (1977). This table, shown as Table 1, Item Frequency Table, following page, was used to present information from all twelve safety modules. It listed all items presented to the student and the answer frequencies given by them for a first test on any one module. The table was also used to list similar information from subsequent tests on the same module.

Table 1

Item Frequency Table

Question Name	True/ False Item AX	BX	Multiple Choice Item XA	XB	XC	XD	Frequency	Percent Correct

The question name is shown in the first column with the response to that item shown in columns AX through XD Columns AX and BX denote a true/false type item with AX representing the answer true and BX representing false. Columns XA through XD represent the four distractors of a multiple choice item. The column frequency lists the number of students who attempted that item. The column percentage correct shows the percentage of students answering the item correctly.

Step 4, the placing of students into groups by relative observed score. This table (Table 2, Student Score Table, following page) was constructed after that developed by Husek and Sirotnik (1968) and like the frequency table, lists all items presented to the student and answer frequencies given by them for a first test on any one module. The table was also used to list similar information from subsequent tests on the same module.

The item name is shown in the first column with answer

Table 2

Student Score Table

Question Name	Students											Frequency of Correct Response
	A	B	C	D	E	F	G	H	I	J	K	

frequency correct by student											
proportion correct											
students above average											
students below average											

frequencies for that item shown in columns A through K, each column representing one student. The answer to each item is shown as either mastery denoted by the number 1 or non-mastery denoted by a zero. The frequency of correct response column shows the frequency of response to that item by all students. In order to determine a student's group the number of correct responses to each item by each student must first be calculated. This calculation is done by independently adding each of the columns A through K with the resultant totals being placed in the row frequency correct by student. These totals of correct student response are then divided into any one of the frequency of correct response totals. This figure is then placed in the row proportion correct. Once this is finalized those students considered to be above average and those considered to be below average can be determined.

Step 5, the development of an item analysis table to contain the information gathered from Tables 1 and 2. This table was devised after that suggested by Denenberg (1977). Table 3, Item Analysis Table, following page, lists all items presented to the student and the answer frequencies given by them for a first test on any one module. The table was also used to list similar information from subsequent tests on the same module.

Table 3

Item Analysis Table

Question Name	Item Frequency	Frequency Correct/ Incorrect All Students R% W%	Frequency Correct/ Incorrect Above Average Students R% W%	Frequency Correct/ Incorrect Below Average Students R% W%	Number Correct	Number Not Correct

The question name is shown in the first column, with the second column listing the number of times the item was presented and attempted by all students. The column frequency correct/ incorrect all students, R%, W% shows how all students who attempted the item fared on it. R% is a percentage of the item frequency column and shows those students who got the item correct. W% is the percentage of students who answered incorrectly. The next column frequency correct/incorrect above average students shows the same information as the previous column but only for those students whose score determined by the student score table was above the median for the group. The frequency correct/incorrect below average students shows the same information as the previous column but only for those students determined by the student score table to be below the median for the group. The number correct column shows the total number of students in the 'correct' category and the value on which percentages can be computed to determine the number of students who passed the test. The last column, number not correct, lists the number of students in the 'incorrect' category. These values can also be used to determine the number of students who failed the test.

SUMMARY

The PLATO system is an interactive computer based educational system developed to enable instructors and courseware designers to create and manage instruction.

The structure of the PLATO Learning Management System is centered around the Group, A Curriculum, Modules, Instructional Units, Question Pools and a set of Learning Resources. PLM data collection takes three forms, basic, extended and summary and the PLM Variable Management Strategy (VMS) provides for the student alternative routes through the curriculum.

The PLM strategy developed for this study was designed around twelve (12) safety test modules with the VMS set to randomize all the Instructional Units in the Module selected by the student. The criterion level was set at 100 percent and the student was required to master all Instructional Units before being routed to another module. Each module used in the study was developed from two series of safety test modules, one a series pilot tested by the Department of Industrial and Vocational Education at the University of

Alberta, and items written by former EDIND 412 students.

Data collection for this study was undertaken on two levels. The first being statistics describing the progress of the student in terms of the body of knowledge on which he was being tested. Secondly statistics were gathered on each item to facilitate a detailed item analysis. The item analysis was divided into five steps as follows:

1 the translation of PLATO data to a form able to be read by an SPSS program

2 the development of an SPSS file

3 the development of an item frequency table

4 the grouping of students by relative observed score

and

5 the development of an item analysis table.

CHAPTER 4

FINDINGS OF THE STUDY

THE PILOT STUDY

The pilot study was conducted using eleven (11) EDIND 412 students in the metalworking laboratory at the University of Alberta during the months of January, 1982, (pre-pilot study verification session) and March, 1982 (the pilot study session).

The pre-pilot study verification session was set up to check the VMS, gauge student reaction and collect data to be used in the development of the Fortran translation program, the SPSS file, the item frequency table and the item analysis table. Five students took part in the session which was conducted over the period of one week.

Prior to the pilot study session a PLATO Instructional Systems Terminal was installed in the industrial arts metals laboratory.

One week before the pilot study session was to take place all EDIND 412 students were given an explanation of the general instructional design, the student path through the system and the management strategy employed for each of the safety tests. All students at this point indicated a willingness to participate in the study. Subsequently however one student dropped the course and one student made the decision not to take part in the study. The students were asked to indicate during the study, using the student notes file or comments file, any problems they encountered using the system.

Finally, the students were asked and encouraged to rewrite, using the same notes or comments file, any item they deemed overly easy, overly difficult or ambiguous. All students had prior experience using the PLATO Instructional Systems Terminal.

In order to implement the CMI system without major disruption to the ongoing laboratory curriculum, students were allowed to use the system during laboratory hours when it was most conducive to their own work schedule. At any time a student was engaged in a terminal session in the laboratory he was observed as to ease of entry onto the system and his general progress during each test period. An observation notebook was not kept as it was felt the student could use the notes and/or comments file to voice his particular concerns. Also the instructor was present in the laboratory during each terminal session held there and therefore able to answer any questions that arose, as well as solve any courseware problems that might occur. During the pilot study however it was noted that a great deal more time than was originally estimated was being taken by the students to complete the twelve safety modules (see Discussion page 98). Therefore students were allowed to use remote sites (away from the laboratory) at a time of day best suited to their needs. At this point greater emphasis was placed on the need to use the notes and comments files. No attempt at observation was made during the remote site sessions.

The remaining sections of this chapter will present the findings of the study, the results of the student questionnaire and the results of the item analysis.

FEASIBILITY OF THE SYSTEM

The pilot study was conceived to explore the feasibility of a computer managed instructional system to deliver a series of safety tests. Tests that would provide the instructor with an indication of student strengths, give the student specific remediation when required and provide for that student an inventory of learnings to maintain an awareness of personal achievement. Based on this development and implementation of the system, the study sought answers to the following questions:

Question 1:

> given the need for instructor feedback will computer managed instruction, specifically the PLATO Learning Management System, provide an indication of student strengths, difficulties and progress?

Note: The student records described in Appendicies III and IV list eighteen (18) persons on the roster when it has been stated (p.66) that only eleven (11) students took part in the study. The reason for this discrepancy came about when the system was being set up by members of the pilot study planning team, who placed their names on a roster in order to test the system. At the time of actual pilot study it was found

The findings indicate that the PLATO Learning Management System will provide feedback to the instructor regarding student progress enough to allow a preliminary judgement on that student to be made. The basis for this judgement is to be found in the following student progress statistics:

- the Student Record Data Display (Appendix III, Table 8, page 147)
- the Course Progress Summary Display (Appendix III, Table 9, page 148)
- Module Progress Summary Display (Appendix III, Table 10, page 149)

and

- the Individual Sign-On and Lesson Usage Page (Appendix III, Table 11, page 152)

The Student Record Data Display shows the course the student is currently working on, if more than one course has been assigned, the page also tells the instructor which module the student has completed. The Course Progress Summary Page lists course mastery or non-mastery and the module progress summary display lists those modules that have been assigned, started and subsequently mastered. These record pages coupled with the individual sign-on and lesson usage page which lists the days, hours and sessions the student has spent

---

that not enough space had been made available on the system to allow for a new roster to be set up. Therefore the pilot study group (student group) was added to the pilot study planning team roster.

working on the curriculum can provide for the instructor an indication of student progress.

Student strengths and difficulties can be assessed using:

- the Course Status Display Page (Appendix IV, Table 14, page 157)
- the Student Module Data (Module B) (Appendix IV, Table 15, page 158)
- Module Report (Module B) (Appendix IV, Table 16, page 159)

The Course Status Display Page of the student gradebook lists for the instructor the modules, their availability, the student score for each module and the number of tests taken for each module. The Student Module Data Pages list scores on the first, second and last tests which, when used with the Course Status Display Pages and compared to the report for each module, provide an indication of student strengths and difficulties.

Question 2:

given the need for student feedback is the system able to provide an inventory of learnings that maintain an awareness of personal achievement?

The results of the study indicated that the PLATO Learning Management System did provide enough feedback to the student to keep them aware of personal achievement. This feedback was achieved through the use of the following:

- the Module Score Display (Mastery) Page (Appendix II, Figure 23, page 135)
- the Module Score Display (Non-Mastery) Page (Appendix II, Figure 26, page 138)
- the Objective Status Display Page (2) (Appendix II, Figure 27, page 139)
- the Course Status Display Page (Appendix II, Figure 11, page 127)

The Module Score Display Mastery or Non-Mastery Pages given at the end of each module provides for the student, feedback on the number of modules mastered, this coupled with the Objective Status Display Page provides the opportunity for the student to view the non-mastered objectives. The Course Status Display Page of the student gradebook also provides a record for the student of available modules, module scores and the total number of tests taken on that module.

The final question posed in this study concerned itself with item analysis. Specifically the question asked:

Question 3:

> given the need for item (question) feedback, is the system able, through its data gathering capability, to provide an indication of overly difficult, overly easy or ambiguous items in the item pool?

Study findings did not indicate that the PLM system was able to provide the type of data to allow a viable item analysis to be performed using the Statistical Package for the Social Sciences (SPSS).

PLATO QUESTIONNAIRE

A questionnaire (Appendix VI) was given to all students involved in the pilot study. This included the one student, who after taking one test on each of the modules declined to take further part in the study. The questionnaire was divided into four areas of concern to elicit student response on the effectiveness, usefulness, suitability and accuracy of the total PLM system. Four other questions of a general nature were also added, these questions dealt with both the system itself and the PLM safety program. The findings of each of these categories are discussed below.

SYSTEM EFFECTIVENESS (QUESTIONS I THROUGH 5)

Rate the overall <u>effectiveness</u> of the following:

1 The PLATO system for the safety tests:

Good	Fair	Poor
5	4	3

2 The safety tests:

Good	Fair	Poor
2	5	5

3 The ability of the system to keep track of what you are doing and how well it is being done:

Good	Fair	Poor
11	1	0

4 The question non-mastery feedback:

Good	Fair	Poor
9	2	1

5 The learning resources:

Good	Fair	Poor
7	3	2

To the first question, that of the overall effectiveness of the PLATO system to deliver the safety tests, five students felt the system was effective, four rated it as fair and three felt it was ineffective. Question two dealt with the rating of the overall effectiveness of the safety tests, to this question two students rated the tests as good, five as fair and five as poor. The third question asked the student to rate the effectiveness of the systems' ability to keep track of what they, the students' were doing and how well it was being done (provide feedback). Eleven (11) students rated the system as good in this respect and one rated it as fair. The fourth question in this series on effectiveness asked the student to rate the effectiveness of the non-mastery feedback (no mastery feedback was provided throughout the tests other than the word 'correct!'). Nine students rated the feedback as good, two as fair and one as poor. The final question elicited response as to the effectiveness of the learning resources. Seven students rated them as good, three as fair and two as poor.

