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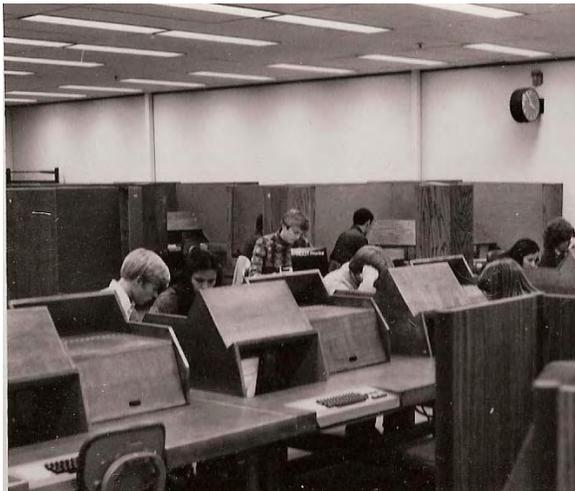
## LEARNER CONTROL IN COMPUTER BASED LEARNING

M. DAVID MERRILL

During the period 1971-1975, with National Science Foundation funding, we cooperated with MITRE Corporation in the design of the TICCIT system. From January 1976 until February 1979, again with NSF funding, we investigated learner controlled strategies with a series of experimental studies. . . . In this presentation I will attempt to briefly describe the TICCIT system and its underlying learner control design. . . .

### WHAT IS TICCIT?

TICCIT is a computer based instructional system. The name is an acronym for Time-shared, Interactive, Computer-Controlled Information Television. To a student TICCIT appears to be a color television set in a study carrel with a special typewriter keyboard. Instructional materials are presented on the television screen (including rule frames, examples, practice problems, and test items). The next display, rather than being prescribed by the system, must be selected by the student. The students soon realize that they have considerable control over the presentation. The materials are presented using a rich variety of display techniques including: a variety of type styles, color used both for emphasis and for appeal, graphics illustrating instructional ideas as well as cartoons for fun, videotapes, and special features, like the ability to use the computer as a calculator. *[This was written in 1979. By today's standards (2007) the TICCIT system is very primitive. The instructional design, however, is still current. TICCIT was considerably ahead of its time.]*



**Figure 1 TICCIT learning center**



**Figure 2 TICCIT study carrel**

Most of the displays presented on the television screen are still frames consisting of diagrams and words. The display is in color which enables the author to use different colors to emphasize important details. Under the usual mode of operation, the display does not change until the student indicates the next display s/he would like to study.

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**Figure 3 TICCIT television screen**



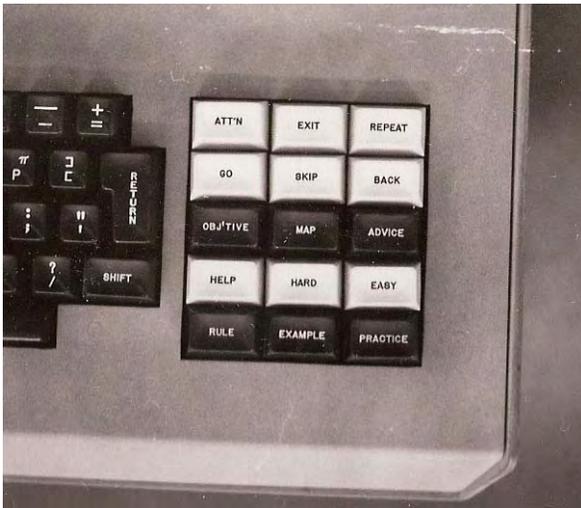
**Figure 4 TICCIT keyboard**

TICCIT is an interactive system. The principal mode of interaction is by way of a special keyboard.

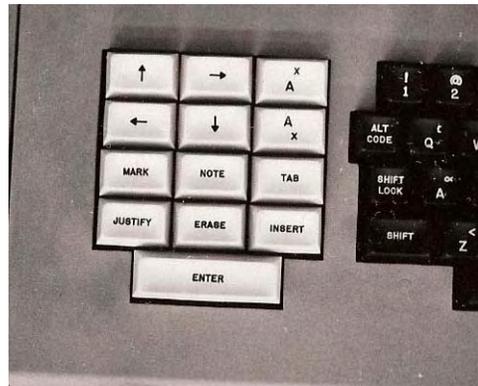
This device is an ordinary typewriter keyboard augmented by an additional shift register, flanked on the left by 'edit keys,' and on the right by 'learner control' keys.