SYSTEM USEFULNESS (QUESTIONS 6 THROUGH 11)

Rate the overall usefulness of the following:

6 The gradebook:

Good	Fair	Poor
9	3	0

7 The learning resources:

Good	Fair	Poor
6	6	0

8 The non-mastery feedback:

Good	Fair	Poor
3	9	0

9 The test lock-out:

Good	Fair	Poor
1	0	11

10 Do you think the test lock-out time should be changed (it is now fifteen minutes)

Yes	No
12	0

11 If yes to the above, what should in your opinion the test lock-out time be changed to?

Time in minutes

20 15 10 7 5 0

The next section of the questionnaire dealt with the usefulness of the gradebook, learning resources, non-mastery feedback and the test lock-out. Question 6 asked the student to rate the usefulness of the gradebook, that is, that section of the PLM system that kept track of what the student was doing and provided feedback to that effect. Nine students rated the gradebook as good or very useful and three rated it as fair. Question 7 asked the student to rate the usefulness of the non-mastery feedback. In this respect three students rated the feedback as good and nine as fiar.

The last three questions in this section dealt with the test lock-out. The lock-out was placed on the system to encourage students to 'master' the test in as few a number of tries as possible and secondly to allow students the opportunity to review the remediation presented to them after a non-mastery attempt. The usefulness of the test lock-out was rated as poor by eleven students and good by one. The second question concerning the test lock-out asked if the lock-out should be changed, to this all students answered in the affirmative. The final question in this series asked 'what should the lock-out time be changed to', nine students suggested five minutes and three suggested the lock-out be removed completely.

SYSTEM SUITABILITY (QUESTIONS 12 THROUGH 15)

Rate the <u>suitability</u> of the following:

12 the test questions:

Good	Fair	Poor
4	6	2

13 The learning resources:

Good	Fair	Poor
5	6	1

14 Should other learning resources have been given?

Yes	No
7	5

15 If yes to the above what other learning resources should have been used?

Test	CAI lessons	Audio Visual	C/R Teaching
1	1		2
Example	Example	Example	Example

Question 12 in this category asked the student to rate the suitability of the test questions (items). Four students felt that the items were good, six felt they were fair and two considered them poor. Question 13, that of rating the suitability of the learning resources, five students thought them good, six fair and one poor. The third question in this series asked if other learning resources should have been given; seven students responded yes and five no. The final question in this series asked the student to list other resources he felt should have been used in the safety course. Three choices were provided for the student to choose from, branching to other safety tests, branching to computer assisted instruction lessons (CAI) and branching to audio visual safety material, a fourth category was added to the questionnaire by the students themselves, that of classroom teaching. Eight students declined to respond to this question. Of the four that did, one suggested branching to other safety tests, one to CAI lessons and two to classroom teaching.

SYSTEM ACCURACY (QUESTION 16)

16 Rate the accuracy of the learning resources, did they give adequate and clear direction?

Good	Fair	Poor
5	6	1

The only question in this category asked the student to rate the accuracy of the learning resources on the basis of adequate and clear directions. Five students rated them as good and six rated them as fair.

SYSTEM AND PLM PROGRAM (QUESTIONS 17 THROUGH 20)

17 Did you find the CMI (safety) PLATO terminal work:

Too much	About right	Too little
7	5	0

18 How do you think the PLATO safety program helped you learn:

Excellent	Good	Fair	Poor
0	7	3	2

19 Rate the quality of the PLATO safety program:

Excellent	Good	Fair	Poor
0	7	3	2

20 Is the PLATO safety program a good way to check for safety knowledge?

Yes	No
6	6

Why? ____

____

The first question in this series asked the student to indicate if they found the CMI (safety) PLATO work too much, too little or just about right. Seven students suggested it was too much, five thought it about right, none considered it too little. The next question, that of asking the student to rate how the safety program helped them learn, elicited the following responses: no student thought the program excellent, seven thought it good, three thought it fair and two thought it poor. The last question in this series asked, 'is the PLATO safety program a good way to check for safety knowledge?'. To this six students answered in the affirmative and six said no. A second part to this final question asked simply 'why'. To this responses varied from "the program is overly time consuming and very frustrating" to "it (the program) ensures that a person knows metal (working) procedures and brings out those procedures that may be missed in the textbook". At the end of the questionnaire the students were given an opportunity to make suggestions for improving the system. Some of those suggestions were as follows:

- rename the modules 'resource units', remove the test lock-out and use the questions as a method of presenting safety information
- remove the 100 percent criteria
- remove such things as 'personal clothing' (safety), eye safety and long hair safety from each module and place them into a single module dealing with personal safety
- allow page back to CAI lessons for such things as lathe cutting speeds and feeds and depth formula
- have non-mastery students retake only those objectives he missed

SUMMARY

Students rated the PLATO system as effective for the delivery of the safety tests, the ability of the system to keep track of what the student was doing and how well it was being done, the non-mastery feedback and the learning resources. The overall effectiveness of the safety tests was however only rated as fair.

In terms of system usefulness, students considered both the gradebook and learning resources as useful. The non-mastery feed back was seen as fair and the test lock-out system as poor. The suitability of both test items and learning resources were considered fair.

The accuracy of the learning resources were rated as fair and a number of students found the safety tests too much in terms of actual work. The learning aspect of the tests were seen as being good and 50 percent of students felt the program was a good way to check safety knowledge.

PLATO DATA ANALYSIS

Before commencing with a full and complete analysis of the data set, a sample set of data collected from the January pre-pilot study verification session were analyzed using the Statistical Package for the Social Sciences (SPSS). This analysis showed a small number of 'suspect values', however it was felt that a larger and more complete analysis would allow these suspect values to be discounted.

The complete data set derived from the PLM system were collected onto four PLATO data files, ED211DFI, ED211DF2, ED211D03 and ED211D04. At the time of full data analysis these files were transferred from the PLATO Cyber 170/720 computer to the Amdahl 470 V7 computing system operating under the Michigan Terminal Systems (MTS). Once transferred to the Amdahl system the PLATO data, using a Fortran translation program, were set up into a number of thirty two bit words that contained the following information:

- student name
- module name
- instructional unit name
- item name
- test date
- test time
- number of tests taken on that module
- item type
- the off-line flag
- the mastery flag
- time taken to answer item
- the item number
- the course number

and

- student item response

After translation, a small amount of the data set from two modules, the Engine Lathe (MO2) and the Pedestal Grinder (MO5) were analyzed using the SPSS analysis program. The suspect values found in the sample analysis of data, those expected to be discounted in the full analysis, compounded themselves and other suspect values became apparent. These suspect values were:

- multiple entry of all test data for a number of modules
- multiple entry of first test data for some students on some modules
- all student data missing for a number of students on a number of modules
- student data missing for test 1 for a number of students on a number of modules
- discrepancy between the time the item was presented to the student and the time taken by the student to respond to that item
- item response shown as incorrect when item was answered correctly by the student
- item response shown as correct when item was answered incorrectly by the student
- multiple correct answers shown when only one response was correct
- an inconsistancy in the randomization of items from each instructional unit

and

- responses from both true/false and multiple choice items attributed to the same item

These data problems prompted a review by the Instructional Systems Group of both the PLATO to Amdahl print program and the Fortran translation program. The assumption was made that both the SPSS program and the PLATO data collection system were working correctly. After review both the print and Fortran programs were considered to be working correctly, therefore it was felt a validation procedure should be set up to assess the data being collected via the PLATO Learning Management System.

PLATO DATA VALIDATION PROCEDURE

In order to assess the PLATO data collection system a new course, using the same twelve (12) safety modules, was set up in the PLM system. A new roster consisting of six students and a new data collection file was also set up. A simple cross-reference sheet was devised so that respondents could enter the item number, the item type and the PLATO Instructional Systems Terminal (IST) key struck to respond to the item as each test was taken. The cross-reference sheet was then used to compare what the respondent entered into the PLM system with what the PLM system recorded on its data file. In order to check the item response time a micro-computer with printer attached was set up with a time loop programmed onto the disk. The program enabled an observer to record the time at which the item appeared on the PLATO screen and the time the item response was entered into the IST by the respondent. Times were recorded for each item and using the 'hard' copy obtained from the printer, compared to the times recorded on the PLATO data file.

The validation procedure was carried out using six volunteers, three inexperienced PLATO users and three experienced PLATO users. Only one module the Pedestal Grinder (M05) was chosen for this procedure as:

- it was considered representative of all the modules
- all suspect values noted previously had shown up at least once during preliminary analysis

and

- the module was considered short enough not to disrupt the volunteers time schedule and long enough to collect sufficient data

During the validation procedure the inexperienced PLATO users were allowed to make function key errors as it was felt this might simulate that which the students had done during the original data collection. The experienced PLATO users made deliberate mistakes for the same reason. Of the six 'students', one 'mastered' the module in two tests, three 'mastered' the module in three tests. One 'mastered' it in four tests and one respondent did not master the module after four tests. Again this procedure was done to simulate that which might have happened during the original data collection.

Once the respondents had completed the validation procedure, the data were collected into PLATO data file EDDFTST in two forms, test summary data and qubasic data, the data file was then printed, ready for checking, using a printer attached to the PLATO IST. No attempt was made to transfer this file to the Amdahl System or to analyze it using an SPSS analysis program. After checking the data file EDDFTST a number of suspect values were discovered. (See Discussion page 101.)

The original data, stored in the Amdahl system, that from the pilot study, were then destroyed. The same data stored in the PLATO system was then translated back to the Amdahl System, and an SPSS analysis carried out on the first test by all students on all modules. The suspect values present in the first data set were again apparent. In addition one other suspect value presented itself. This was as follows:

- only true/false type items were analyzed for test 1 on one module when both true/false and multiple choice items had been responded to.

An SPSS analysis was then carried out on the second test by all students on the same modules, the following suspect value was detected:

- only multiple choice items were analyzed for test two on one module when both multiple choice and true/false items had been responded to.

It was concluded that in view of the appearance of more suspect data a viable item analysis of the data set would not be possible. It was further concluded that system faults would have to be isolated, analyzed and corrected prior to any PLATO data set being analyzed using an SPSS analysis program.

The decision was made therefore not to present the pilot study data but rather present a full and complete description of that which was to have taken place using 'simulated data' to show how item reliability and validity might be assessed. (See Appendix I)

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

PURPOSE OF THE STUDY

The purpose of this study was to develop and explore the feasibility of a computer managed instructional system to deliver a series of safety tests. Tests that would provide the instructor with an indication of students' strengths, give the student specific remediation when required and provide for that student an inventory of learnings to maintain an awareness of personal achievement.

The study sought answers, based on the development and implementation of that system to the following questions:

- given the need for instructor feedback, will the computer managed instruction, specifically the PLATO Learning Management System, provide an indication of student strengths, difficulties and progress?
- given the need for student feedback, is the system able to provide an inventory of learnings that maintain that awareness of personal achievement?
- given the need for item (question) feedback, is the system able, through its data gathering capability, to provide an indication of overly easy, overly difficult or ambiguous items?

CONCLUSIONS

The study determined that the PLATO Learning Management System will provide feedback to the instructor regarding a student's progress enough to allow a preliminary judgement on that student to be made.

The study concluded that the PLATO Learning Management System did provide enough student feedback to keep students aware of personal achievement.

The research did not indicate that the PLATO Learning Management System is able to provide the type of data to allow a viable item analysis to be performed using the SPSS analysis program.

The SPSS Analysis Program did not show it was able to provide an in-depth analysis of the PLATO data nor did the results indicate that overly easy, overly difficult and/or ambiguous items could be identified.

The pilot study as a whole cannot be considered a complete success as it did not answer all the questions raised. The study did however point out a number of potential problem areas such as the moving of data from one computer system to another and the size of the data set. The study also raised the question of the data gathering capabilities of the PLATO system and its ability to truly randomize items in each of the instructional units.

DISCUSSION

The following section outlines and discusses the various results arising from the pilot study.

THE PLM SYSTEM

The acquisition of knowledge regarding the PLM system was found to be a less than easy task. While publications on the subject of CMI are numerous, those relating to PLM in particular are both scarce and superficial in nature. The PLATO system itself contains large amounts of information regarding the capabilities of the system, however this information is promotional rather than technical and consequently has little utility for prospective PLATO authors.

It would also appear that a credibility gap exists between that which the system is promoted as being able to do and that which it can actually do, and that those expecting to use the system should reconsider until further evidence is gathered to demonstrate that data collected for item analysis is not subject to error or random generation.

AUTHORING THE PLM SYSTEM

Authoring of the PLM system proved to be a complex procedure. Documentation was found to be lacking and that which was available somewhat outdated. Function key sequences used during the authoring procedure were found to be very complex structures seemingly unrelated to the task at hand.

RUNNING THE PLM SYSTEM

Running the system, that is setting up student rosters, creating and destroying files after archiving, collecting student statistics and overseeing the system while it was in use by the students was found to be the most straightforward task assigned to the author/instructor. However the function key sequences were again found to be difficult and complex.

ANALYSIS OF PLATO STUDENT DATA

Analysis of the PLATO data, that is the reading of the statistics listed in the student gradebook as well as the 'in-depth' analysis provided by the SPSS Analysis Program proved in the former case to be a simple task but one requiring a great deal of subjective judgement. The latter proved to be a very difficult task and one requiring an in-depth knowledge of computing systems. Documentation was found to be lacking in the areas of student response recording, the system of PLATO data collection and data packing. (See pages 62-63). The amount of data collected by the PLM system is also a significant factor that should be taken into account when considering PLATO data analysis. In order to do an item analysis the PLM system must be set to collect qubasic data (see Qubasic data and Basic data format figures 6 and 7, pages 62-63) for each item answered by all students in all tests, which in the case of this pilot study amounted to approximately 10,000 pieces of data collected. This data, in order for an SPSS analysis to be carried out then had to be printed (transferred) to another computing system, in this the Amdahl 470 V8, a task that required up to 2,400 pages of disk space. The data then had to be translated into a format able to be read by the SPSS program. Because of the size of the data set analysis it was very expensive. Once the data had been translated however the amount of disk space was reduced to approximately 800 pages. The size of the data set also presented problems with the SPSS analysis program in that the size of the tables produced by the analysis would not fit SPSS parameters of a standard format and therefore limits had to be placed on the program by using 'select if' and '*select if' cards (see pages 65-66).

STUDENT USE OF THE PLM SYSTEM

For students the suitability and ease of use of the total system met a mixed reaction. All students found the system easy to use although some of the procedures they were using were more complex than they had been using in various CAI programs. Students generally however considered the system unsuitable for presentation of safety material. From an instructor point of view however, the system was considered to be both suitable and useful. The PLM system tested safety knowledge in the cognitive domain but as was indicated by the number of tests all students had to take before they achieved mastery it appeared the pilot group lacked significantly the safety knowledge it was thought they had acquired over the period of their undergraduate degree.

STUDENT QUESTIONNAIRE

The student questionnaire given to all students involved in the pilot study was divided into four areas of concern to allow respondents to air views on the overall effectiveness, usefullness, suitability and accuracy of the total PLM system, questions 1 through 5 dealt with the effectiveness of the system; a total of five students thought the system effective, four thought it fair and three thought it ineffective. The reason for this negative attitude is not clear, however it could stem from the fact that the mastery level (criterion) was set by the author at 100 percent, a figure that in retrospect was too high and did not allow for the student to make an error or allow for an error in measurement due to poor items. It could be argued that in the area of safety no room exists for error, never the less the students involved in this study were affected by the high criterion, taking longer to complete a test, using a textbook to check possible item answers before entering that answer into the PLATO System and exhibiting a great deal of frustration if they got the item incorrect.

A second factor that should also be considered is the randomization by the PLM system of the Instructional Units and the selection from the IU pool of just one item for presentation to the student. Because of the way this part of the PLM system was set up (see page 51) a student failing to answer one item correctly was forced to repeat not only the missed objective or objectives but a test, again selected at random by the PLM system that included all objectives in the module. This 'retesting' led, on the students' part, to a great deal of frustration especially when only one item had been missed. Randomization by the PLM System was an option chosen by the author for this study to facilitate generalization by the student from a "concrete domain to performance in the larger universe of knowledge" (Hively, 1974, p.8). It would seem however that this randomization option should be removed from the PLM system as it checks for and finds non-mastery flags at the end of the testing sequence. In this way a test would then repeat allowing the student to correct only those items he missed. As the system is now set up the student is never guaranteed the same test and therefore stands a good chance of missing one or more items so beginning the cycle once more. The total level of frustration this cycle created, was, it was felt, translated by the student into a system wide/instructor ineffectiveness rather than being seen as the VMS being set too rigidly.

Student negativity toward the system as a whole was apparent throughout the total questionnaire. When rating system effectiveness only two students saw the system as being effective, five saw it as fair and five as poor. These results were both surprising and disappointing and again the reasons are not clear. The negativity is possibly attributable to the students' expectations in terms of the type of safety test they were expecting. It is possible they were expecting tests similar to those given school age students working in an industrial arts laboratory, not a series of items dealing with safety procedures they themselves as teachers were expected to have knowledge of and be able to follow when working in the university laboratory.

PLATO DATA VALIDATION PROCEDURE

As noted, pages 86 through 92, both the print and translation programs were, at the time of the pilot study, reviewed and considered to be working correctly. The SPSS program was also considered to be working correctly. A validation procedure was then set up in order to assess the PLATO data collection system. A new student roster was set up and six volunteers selected to 'run through' one module. A cross reference sheet was devised so that data entered into the PLM system could be checked with what was being recorded on the data file. In order to check item response time, a time record loop was programmed onto a micro-computer disk which allowed an observer to record the time an item appeared on the PLATO screen and the time a response was entered by the respondent. While this method was not in any way an accurate method of validating PLATO response time it did serve as a way of gauging the accuracy of the times entered into the PLATO data file. On checking the data file at the conclusion of the validation procedure it appeared a number of errors were present. The Instructional Systems Group (Computing Services) then made adjustments (of an unknown nature) to both the print and translation programs and carried out a similar validation procedure on all twelve safety modules. When their procedure was concluded no errors were found on the PLATO data file. They then carried out an SPSS analysis on the data set, again no errors were detected. (It should be noted that at this point in the validation procedure the student gradebook and the student records available to the instructor were not in question and were not part of any validation procedure.) The reasons for this inconsistency are not clear.

As has been described in detail the PLATO data analysis was unable to be carried successfully due to a number of suspect values present in the data set. The reason for these suspect values is not clear however four possibilities must be considered. These are:

1. The PLATO data collection system
2. The PLATO to Amdahl print program
3. The Fortran translation program

and

4. The SPSS analysis package.

Only one of these possibilities, the SPSS analysis package, least likely to be at fault given its extensive usage in a myriad of situations that has caused problem areas to be eliminated. Of the remaining three, the PLATO data collection system cannot be ruled out until a thorough investigation is conducted by systems analysts. It would appear that given PLATO's highly technological nature some form of validation procedure would have been carried out on the system prior to it being placed into a production environment to prevent these types of problems arising. Secondly, it would seem appropriate for a researcher to consider some form of validation procedure for any system similar to the one described in this study if only to eliminate the problem of taking for granted that all he reads in regards to that system is true.

The Fortran translation program and the Amdahl print program also present themselves as being a probable cause of the data set problems as they were both untried programs, the amount of data being transferred from PLATO to Amdahl was exceptionally large and the translation program for the PLATO data from its packed octal format to a format able to be used on the Amdahl system and subsequently manipulated by the SPSS program was not validated by the Instructional Systems Group.

ITEM ANALYSIS

Because of the inherent problems with the data set the decision was made to present 'simulated' data in the same format a full analysis would take (see Appendix I) one module M05 The Pedestal Grinder was chosen. It should be noted that the tables constructed for this research reflect that provided by the item analysis but are not a true indication of the data collected by the PLATO system and so cannot be judged as displaying true problem items.

Denenburg (1977) suggests the item frequency table (Appendix I, page 118) as being useful to determine answer frequencies for a test on one module by all students. The table is not designed to provide a definitive answer as to the quality (validity and/or reliability) of the item, it is designed to highlight only those items that the instructor might need to review.

The student score tables (Appendix I, page 119) devised from Husek and Sirotnik (1968) shows module items listed with their answer frequencies, from these tables it is determined that students C through G and I were considered to be above the median for the group and students A,B,H,J, and K were below the median for the group.

The item analysis table (Appendix I, page 121) devised from Denenburg (1977) lists the information gathered from the previous three tables. From Table 7 (Appendix I, page 121) it can be determined that:

- item 5A-1 is overly easy as all students are getting it correct. This item should warrant some investigation from the author

- item 5F-2 is too difficult as all students are getting the item incorrect. This item should also warrant some investigation from the author
- items 5B-2, 5C-2 and 5D-3 are positive discriminating as those students considered to be above the median for the group are getting the items incorrect. These items could be considered to be representative of the total test
- item 5B-1 is a negative discriminating item since those students considered to be above the median for the group answered the item incorrectly and those considered to be below the median answered correctly. This item should warrant some investigation from the author.

RECOMMENDATIONS

THE PLM SYSTEM

1. That the PLM response recording system be checked, tested and documented.
2. That the Cyber to Amdahl print program be checked, tested and documented.
3. That the PLATO data translation program be checked, tested and documented.
4. That the randomization option in the Variable Management Strategy be checked, tested and documented.

5. That PLM documentation be made available, on request, to both PLM authors and instructors using the PLATO system.

6. That the study be replicated using a larger number of students.

7. That the study be replicated so as to judge the educational effectiveness of the PLM system.

8. That the study be replicated using a micro-computer in place of the PLM system.

THE SAFETY COURSE

1. That the pilot study work be continued and expanded to twenty-one modules.

2. That greater emphasis be placed on the teaching of safety and the role of the computer in the acquisition of that safety knowledge.

3. That the Learning Resources for the safety program be expanded to include CAI lessons.

4. That the criterion level be set lower than the present 100 percent.

5. That a student lock-out be placed on the modules after three unmastered attempts on the same module.

6. That the test lock-out be changed from fifteen to five minutes or be removed completely.

7. That the Variable Management Strategy be changed so that only unmastered objectives be retested.

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APPENDICES

APPENDIX I

ITEM ANALYSIS

ITEM ANALYSIS

A full data analysis was as already noted (page 64) not possible. However the following has been constructed using 'simulated data' as an example of the form a full analysis would take. One module forms the basis for this example, the Pedestal Grinder, Module M05.

On reviewing Table 4, Item Frequency Table, showing summary results for the first attempt on a test by all students, following page, it can be seen that all items presented elicited a response from each student, that all items 5C-1 through 5C-4 were answered correctly by all respondents and item 5F-2 was answered incorrectly by all students.