The edit keys are used by the student to move the cursor on the screen, for entering sub- and superscripts, and for modifying verbal message already displayed on the screen. They are also used by authors for creating and editing displays.

The 'learner control' keys are a unique feature of the TICCIT system. These 15 buttons are used by the student to indicate which instructional display s/he would like to study next. These keys are also used to select the next segment of material for study. These features enable students to control their own presentation strategies. Thus each student can select a combination of displays that is most appropriate for his/her own unique combination of aptitudes or prior learning.



**Figure 5 Learner control keys**



**Figure 6 Edit keys**

TICCIT instruction is comprised of a very large set of displays, each of which can be retrieved by means of an appropriate learner-control key. Each display contains only one kind of information hence the displays are not the same as the pages of a book or the frames of a film strip. In TICCIT a given display may require several

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frames or pages. Once a learner is aware of the various types of displays that are available, the one which would best meet his/her immediate instructional need can be selected.

TICCIT is based on the assumption that a given idea-concept, procedure, or principle-should be presented in each of three modes: rule, example, and practice.

A **RULE** display (Figure 7) is a general statement which attempts to present the idea being taught as concisely and clearly as possible. A rule may be a definition of a concept, a list of steps in a procedure, or a statement of relationship between concepts. A rule display usually contains a minimum of elaboration and seldom includes an illustration of the idea.

An **EXAMPLE** display (Figure 8) is an illustration of a concept, a demonstration of a procedure, or the application of a principle. An example is a specific object or event which illustrates a particular rule. This display usually presents the illustration as directly as possible with a minimum of elaboration.

A **PRACTICE** display (Figure 9) provides an opportunity for the student to apply the rule to a specific object or event. For a concept, practice requires the student to classify a particular object or event into one or more categories. For a procedure, practice requires the student to use a series of steps to solve a problem or manipulate objects or events. For relationships, practice requires the student to explain a particular occurrence or set of events. A practice display usually provides minimum clues concerning the solution.

A student responds to a practice display by typing an answer on the keyboard or by moving the cursor to point to a correct answer. Following the response the system evaluates the answer and provides an appropriate **FEEDBACK** message (Figure 10).

If the response was incorrect the **FEEDBACK** display provides an explanation of why a given response is correct or incorrect (Figure 11). This information may merely suggest that the student try again or it may indicate the kind of mistake the student made. Sometimes a feedback message will work the problem for the student, making it similar to an example display.

The **EASY**, **HARD**, and **HELP** buttons are used to access displays which are modifications of rule, example, and practice displays. These displays are used to provide additional information when the three basic displays are insufficient for a given student. These elaboration keys provide an additional way for students to adapt the presentation to their individual needs.

The **HELP** key can be used following each of the three primary displays providing (1) rule-help, (2) example-help, or (3) practice-help. Practice help can be accessed either prior to or following the student's response to a practice problem.

A **RULE-HELP** display (Figure 12) uses color or graphics to identify critical attributes of each part of the rule.

In this example the referent and its pronoun are shown in the same color. The two words are connected by an arrow indicating that the pronoun stands for the referent.

An **EXAMPLE-HELP** display (Figure 13) usually includes the original example with additional information added to help the student see why the illustration is really an example of the rule. In this example color and graphics have been used to emphasize the pronoun and its referent. The interest is to assist the student in finding the pronoun and its referent, and to help the student determine whether the referent is plural or singular. Help displays often involve several pages or frames. We have included only one of the several pages for our illustration.

A **PRACTICE-HELP** display (Figure 14) can be requested either prior to or after making a response. In either case the same practice item is elaborated by means of attention focusing devices, graphics or further explanation of the problem. In the illustration color has been used to isolate pronouns and referents from the rest of the sentence. Like example helps, practice helps sometimes require several pages; our illustration includes only one of these pages.