Table 5, Student Score Table, showing relative observed scores for the first attempt on a test by all students, page 119, lists relative observed scores for all students in test one on the module, Pedestal Grinder. The number one (1) represents the student having answered that item correctly while the zero (0) represents an incorrect answer. The absence of either a one or zero shows that the student did not receive that item. From Table 6, Student Score Table, Above and Below Average Students, shown on page 120, it can be seen that student A answered four (4) items correctly. If this total is divided into the frequency of correct response total for item 5A-1 column 13, Table 5, student A's proportion correct score will equal .6 (row 2, Table 6, page 120). If this same procedure is followed for all students a proportion correct score can be determined for all students.

Table 4

Item Frequency Table, Showing Summary Results for the First Attempt on a Test by All Students

Question Name	True/False Item		Multiple Choice Item				Frequency	Percent Correct
	AX	BX	XA	XB	XC	XD		
5A-1						*6	6	100
5A-2	*3	2					5	60
5B-1	2	*4					6	66
5B-2					1	*4	5	80
5C-1					*3		3	100
5C-2		*2					2	100
5C-3			*2				2	100
5C-4						*4	4	100
5D-1	1	*4					5	80
5D-2			1			*3	4	75
5D-3				*2			2	100
5E-1				*3	1	1	5	60
5E-2		*6					6	100
5F-1			2		*3		5	60
5F-2	6	*0					6	0
5G-1					1	*5	6	100
5G-2	*5						5	100

NOTE: * Denotes the correct answer

Table 5

Student Score Table, Showing Relative Observed Scores for the First Attempt on a Test by All Students

Question Name	Students											Frequency of Correct Response
	A	B	C	D	E	F	G	H	I	J	K	
5A-1		1	1	1			1		1		1	6
5A-2	1				1	1		0		0		3
5B-1	1	1			0			1	0	1		4
5B-2			1	1	1	1	0					4
5C-1		1	1	1								3
5C-2					1	1						2
5C-3	1								1			2
5C-4							1	1		1	1	4
5D-1	0		1					1	1	1		4
5D-2		0		1			1				1	3
5D-3					1	1						2
5E-1							1	1	1	0	0	3
5E-2	1	1	1	1	1	1						6
5F-1			0		0		1		1		1	3
5F-2	0	0		0		0		0		0		0
5G-1	0	1			1				1	1	1	5
5G-2			1	1		1	1	1				5

Table 6

Student Score Table, Above and Below Average Students

Student	A	B	C	D	E	F	G	H	I	J	K
frequency correct by student	4	5	6	6	6	6	6	5	6	4	5
proportion correct	.6	.8	1	1	1	1	1	.8	1	.6	.8
students above average			x	x	x	x	x		x		
students below average	x	x						x		x	x

From Table 6 it can be seen that the students' proportion correct scores ranged from a low of .6 for student A to a high of 1 for students C through G and I. After determining the students' proportion correct score the scores were then placed into an 'above' or 'below' average category, rows 3 and 4, Table 6. The median was .87.

Table 7, Item Analysis Table, summarizing information from Tables 4,5 and 6, following page, lists all the relative information gathered from those tables. Table 7 indicates how overly difficult, overly easy or ambiguous items from the Instructional Unit Item Pool may be identified. From the Table it is indicated that:

- item 5A-1 has been answered correctly by all students

Table 7

Item Analysis Table, Summarizing

Information From Tables 4, 5 and 6

Question Name	Item Frequency	Frequency Correct/ Incorrect All Students R%	W%	Frequency Correct/ Incorrect Above Average Students R%	W%	Frequency Correct/ Incorrect Below Average Students R%	W%	Number Correct	Number Not Correct
5A-1	6	100	-	83	-	17	-	6	-
5A-2	5	60	40	40	-	20	40	3	2
5B-1	6	71	29	-	34	66		4	2
5B-2	5	80	20	80	20	-	-	4	1
5C-1	3	100	-	67	-	33	-	3	-
5C-2	2	100	-	100	-	-	-	2	-
5C-3	2	100	-	50	-	50	-	2	-
5C-4	4	100	-	50	-	50	-	4	-
5D-1	5	80	20	40	-	40	20	4	1
5D-2	4	75	25	50	-	25	25	3	1
5D-3	2	100	-	100	-	-	-	2	-
5E-1	5	60	40	40	-	20	40	3	2
5E-2	6	100	-	67	-	33	-	6	-
5F-1	5	60	40	40	40	20	-	3	2
5F-2	6	-	100	-	34	-	66	-	6
5G-1	6	83	17	33	-	51	16	5	-
5G-2	5	100	-	66	-	34	-	5	1

- item 5F-2 has been answered incorrectly by all students
- items 5B-2, 5C-2 and 5D-3 have been answered correctly by those students determined in Table 6 to be above the median for the group and answered incorrectly by those determined to be below the median
- item 5B-1 has been answered incorrectly by those students determined in Table 6 to be above the median for the group and answered correctly by those determined to be below the median

SUMMARY

The simulated data were set up into three tables to show results as if the data were analyzed by an SPSS program. An Item Frequency table showing summary results for the first attempt on a test by all students. A Student Score table showing relative observed scores for the first test for the module Pedestal Grinder, a second Student Score table showing above and below average students and an Item Analysis table listing all relative information gathered from the previous two tables. From these tables the response to each item can be determined, student proportion correct scores can be calculated and finally, overly difficult, easy or ambiguous items may be identified.

APPENDIX II

THE PLATO SAFETY COURSE

THE PLATO SAFETY COURSE

The following is a description of the PLATO safety course used in this pilot study. Shown are the various screen displays given to students and the various options open to them at each of those displays. Also shown are examples of the items used during a test and the various displays shown to the student after a test for both mastery and non-mastery.

When the student signs on to a PLATO Instructional Systems Terminal and enters his course name and password, he is first presented with a screen display telling him his group, the date, the last time he signed on to the system and the number of terminal sessions he has had to date. (See Figure 8, Student Welcome Page, shown below.)

Figure 8

Student Welcome Page

PLATO Learning Management

Name .... Session # 11
Group edind211

Today's date ...... April 13, 1982
Last date on ...... April 13, 1982

Welcome back!

Press NEXT to continue

After pressing the function key 'next' to continue, the student is shown the 'menu' or Course Selection Display page that lists the modules (tests) that he has 'tested out' on to date. Also indicated, using an arrow, is the module (test) that the student should work on next (see Figure 9, Course Selection Display, shown below).

Figure 9

Course Selection Display (Student View)

test course

MODULE INDEX

MODULES YOU CAN WORK ON NOW:		TESTS TAKEN
a.	Drill Press	0
b.	Engine Lathe	0
d.	Handtools.	0
e.	Pedestal Grinder	0
f.	Horizontal band saw	0
→ i.	Foundry Furnace	2
j.	The Shaper	0
o.	Milling Machine	0
p.	oxy-acetylene weld.	0
q.	The Bandsaw	0
r.	The Tool Grinder.	0
t.	The Arc Welder	0

TYPE A LETTER (to work on that module): >

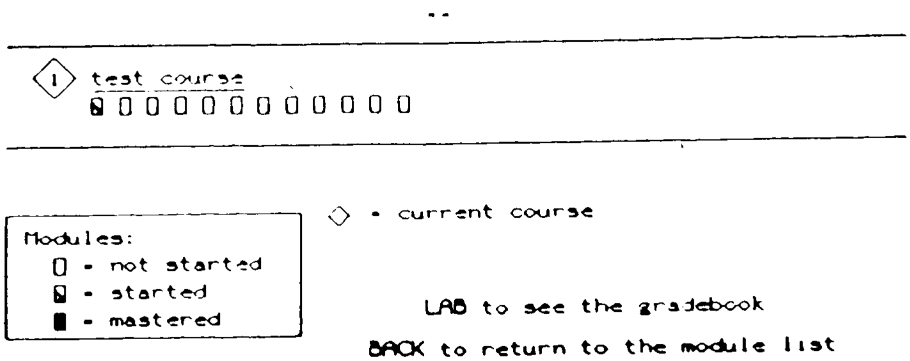
OR

1. To see how well you're doing
2. To sign off
3. To review instructions
4. To read and write notes

As well as being able to select a test from the Course Selection Page the student also has four other options available to him. Option 1 Figure 10, Student Progress in Curriculum, following page, allows the student to see how well he is doing on the course as a whole. The screen display also shows the student which course he is presently working on, and his status for each module in that course.

Figure 10

Student Progress in Curriculum (Student View)



Also available is the Course Status Display, Figure 11, shown on the following page. This display allows the student to get a much better idea of his progress to date as it shows test scores, the number of tests taken, which modules are available for testing, the last test taken and the last test mastered.

Once the student has reviewed the Course Status Display he can, by entering a module letter, review any one of the modules he has been tested on. When the student leaves the Course Status Display he is then returned to the Course Selection Display Page (or menu). (See Figure 9, page 125).

Option 2 on the students' Course Selection Display Page allows the student, after reviewing his gradebook, to sign off the system. Option 3, 'to review instructions', gives a student an opportunity to review the instructions for

Figure 11

Course Status Display

edind211 April 13, 1982 2:35 PM

Course 1: test course

Started: 1/18/82

Last Test: Module R, 4/13/82
Last Mastery: Module R, 4/13/82

Course Score: 8

MODULE	STATUS	MASTERED	SCORE	TESTS
I	available		15 of 100	2
A	no testing		67 of 100	1
→ R	mastered	4/13/82	100 of 100	1
B	available			
D	available			
E	available			
F	available			
J	available			
O	available			
P	available			
Q	available			
T	available			

Enter a module letter >

using the Course Selection Display Page. (Figure 12, Test Course Page Instructions, shown following page).

The Test Course Page Instructions also give the student a review on how he should go about choosing a module for testing, this is done by pressing function key 1. Option 2 on the same page allows the student to review the criteria for the course and option 3 provides a course introduction overview.

The final option open to the student from the Course Selection Display Page is the option to read and/or write notes. Notes can be sent to, and received by, other

Figure 12

Test Course Page Instructions

> On the MODULE LIST page, you can:
>
> - type the module letter to work on that module. The "→" marks the module you should probably work on next.
> - type a number for any of the options listed on the page.

Press BACK now to return to the module list.

OR

Press: 1 to get more help,

2 to see what you have to do to master this course, or

3 to review the introduction to this course.

students or the course instructor. Once the student has selected a module from the Course Selection Display Page he is presented with a screen display that describes the Module Criteria for that module. (Figure 13, Module Criteria Page, shown following page). When presented with the Module Criteria Page, the student again has three options open to him: he can see all the objectives for that module, take the test immediately or choose another module. If the student chooses to see the objectives, he is presented with the Module Objective Page shown in Figure 14, following page.

After the Module Objective Page has been presented to the student he can press the function key 'next' which will then display each objective to be mastered. (Figure 15,

Figure 13

Module Criteria Page

MODULE A

Drill Press

NOTE! 100% must be achieved on this test in order to pass. If you attain the 100% you will be given a 'learners permit'. If you score less than 100% you will be given a list of references. After studying them you may attempt the test again.

WHAT DO YOU WANT TO DO NOW?

1. See the objectives   2. Take the test

3. Choose another module

Figure 14

Module Objective Page

Module Objectives   **Module A: "Drill Press"**

1. 1A
2. 1B
3. 1C
4. 1D
5. 1E
6. 1F
7. 1G
8. 1H
9. 1J
10. 1k
11. 1L
12. 1N

The most important thing for you to do in this course is to master the objectives.

Press NEXT to see the objectives.

Objective Status Display (1) shown below.

Figure 15

Objective Status Display (1)

```
Module Objectives                  Module A: "Drill Press"

   1. 1A                 11. 1L
   2. 1B                 12. 1N
   3. 1C
   4. 1D
   5. 1E
   6. 1F
   7. 1G
   8. 1H
   9. 1J
  10. 1k

Objective "1A"
Speed selection for drills.

Enter an objective number >        BACK for more options
NEXT only for objective # 2        HELP for instructions
```

When the student elects to take a test, option 2 on the Module Criteria Page (Figure 13, page 129) he is presented with the Instructional Unit Testing Strategies Option Display, Figure 16, following page. After pressing the function key 'next' a Begin Test Display Page is shown, (Figure 17, following page) at this point the student has the option to go back to the Course Selection Display Page and make another choice, once the test is started this option is no longer available.

On pressing the function key 'next' to begin a test the

Figure 16

Instructional Unit Testing Strategies Option Display

Testing Procedure for Module A

This test covers 12 objectives.
To master this module, you must master 12 objectives.

Figure 17

Begin Test Display

Your test begins with the next screen display.

Press ANS to begin this test.

Press BACK if you don't want to take the test now.

student causes the PLM system to randomize all the instructional units in that module. Once randomized one instructtional unit is presented to the student, Figure 18, Instructional Units Objectives Option, following page. From this display the function key 'next' is again pressed, this

Figure 18

Instructional Units Objectives Option

Objective "1C" Module A

Eye Protection.

time to cause one item from that instructional unit item pool to be presented to the student. (Figure 19, Test Item (1), shown below).

Figure 19

Test Item (1)

Module A Objective: 1C Question: 1C1

1. Safety glasses need only be worn when using a reamer on the drill press.

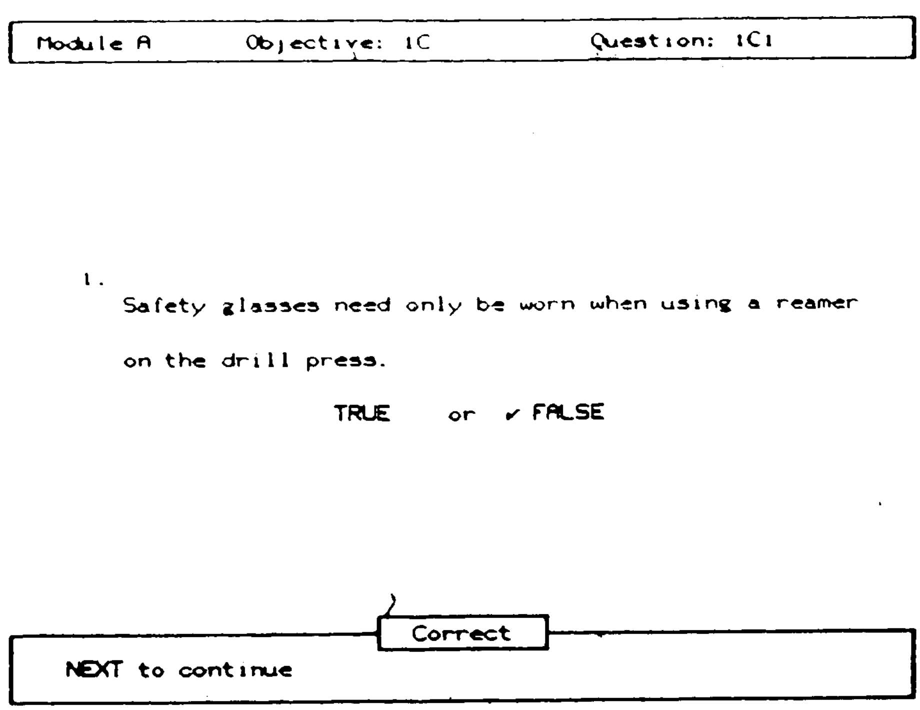
TRUE or FALSE

Press "t" or "f" and then press ANS to score.

In order to answer the item presented, the student selects the best possible answer choice available by pushing the appropriate number or letter key on the IST keyboard. Once a choice has been made a check mark appears next to that choice. The student can at this point change his answer by pressing another number or letter key. Once this selection process is completed the function key 'ans' is pressed and the answer recorded in the PLM system file. If the answer given was correct the word 'correct' appears at the bottom of the screen display (see Figure 20, Correct/Incorrect Feedback Option, shown below).

Figure 20

Correct/Incorrect Feedback Option



If the item was answered incorrectly the feedback 'incorrect' appears at the bottom of the screen display along with other non-mastery feedback. (See Figure 21, Question Feedback Messages Option, shown below).

Figure 21

Question Feedback Messages Option

Module A   Objective: 1L   Question: 1L1

1\. The most critical time of the drilling operation occurs when the drill starts to break through - when this happens you should

1) exert more pressure
2) continue with the same pressure
3) ease up on the pressure
✔ 4) change drills
5) stop the machine

Incorrect

NEXT to continue

Always ease up on the drill as it starts to break through. Otherwise it could jam in the work causing damage to the drill, the work, or injure the operator.

Once all the objectives and items in the module have been presented to the student he is then given a Module Mastery Feedback Display, Figure 22, following page, or a Module Score Display Non-Mastery Page (see page 138). After the student has read the Module Mastery Feedback

Figure 22

Module Mastery Feedback Display

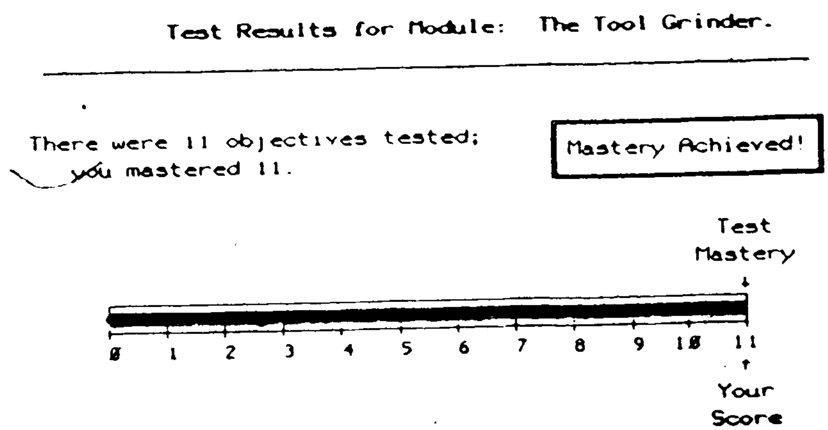
Module A

WELL DONE! You have achieved 100% on this test and are therefore eligible for your 'learners permit'. Your record has been marked accordingly. Please go on to the next module.

Display Page and presses the function key 'next' he is shown a Module Score Display Mastery Page, Figure 23, shown below.

Figure 23

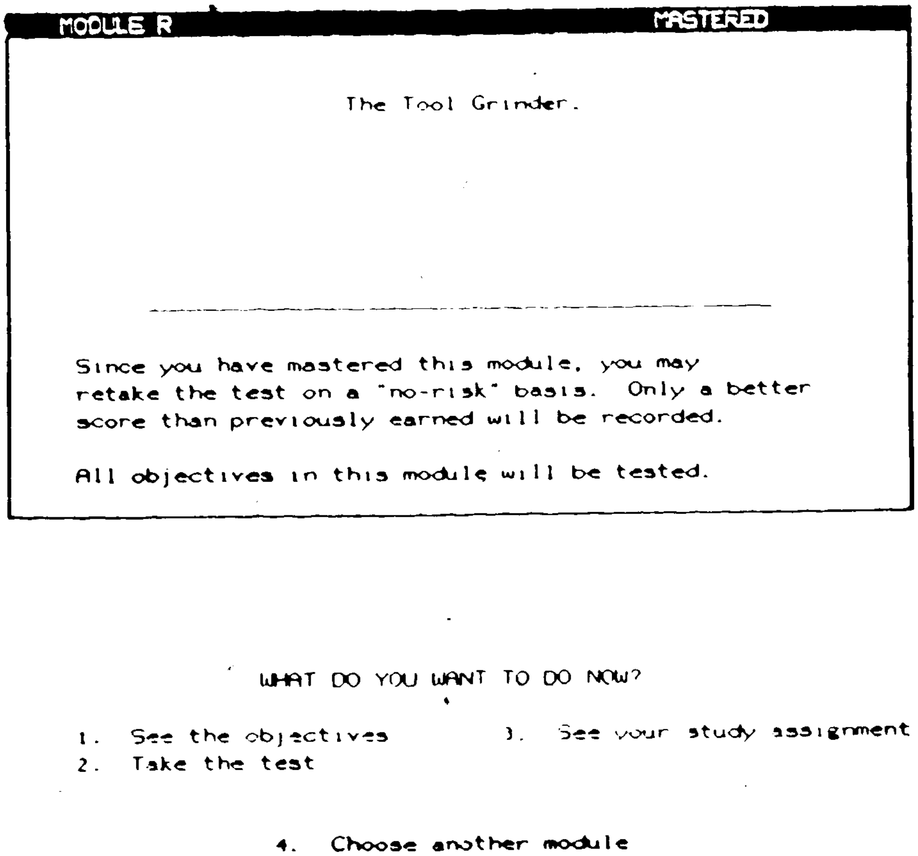
Module Score Display (Mastery) Page



Again the function key 'next' is pressed and the student is shown the Exempt Module Page (Figure 24, following page). The Exempt Module Page gives the student the option of seeing the objectives again, retaking the tests to get a better score or choosing another module. Option 3 'see your study assignment', Figure 25, Optional Assignment Display, page 137, gives the student an opportunity to review the learning resource list. (This option was not available to

Figure 24

Exempt Module Page



the students during this pilot study.) If the student does not achieve mastery a Module Score Display Non-Mastery Page is presented on which his score is displayed. (Figure 26, page 138). From this page the student has the option of first seeing the objectives he missed (Figure 27, Objectives Status Display (2), page 139) or going directly to his study assignment. (Figure 28, Study Assignment Display Page, page 140). The Study Assignment Display Page lists in its left hand column the type of material the assignment contains, the center column shows the objectives missed and the right hand column the number of the objective as it appears in the

Figure 25

Optional Assignment Display

Your record shows you need no assignment for module "Drill Press"

NEXT to return.

LAB for an optional assignment teaching all objectives in "Drill Press"

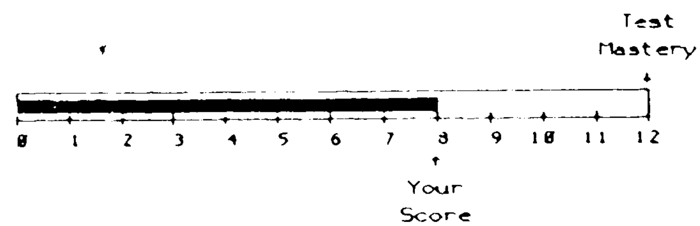
SHIFT-NEXT to see the complete list of learning resources for this module.

Figure 26

Module Score Display Non-Mastery Page

Test Results for Module: Drill Press

There were 12 objectives tested;
you mastered 8.



I'm sorry but you have not achieved the 100% pass mark required for this test, you should copy down the references that will be presented to you in a moment, read them, and try the test again.

NEXT to see which objectives you mastered and did not master

LAB to see your study assignment

Figure 27

Objective Status Display (2)

Objective Status **Module A: "Drill Press"**

✓ 1. 1A	▫ 11. 1L
✓ 2. 1B	▫ 12. 1N
✓ 3. 1C	
✓ 4. 1D	
✓ 5. 1E	
✓ 6. 1F	
✓ 7. 1G	
✓ 8. 1H	
▫ 9. 1J	
▫ 10. 1K	

✓ = mastered

▫ = not mastered

\- = unattempted

The most important thing for you to do in this course is to master the objectives. The above table shows you which objectives you have and have not mastered as a result of the test you just took.