When the **EASY** or **HARD** key is used following the rule key the student is presented a rule-easy or rule-hard display. A **RULE-EASY** display (Figure 15) is a more concrete statement of the definition, procedure, or

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principle. Often a graphic illustration or analogy is used. Technical terms are defined or synonyms are substituted. The intent is to present the rule in as simplified a Form as is possible. Our illustration again includes only one of several pages which comprise this display.

A RULE-HARD display (Figure 16) presents the definition, procedure, or principle in its most technical Form. Often special symbols which characterize the subject matter are used. The intent is to present the rule as it would be stated by experts in the field.

Here, then, is the general rule for pronoun-referent agreement.

A pronoun agrees in number with its REFERENT. Singular referents take singular pronouns. Plural referents take plural pronouns. Singular referents which have no sex indicated take the generic pronouns him/he/his.

RULE PAGE 1/1

Figure 7 Rule display

In the passage below, the pronoun in green agrees with its referent in light blue.

Neither John nor Harry brought his coat to the ball game.

This can be reviewed in lesson 4.2

EXAMP 1 EASY PAGE 1/1

Figure 8 Example display

Edit any pronoun in the passage below that doesn't agree in number with its referent. If all pronouns are correct, press ENTER.

Several of the mechanics brought his tools.

PRACT 3 EASY PAGE 1.1

Figure 9 Practice display

Edit any pronoun in the passage below that doesn't agree in number with its referent. If all pronouns are correct, press ENTER.

Several of the mechanics brought their tools.

CORRECT!

FDBK 3 EASY PAGE 1/1 AUDIO

Figure 10 Correct feedback display

Edit any pronoun in the passage below that doesn't agree in number with its referent. If all pronouns are correct, press ENTER.

Several of the mechanics brought his tools.

Wait. One of the words you changed wasn't even a pronoun.

FDBK 3 EASY PAGE 1/1

Figure 11 Incorrect feedback display

The word that gives a pronoun its meaning is called the REFERENT of the pronoun (because the pronoun refers to that word). The referent is the noun or noun substitute which the pronoun stands for.

In clear writing the PRONOUN REFERENT is easy to find. Just ask WHO or WHAT the pronoun stands for:

STANDS FOR

The coach was happy only when he won. Who does he stand for? Coach. Coach is the referent of the pronoun he.

RULE HELP PAGE 1/14

Figure 12 Rule help display

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Neither John nor Harry brought his coat to the ball game.

singular REFERENT ← singular PRONOUN

John nor Harry his

E HELP 1 EASY PAGE 3/3

Several of the mechanics brought their tools.

plural REFERENT ← plural PRONOUN

mechanics several

P HELP 3 EASY PAGE 3/4

Figure 13 Example help display

Figure 14 Practice help display

PRONOUNS can refer only to nouns that have the same number they have.

SINGULAR pronouns refer to SINGULAR nouns (referents):



Dick laughed as he ran.

PLURAL pronouns refer to PLURAL nouns (referents):



The men liked what they saw.

RULE EASY PAGE 4/11

Generally:

A PRONOUN agrees in number with its REFERENT.

RULE HARD PAGE 1/1

Figure 15 Rule easy display

Figure 16 Rule hard display

On the example and practice displays there are three levels of difficulty-easy, medium and hard.

The EASY and HARD keys pressed following an example or practice display shift the student to the next easier or next harder file. These displays are merely more or less complex instances which resemble the example and practice displays already illustrated, so we have not provided additional sample displays here.

In addition to display selection control TICCIT students may also select which unit, lesson, and segment they wish to study next. A student makes this selection from a course, unit, and lesson map. A course map (Figure 17) is a hierarchy diagram indicating the prerequisite relationships among the units in the course. Entering a unit number and pressing the GO key while on a course map causes the system to display a unit map (Figure 18). This is a hierarchy diagram indicating the prerequisite relationships among the lessons of the unit. Entering a lesson number and pressing the GO key while in a unit map causes the system to display a lesson map (Figure 19). A lesson map is a hierarchy diagram indicating the prerequisite relationships among the segments of a lesson. A segment corresponds to a particular concept, procedure, or principle represented in the system by a set of rule, example, practice, and help displays. Each segment box on a lesson map has an associated objective display which can be accessed by entering the segment number and pressing the OBJ key (Figure 20 - 21). Students can return a higher order map by pressing the MAP key.