Press NEXT to review the objectives and see your instructor's comments, or

LAB to see your study assignment.

Figure 28

Study Assignment Display Page

Study Assignment for Drill Press

9	removing sleeves, sockets, drill chucks.	TEXT
10	Clamping Work.	TEXT
11	Using Drills.	TEXT
12	Cutting Fluid.	TEXT

Enter an assignment number for instructions >

SHIFT-NEXT to list all study materials

BACK to take a test or review objectives HELP available

CMI program. The student must now enter the objective number of his choice and note down the assignment given. (See Figure 29, Learning Resource Assignment, following page). This procedure continues until all assignments have been read. When the task is complete the student is shown his final display page, the Locked Module Display, see Figure 30, page 142. This final page, reviews for the student the module criteria and tells him he is locked out of the module for a period of fifteen minutes. This lock-out is placed on the system to allow students time to complete the given assign-

Figure 29

Learning Resource Assignment

Study Assignment for Drill Press

9	removing sleeves, sockets, drill chucks.	TEXT

How to Hold Drills in the Drill Press.
Walker 34-7

Fitting Taper Shank Drills
Repp and McCarthy p. 159

You should complete this activity before taking another test on this module.

NEXT for the next item in this assignment

Figure 30

Locked Module Display

MODULE A NO TESTING

Drill Press

NOTE! 100% must be achieved on this test in order to pass. If you attain the 100% you will be given a 'learners permit'. If you score less than 100% you will be given a list of references. After studying them you may attempt the test again.

You are locked out of this module. You have been locked out until 2:43 PM MST / 4/13/82

Because you have taken 1 test on this module in which you have not demonstrated mastery, you cannot take any more tests at this time.

You can resume testing after 2:43 PM MST on 4/13/82.

WHAT DO YOU WANT TO DO NOW?

1. See the objectives 2. See your study assignment

3. Choose another module

ments. The student can at this point review the module objectives, see his study assignments again or choose another module.

APPENDIX III

PLM DATA: INSTRUCTOR ACCESS

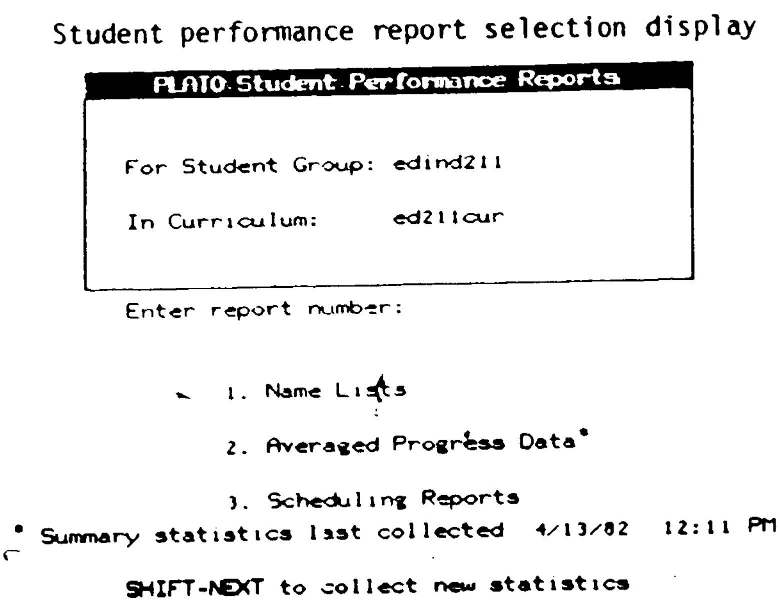
PLM DATA: INSTRUCTOR ACCESS

The PLM data collection for this pilot study used both basic and summary data that was set up to collect data from every test the student took up to and including the first time the student achieved mastery.

The raw data is first collected into a data file attached to the PLATO group, then when needed by the instructor, collected into a second data file where it is sorted into meaningful statistics. Data collection is carried out by the instructor accessing the student performance report selection display (Figure 31, shown below) and pressing the function key 'shift next'.

Figure 31

Student Performance Report Selection Display



Once new statistics have been collected, the instructor then accesses, via option 1 on the Student Performance Report Selection Display, the Student Name List Selection Display Page, Figure 32, page 147, from which he has four data display options. Option 1 shows the instructor the Student Record Data Display Page, Table 8, page 147. This page allows the instructor to review the module the student is working on and the course the student is working in. Also given is the status of the student regarding the module he is working on. The final piece of information given on this page is student curriculum mastery, this is indicated by the check mark on the left side of the screen display. From this display an individual student record is available. Under option 2 from the same selection display page the Course Summary Display Page can be accessed, (see Table 9, page 148) this display shows the instructor which courses the student has mastered or started, if the student is responsible for more than one course. Again an individual student record is available.

Option 3 accesses the Module Progress Summary Display Page given with an individual records option. (Table 10, page 149). This page allows the instructor to review the status of each individual student for each module in each particular course the student is involved in. Under option 3, access is also provided to the Course/Module Reports Selection Display Page (Figure 33, page 150). From this page all data from a particular course can be viewed, this

Figure 32

Student Name List Selection Display Page

Student Name Lists

What would you like to see?

1. Student record data (class, VMS, etc.)
2. Course progress summary*
3. Module progress summary*
4. Last module mastery dates*

* Summary statistics last collected 4/13/82 12:11 PM

Table 8

Student Record Data Display Page

Curriculum/Group: ed211cur/edind211 5/05/82 12:35 PM

Student	Class	VMS	Current Course	Current Module	Current Status
andrew	1	1	2	T	
✔ craig	1	1	2	P	
david	1	1	2	R	
david i	1	1	2	I	
✔ don	1	1	2	D	
fred	1	1	2	A	
greg	1	1	2	A	
hugh	1	1	2	E	
✔ john b	1	1	2	T	
✔ john c	1	1	2	R	
john w	1	1	2	B	
kelly	1	1	2	A	locked
linda b	1	1	2	Q	
✔ linda j	1	1	2	R	
✔ paul	1	1	2	O	
✔ rick	1	1	2	T	
✔ robert	1	1	2	O	
✔ steve	1	1	2	P	

✔ = curriculum mastered

*** End of Students *** LAB for listing options

Enter student name for individual records ❯

Table 9

Course Progress Summary Display Page

Curriculum/Group: ed211cur/edind211 5/05/82 12:36 PM

	Student	Class	COURSES: 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	andrew	1		□													
✓	craig	1		■													
	david	1		□													
	david i	1		□													
✓	don	1		■													
	fred	1		□													
	greg	1		□													
	hugh	1		□													
✓	john b	1		■													
✓	john c	1		■													
	john w	1		□													
	kelly	1		□													
	linda b	1		□													
✓	linda j	1		■													
✓	paul	1		■													
✓	rick	1		■													
✓	robert	1		■													
✓	steve	1		■													

✓ - curriculum mastered □ - started ■ - mastered

*** End of Students *** LAB for listing options

Enter student name for individual records ❯

Table 10

Module Progress Summary Display Page

Curriculum/Group: ed211cur/edind211 5/05/82 12:36 PM

COURSE #2

	CLASS	ABCD	EFGH	IJKL	MNOP	QRST	UVWX	YZ$X
andrew	1	■□ □	□□	□□	□□	□□ □		
✓ craig	1	■■ ■	■■	■■	■■	■■ ■		
david	1	□- -	--	□-	--	-■ -		
david i	1	■-		□-	-	- -		
✓ don	1	■■ ■	■■	■■	■■	■■ ■		
fred	1	□-		--	-	□ -		
greg	1	□		--	-	□		
hugh	1	■■ ■	■■	■■	■■	■■ ■		
✓ john b	1	■■ ■	■■	■■	■■	■■ ■		
✓ john c	1	■■ ■	■■	■■	■■	■■ ■		
john w	1	■■ ■	■■	■■	■■	■■ ■		
kelly	1	■□		□■	□	- -		
linda b	1	-- -	--	--	--	-- -		
✓ linda j	1	■■ ■	■■	■■	■■	■■ ■		
✓ paul	1	■■ ■	■■	■■	■■	■■ ■		
✓ rick	1	■■ ■	■■	■■	■■	■■ ■		
✓ robert	1	■■ ■	■■	■■	■■	■■ ■		
✓ steve	1	■■ ■	■■	■■	■■	■■ ■		

✓ = course mastered

□ = module started ■ = mastered

\- = assigned

*** End of Students *** LAB for listing options

Enter student name for individual records ❯

Figure 33

Course/Module Reports Selection Display Page

Curriculum/Group: ed211cur/edind211	4/13/82 12:11 PM

Course #2: "test course"

ENTER A MODULE LETTER for detailed information on that module or enter course level report number (see list below):

COURSE LEVEL REPORTS

1. Module progress summary
2. Average module scores
3. Average module durations
4. Average module confidence
5. Choose new course number

Now in GRAPHIC display mode. LAB to switch to TABULAR.

SHIFT-NEXT for next course

includes a module progress summary, (option 1) average module scores, (option 2) average module durations, (option 3) and average module confidence, (option 4). (An option not in use during this pilot study.) Option 5, choose new course number, provides instructor access to different PLM courses. The final option, 4 from the Selection Display Page, lists the last modules mastered by the student and the date on which that mastery took place.

The instructor also has access as a general guide to student progress, a record of lesson usage showing the number of times the student has signed-on to the system, the time spent during those sessions, the total number of IST sessions and the amount of Central Processing Unit (CPU) time used. (See Table 11, Individual Sign-On and Lesson Usage Display, page 152. From the individual record, a group record is also available that shows average times, sessions and CPU time used for all students. (See Table 12, Group Sign-On and Lesson Usage Display, page 152).

Option 2 from the Student Performance Report Selection Display (Figure 31, page 145) gives the instructor a Course Program Summary which can be shown in either a graphic format (Figure 34, Course Progress Summary Page (Graphic), page 153) or a tabular format (Table 13, page 154). Finally, option 3 from the same display page (Figure 31, page 145) accesses the scheduling reports which allow the instructor to check student progress through a curriculum based on a starting date, module durations, study times and a master calendar of dates.

Table 11

Individual Sign-On and Lesson Usage Display

Record usage for group edind211 as of 05/05/82:

		Last On	Days	Hours	Sess.	CPU
andrew	s	04/02/82	2	1.5	5	4.4
craig	s	04/01/82	9	4.8	14	3.8
david	s	04/13/82	5	0.8	11	4.7
david i	s	01/21/82	3	0.5	8	5.6
don	s	04/07/82	4	4.4	7	3.6
fred	s	01/25/82	2	1.1	6	1.8
greg	s	01/19/82	2	0.4	7	3.3
hugh	s	04/07/82	6	4.0	8	2.9
john b	s	03/22/82	2	5.2	9	2.6
john c	s	03/22/82	5	7.8	13	3.1
john w	s	04/08/82	3	5.8	4	3.1
kelly	s	01/27/82	1	1.1	1	4.8
linda b	s	03/03/82	2	0.4	2	3.6
linda j	s	03/05/82	3	9.3	8	1.7
paul	s	03/03/82	4	7.1	8	2.5
rick	s	04/13/82	7	5.4	10	3.1
robert	s	04/05/82	4	5.0	14	4.9
steve	s	03/24/82	5	3.4	7	4.1

Table 12

Group Sign-On and Lesson Usage Display

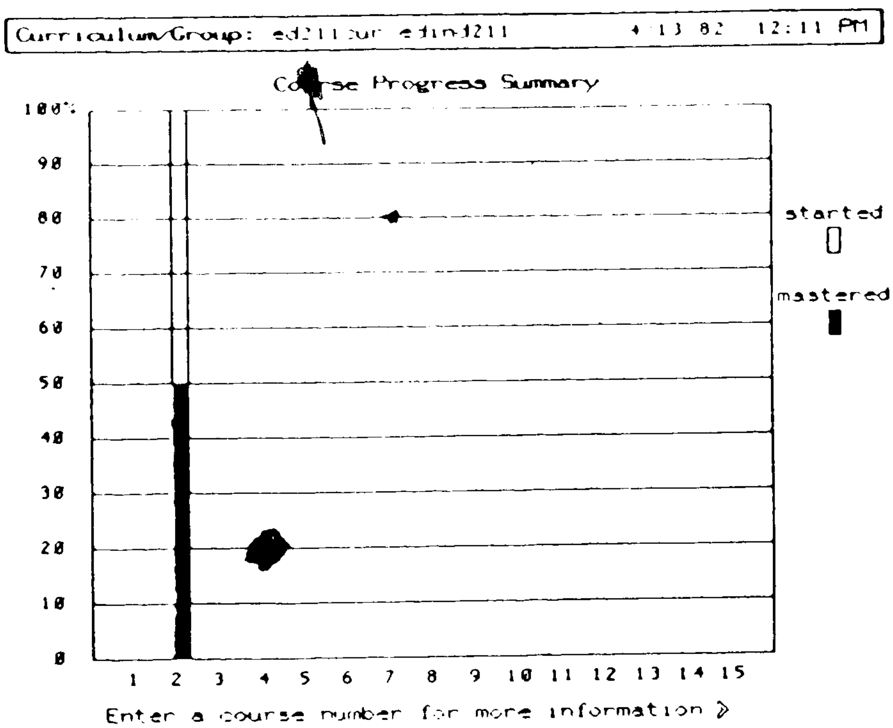
Usage averages for group edind211 as of 04/13/82:

	#	Days	Hours	Sessions	CPU
Students	18	4	3.8	8	3.6
Multiples					
Authors					
Instructors					

These statistics include only those records which have signed on at least once.

Figure 34

Course Progress Summary Page (Graphic)



LAB to switch to TABULAR display mode

Table 13

Course Progress Summary Page (Tabular)

Curriculum/Group: ed211cur edind211 4/13/82 12:11 PM

Course Progress Summary

Course	Number of Students (%) Assigned	Started	Mastered	Average Score
2	18	18 (100)	9 (50)	63

Enter a course number for more information >

LAB to switch to GRAPHIC display mode

APPENDIX IV

PLM STUDENT DATA

PLM STUDENT DATA

The following data are used by the course instructor to view and judge student progress. These statistics are accessed through the name list option shown in Figure 31, Student Performance Report Selection Display, page 145, Appendix III. Shown is one student's test results for one module assigned during the pilot study test period. Table 14, Course Status Display Page, following page, shows the course status display from the student's gradebook. This page lists for both the student and the instructor the module the student is working on, or just mastered, the student's score and the number of tests he has taken before mastery. Table 15, Student Module Data, page 158, shows an individual student record for one module giving the date the module was last 'worked on', the time of day the module was accessed and the duration in minutes of the first, second and last tests taken, the number of tests on that module and when the module was mastered. Also listed is the score the student achieved on the first, second and last test taken, the possible score (criterion) and the percentage score. Table 16, Module report, (Module B), page 159, shows the group averages for all students over all first, second and last tests for that module. Also shown is the number of students starting the module, the average number of tests for that module and the average number of tests taken before mastery.

Table 14

Course Status Display Page

/ edind211   April 13, 1982   1:27 PM

Course 2: test course

Started: 1/22/82   Last Test: Module R, 3/05/82
Mastered: 3/05/82   Last Mastery: Module R, 3/05/82

Course Score: 100

MODULE	STATUS	MASTERED	SCORE	TESTS
A	mastered	1/22/82	100 of 100	1
T	mastered	1/22/82	100 of 100	3
B	mastered	3/03/82	100 of 100	3
I	mastered	3/03/82	100 of 100	3
J	mastered	3/03/82	100 of 100	2
P	mastered	3/03/82	100 of 100	3
O	mastered	3/03/82	100 of 100	3
D	mastered	3/05/82	100 of 100	5
→ R	mastered	3/05/82	100 of 100	5
Q	mastered	3/03/82	100 of 100	1
F	mastered	3/05/82	100 of 100	2
E	mastered	3/05/82	100 of 100	2

Enter a module letter ›

LAB for next student   EDIT to change this record

Table 15

Student Module Data, (Module B)

/ edind211 April 14, 1982 1:26 PM

Course #2 Module B: "Engine Lathe"

3 tests taken Module mastered on: 3/03/82

TEST	FIRST	SECOND	LAST
DATE	1/22/82	1/22/82	3/03/82
TIME	9:50 AM	10:55 AM	12:48 PM
DURATION	12 min.	13 min.	8 min.
SCORE	75	88	100
POSSIBLE	100	100	100
PERCENT	75 %	88 %	100 %

EDIT to change this record

NEXT for objective status SHIFT-NEXT for next module
LAB for assignments SHIFT-LAB for group averages

Table 16

Module Report, (Module B)

Curriculum/Group: ed211cur/edind211 4/13/82 12:11 PM

Course #2 Module B

Students started: 13 Average number of tests: 4
Average number of tests taken before mastery: 3.909

	Overall	Test		
		First	Second	Later
Tests Mastered*	11	0	3	8
Percent Score	88	80	90	100
Average Test Duration (min.)	8	10	7	6

*Only the first mastery by each student is counted.

Press NEXT to return

APPENDIX V

PLM MODULE DATA

PLM MODULE DATA

The following basic and summary statistics are those collected by the PLM system during the pilot study session, March, 1982. They serve as data on which a judgement regarding the module as a whole can be based, Figure 35, Module Progress Summary Page (Graphic), shown below, shows the module progress for the safety course number two.

Figure 35

Module Progress Summary Page (Graphic)

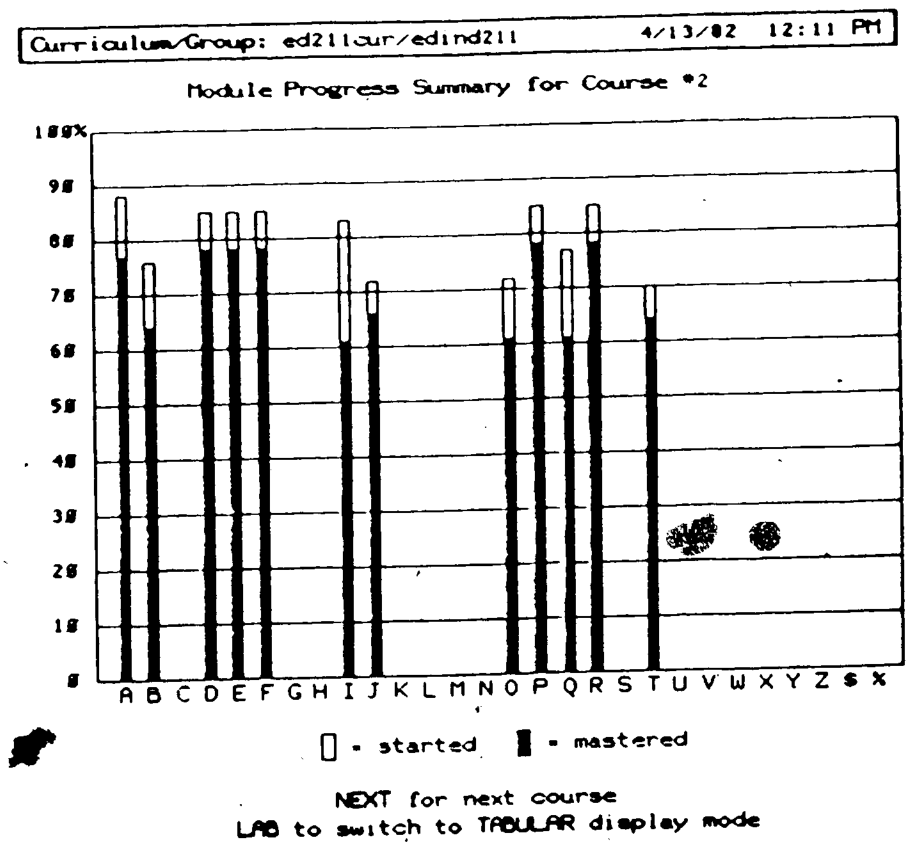


Figure 35, above, shows the number of students starting and the number of students mastering the module, i.e. for module A, 88 percent of the total student group started the module and of that group 77 percent mastered the module. The same figure is also presented in a tabular format, Table 17, below, and shows in column 1 the assigned modules and in column 2 the number of students to whom the module was assigned. Under the heading 'started', column 3 the number of students who started the module is listed with the number in parenthesis being the percentage of same. Column 4 lists the number of students who mastered the module and the relevant percentage. The final column, 5 lists the average number of tests taken by all students for that module.

Table 17

Module Progress Summary Page. (Tabular)

Curriculum/Group: ed211cur/edind211 4/13/82 12:11 PM

Module Progress Summary

Course #2

LAB for GRAPHIC display mode

Module	Students (%) Assigned	Started	Mastered	Avg # Tests
A	18	16 (88)	14 (77)	2
B	17	13 (76)	11 (64)	4
C				
D	14	12 (85)	11 (78)	3
E	14	12 (85)	11 (78)	2
F	14	12 (85)	11 (78)	2
G				
H				
I	18	15 (83)	11 (61)	2
J	18	13 (72)	12 (66)	3
K				
L				
M				
N				
O	18	13 (72)	11 (61)	4
P	14	12 (85)	11 (78)	3
Q	13	14 (77)	11 (61)	2
R	14	12 (85)	11 (78)	2
S				
T	17	12 (78)	11 (64)	3
U				
V				
W				
X				
Y				
Z				
$				
X				

Figure 36, Average Module Score Page (Graphic), shown below, shows the average module scores for all students over all modules for one test. Table 18, following page, shows the same information in a tabular format. Column 1 lists the assigned modules, column 2 (right hand side) the number of first tests completed and on the left hand side the average score for those tests. In column 3, the number of second tests is shown on the right hand side with the average mark for these tests shown on the left. Column 4 lists,

Figure 36

Average Module Score Page (Graphic)