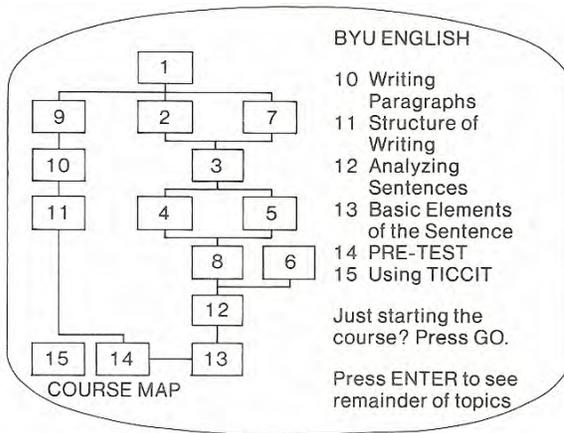


Figure 17 Course map

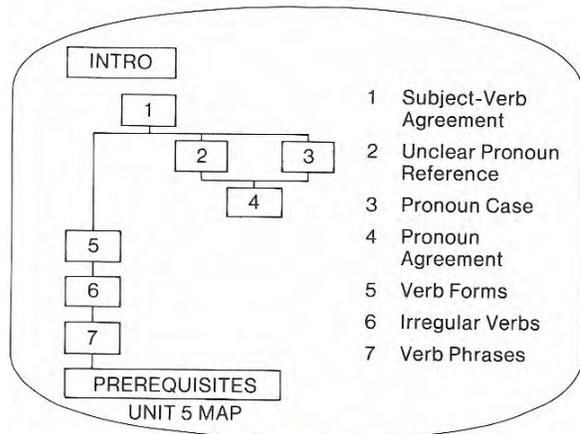


Figure 18 Unit map

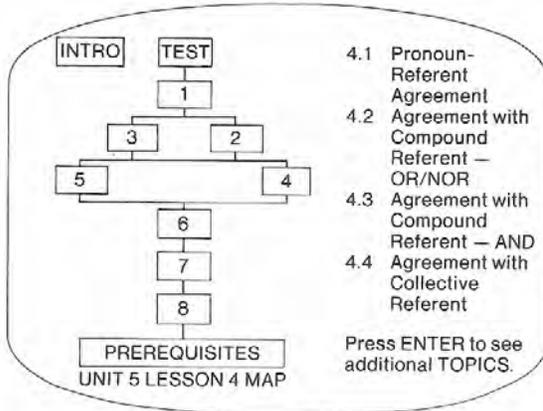


Figure 19 Lesson map

Given a passage containing pronouns...

ALL POLLY'S ADMIRERS LOST HIS INTEREST IN HER.

OBJECTIVE PAGE 1/3

Figure 20 Segment objective p. 1

2) edit to correct any agreement problems between pronouns and referents.

THEIR  
ALL OF POLLY'S ADMIRERS LOST HIS INTEREST IN HER.

OBJECTIVE PAGE 3/3

Figure 21 Segment objective p. 2

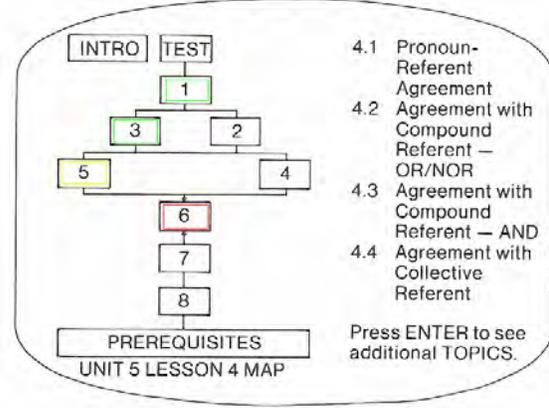


Figure 22 Map color advice

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Students on TICCIT are given considerable ADVICE as to their status and suggesting what to do next. Some of this advice is solicited by the student by pressing the ADVICE key; some is presented by the system without student solicitation.