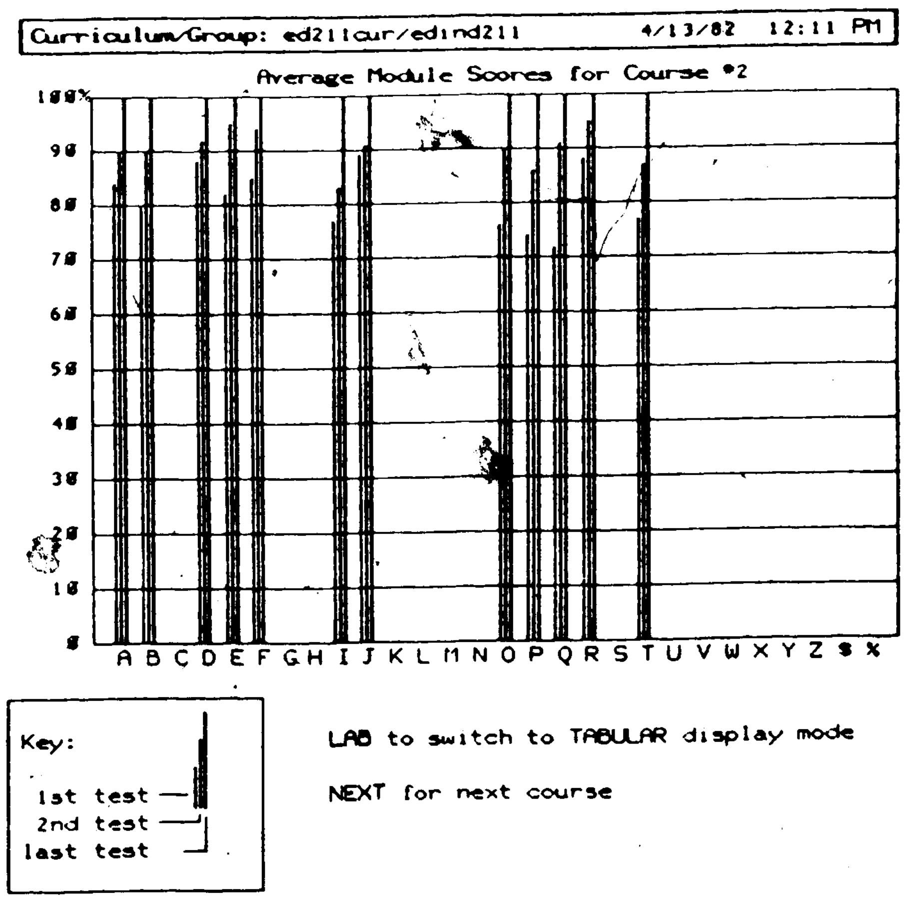


Table 18

Average Module Score Page (Tabular)

Curriculum/Group: ed211cur/edind211 4/13/82 12:11 PM

Average Module Scores (%)

Course #2

LAB for GRAPHIC display mode

Module	TEST (avg/n) First	Second	Last	Average Overall
A	83/ 16	89/ 9	100/ 6	91/ 31
B	79/ 13	89/ 12	100/ 8	90/ 33
C				
D	87/ 12	91/ 10	100/ 8	93/ 30
E	82/ 12	95/ 9	100/ 3	92/ 24
F	85/ 12	94/ 11	100/ 4	93/ 27
G				
H				
I	77/ 15	82/ 12	100/ 7	86/ 34
J	88/ 13	91/ 11	100/ 5	93/ 29
K				
L				
M				
N				
O	76/ 13	90/ 12	100/ 9	88/ 34
P	74/ 12	86/ 11	100/ 8	86/ 31
Q	72/ 14	91/ 8	100/ 6	87/ 28
R	88/ 12	94/ 7	100/ 3	94/ 22
S				
T	76/ 12	86/ 9	100/ 9	88/ 30
U				
V				
W				
X				
Y				
Z				
$				
%				

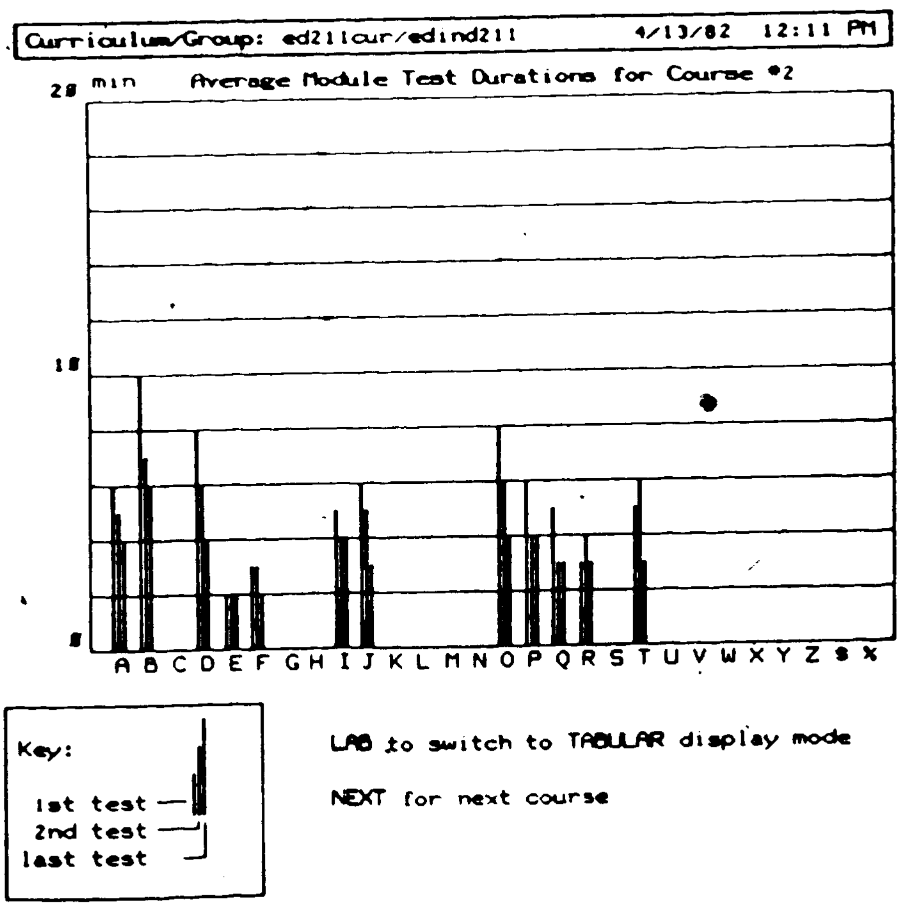
on the right the number of tests taken beyond two before mastery was achieved by all students, with the mastery score of 100 percent shown on the left. The final column, 5 shows, on the right, the total number of tests given for that module before mastery was achieved by all students. The average score for these tests is given on the left.

The final graph, Average Module Durations Page (Graphic) following page, lists the time in minutes taken to complete each module. Table 19, Average Module Durations Page (Tabular), page 166, lists in column 1 the assigned modules.

Column 2, left side, lists the average time taken for that module and the number of first tests completed. In column 3 the average time is again given on the left hand side with the number of second tests shown on the right. Column 4 lists, on the left, the average time taken over all tests after the second test, with the total number of tests taken before mastery was achieved by all students, shown on the

Figure 37

Average Module Durations Page (Graphic)



right. The final column lists the average time taken by the student for all tests for that module, with the total number of tests given for that module shown on the right.

Table 19

Average Module Durations Page (Tabular)

Curriculum/Group: ed211cur/edind211 4/13/82 12:11 PM

Average Test Durations (in minutes)

Course #2

LAB for GRAPHIC display mode

Module	TEST (avg/n) First	Second	Last	Average Overall
A	7/ 16	6/ 9	4/ 6	6/ 31
B	10/ 13	7/ 12	6/ 8	8/ 33
C				
D	8/ 12	6/ 10	5/ 8	6/ 30
E	2/ 12	2/ 9	2/ 3	2/ 24
F	4/ 12	3/ 11	2/ 4	3/ 27
G				
H				
I	5/ 15	4/ 12	4/ 7	4/ 34
J	7/ 13	5/ 11	3/ 5	5/ 29
K				
L				
M				
N				
O	9/ 13	6/ 12	4/ 9	6/ 34
P	7/ 12	5/ 11	5/ 8	5/ 31
Q	5/ 14	3/ 8	3/ 6	4/ 28
R	4/ 12	4/ 7	3/ 3	3/ 22
S				
T	5/ 12	6/ 9	3/ 9	4/ 30
U				
V				
W				
X				
Y				
Z				
$				
X				

APPENDIX VI

PLATO STUDENT QUESTIONNAIRE

PLATO SAFETY MODULES

Term II 1981/82 Use questionnaire

Rate the overall <u>effectiveness</u> of the following:

1. The PLATO system for the safety tests:

Good ☐ Fair ☐ Poor ☐

2. The safety tests:

Good ☐ Fair ☐ Poor ☐

3. The ability of the system to keep track of what you are doing and how well it is being done:

Good ☐ Fair ☐ Poor ☐

4. The question non-mastery feedback:

Good ☐ Fair ☐ Poor ☐

5. The learning resources:

Good ☐ Fair ☐ Poor ☐

Rate the overall <u>usefulness</u> of the following:

6. The grade book:

Good ☐ Fair ☐ Poor ☐

7. The learning resources:

Good ☐ Fair ☐ Poor ☐

8. The non-mastery feedback:

Good ☐ Fair ☐ Poor ☐

9. The test lock-out:

Good ☐ Fair ☐ Poor ☐

10. Do you think the test lock-out time should be changed (it is now 15 minutes)

Yes ☐ No ☐

11. If yes to the above, what in your opinion should the test lock-out time be changed to?

Time in minutes

20 15 10 7 5 0

Rate the suitability of the following:

12. The test questions:

Good ☐ Fair ☐ Poor ☐

13. The learning resources

Good ☐ Fair ☐ Poor ☐

14. Should other learning resources have been given?

Yes ☐ No ☐

15. If yes to the above what other learning resources should have been used?

Test ☐ CAI Lessons ☐ Audio visual ☐

Example ______ Example ______ Example ______

16. Rate the accuracy of the learning resources, did they give adequate and clear directions:

Good ☐ Fair ☐ Poor ☐

17. Did you find the CMI (safety) PLATO terminal work:

Too much ☐ About right ☐ Too little ☐

18. How do you think the PLATO safety program helped you learn:

Excellent ☐ Good ☐ Fair ☐ Poor ☐

19. Rate quality of the PLATO safety program:

Excellent ☐ Good ☐ Fair ☐ Poor ☐

20. Is the PLATO safety program a good way to check for safety knowledge?

Yes ☐ No ☐

Why? ____

____

21. What suggestions do you have for improving the system

____

____

____

____

APPENDIX VII

AUTHOR INFORMATION AND QUESTION SHEET

Note: The Author Information and Question Sheet shown on the following page has been subject to reduction for printing purposes. This reproduction therefore does not reflect the screen space allotted by the P.L.M. program for each of the items listed. (See page 60.)

TITLE ______ NUMBER ___ IU ______

OBJECTIVE

IU
1 ______
2 ______
3 ______
4 ______

Question 1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

5 10 15 20 25 30 35 40 45 50 55

Question mastery feedback

1 ______
2 ______

Question non-mastery feedback

1 ______
2 ______
3 ______
4 ______

TITLE

Learning Resource

1 ______
2 ______
3 ______
4 ______
5 ______
6 ______
7 ______
8 ______
9 ______
10 ______
11 ______
12 ______
13 ______
14 ______
15 ______

APPENDIX VIII

SPSS DATA ANALYSIS FILE

```
$RUN *SPSS 6=-OUT 8=SORT
FILE NAME         SPSS1, ITEM ANALYSIS
VARIABLE LIST     STUDENT,MODULE,IU,QNAM,NUMTST,SCORE,IUTIME,ANSWER
INPUT MEDIUM      DISK
INPUT FORMAT      FIXED(1A4,T15,A4,T21,A4,T31,A4,T63,F1.0,T69,F1.0,T71,F3.0,T89,A3)
PRINT FORMATS     STUDENT MODULE IU ANSWER QNAM (A)
SELECT IF         (NUMTST EQ 1)
*SELECT IF        (MODULE EQ 'M05')
FREQUENCIES       GENERAL = STUDENT , NUMTST , ANSWER
FREQUENCIES       GENERAL = SCORE ,MODULE,
STATISTICS        ALL
*SELECT IF        (MODULE EQ 'M05')
CROSSTABS         TABLES = QNAM BY ANSWER BY SCORE
STATISTICS        ALL
*SELECT IF        (MODULE EQ 'M05')
CROSSTABS         TABLES = STUDENT BY ANSWER BY QNAM
STATISTICS        ALL
*SELECT IF        (MODULE EQ 'M05')
CROSSTABS         TABLES = STUDENT BY SCORE
STATISTICS        ALL
FINISH
```