Maps provide one form of unsolicited advice. Map boxes are colored red, yellow, or green to indicate student progress in learning the material (Figure 22). On a lesson map a black box means the segment has not been studied; the box is yellow if the student has seen some part of the segment but has not satisfied the advisor requirement for adequate study; the box is green if the student has satisfied the advisor requirement for adequate study; and the box is red if the student has dropped below the minimum advisor requirement for satisfactory study. The advisor requirement is based on a recency formula which includes the minimum number of instances thought to adequately illustrate the idea and a minimum number of correct practice attempts.

Students can press the ADVICE key and obtain a segment status display which indicates what the student must do to attain a green status for the segment box on the lesson map. When the ADVICE key is pressed the second time the student is given guidance about what to do next.

The system also provides a series of messages to help the student when it appears that progress is too slow, such as suggesting the student try a harder example or practice item; or when it appears that progress is too fast, such as warning a student that he has not seen several segments or that his/her performance has not been adequate when he/she attempts to take the test. Usually such advice can be ignored by the student. Under some circumstances system response is constrained limiting possible student action.

TICCIT testing involves a sequential procedure in which parameters set by the author determine regions of acceptable and unacceptable performance. Testing continues, within limits, until a *reject* or *accept* decision can be reached. The parameters of test performance can be stringent, thus requiring a large number of potential test items or less stringent; requiring fewer items. A given student is required to complete only as many test items as are required for a decision. Test items are usually similar to practice items and usually require concept classification, procedure using or principle application level of behavior.

[The following paragraphs are from Merrill, Schneider and Fletcher, 1980 pp.59-62]

*Advice on learning strategies.* When a student presses ADVICE while working on a segment, the segment status display, which was previously explained, is presented. When the ADVICE key is pressed a second time, guidance is provided suggesting what to do next as follows:

If you think you understand this segment then press PRACTICE.  
If you are not sure you understand then press EXAMPLE.  
If you're having trouble then press RULE.  
To get more information press ENTER  
To get back to the page you were working on press EXIT

Learning strategy advice is determined by a complex decision tree which evaluates what the student has done so far in the segment and then provides several suggestions based on the student's own evaluation as to his or her degree of comprehension. The basic philosophy underlying the learning strategy advice is a win-shift up, unsure-stay, lose-shift back notion based on a recommended sequence of rule, example, practice easy, practice medium, practice hard. Helps are usually a *stay* recommendation.

The system also provides unsolicited learning strategy advice when it appears that the student may be having trouble or may not be making wise display selection choices. For example, if the student continues working practice problems after having attained a practice score of 80, the advisor will display an unsolicited message which says:

The ADVISOR thinks you've done enough work on this segment. Go on to segment 2.

Or, perhaps, the student shifts immediately to the hard practice file and misses several in a row; the advisor will then display an unsolicited message which says:

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The ADVISOR suggests you try some easier problems (press EASY).

Perhaps the student selects the test prior to turning all the segment boxes on the lesson map green. The advisor will display the following unsolicited message:

Are you sure you're ready for the test? Press GO to begin.

Not sure? The quickest way to find out is to look at the PRACTICE for the segments which are covered on the test. (You can tell which these are by looking at the MAP. The test segments have yellow titles.) Want to play it safe? Work on segment 3.

If the student has already tried the test once and failed, and then he or she tries to take the test a second time before turning all the segment boxes green, the following message will be presented:

Sorry, but you cannot take this test until you have completed segments 3, 2, and 1.

If the student solicits advice and continues to ignore the suggestions given by doing something else, the advisor would send the following message:

You have been ignoring the suggestions the ADVISOR has been giving you. The ADVISOR's designers would appreciate it if you would press NOTE and explain why. This will help us make the advice better.

*Directions for system operation.* Sometimes a student does not know or forgets how the system operates. An additional press of ADVICE in various situations will result in a presentation of such directions to the student. The following is presented to a student who tries to work on more than two lessons without passing the tests.

Sorry, but you can't start another lesson until you finish: lessons 3 and 4 in unit 6. If you wish, you may SURVEY this lesson by pressing GO at this time. Remember, work in survey mode is NOT FOR CREDIT.

Perhaps the student does not know what makes up the survey mode. Pressing ADVICE while the above display is being shown would retrieve the following message:

### HOW TO USE SURVEY MODE

1. Survey mode is a way for you to look over any lesson to get an idea of what's in it. This might help you decide which lesson to study, or just "look ahead" to see what's coming up.
2. In survey mode, you can look at MAPs, Rules, Prerequisites, Introductions, and Objectives. You CANNOT look at Examples, Practice, or Tests.
3. Remember, survey mode is "not for credit." To pass a lesson you must pass its test, and *you* can't do that in survey mode.

The following message may be presented to a student who requests to take a lesson test:

If you are ready to start the test, press GO. Remember, you can't quit in the middle of the test without failing it, so be sure you're ready and have time before you start. For other information, press ENTER.

Pressing ENTER the student is given the following message:

### SOME INFORMATION ABOUT TICCIT TESTS ...

1. How many questions must you answer? This depends on the test, and on your answers! If you get every item right, you will pass quickly; if you get them all wrong, you'll fail quickly. With some right and some wrong, TICCIT will need more answers to decide whether you know the material. You may see as few as two or as many as 46 problems.
2. Sometimes you will be allowed to try again on the test-just remember to press ENTER to re-answer when you are given this option.

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[End of insert from Merrill, Schneider and Fletcher, 1980]

The foregoing provides a very brief review of TICCIT operation looking in at the student end. My interest in this paper is the learner control rationale underlying the design; hence the foregoing is sufficient for this purpose. However, in fairness to my colleagues I must comment in passing that TICCIT also involves a number of other innovations in computer assisted learning, including a unique hardware configuration, a unique natural language authoring system, a unique graphics input system, a data output system which allows users to "track" a student's strategy path, and other special features. We have a small book which describes some of these features in addition to learner display control which is the emphasis of the current paper (Merrill, Schneider and Fletcher, 1980). [*You need to keep in mind the time frame for this system. Graphics were very new and very primitive, colored text did not exist on other systems and on TICCIT it only allowed 8 colors. Windows were yet to be invented yet TICCIT used a primitive window system to construct displays from several components in a data base. The same "base frame" would stay on the screen while the example being considered would be changed in a window. All of this was new in the mid 1970s.*]

### TICCIT DESIGN PHILOSOPHY

TICCIT was an attempt to implement through hardware and software a unique courseware philosophy which has come to be known as *Component Display Theory* (CDT). This instructional design theory is applicable to any instructional situation; hence TICCIT is merely one application. In the following paragraphs I will attempt to highlight a few of these design ideas as they were incorporated in the TICCIT system.

TICCIT differs from most other computer based instructional systems in several important ways.

First, TICCIT authors are required to provide only the content to be taught but not the instructional strategy to be used because the presentation strategy is already *built into the system*. Second, TICCIT was designed to teach primarily concept classification, procedure using or principle using objectives rather than memory-drill or problem-solving. Third, it assumes that strategies for teaching these objectives are comprised of sequences of relatively discrete displays and that there are only a few different types of such displays. Fourth, it allows the student to determine which content to study next and which strategy (display selection and sequence) to use rather than having these decisions under program control.

Let us briefly consider each of these characteristics.

Most CAI systems prior to the TICCIT system required authors to learn a computer authoring language. This language was used to enter both the content to be learned and to determine the strategy by which the content would be presented. An assumption underlying the courseware design of the TICCIT system is that strategy and content are relatively independent of one another. The primary job for the author is to determine appropriate content for each of the primary presentation displays and their variations for a given segment. The author does not need to be concerned with instructional logic, branching, etc., which is usually required by other CAI systems.

Component Display Theory assumes that the components of cognitive subject matter, excluding certain psychomotor skills and affective outcomes, can be classified into four categories: facts, concepts, procedures, and principles. A fact consists of a one-to-one association usually between some object or event and a symbol used to represent the object or event. A fact may also be some constant associated with a particular phenomenon or event. A concept consists of a class of distinctively different objects, events, or symbols which share a set of common characteristics and are referenced as a group by a distinctive label or name. A procedure is a sequential series of steps the execution of which produces a desired phenomenon. A principle is a cause-and-effect relationship which provides an explanation for the occurrence of a particular phenomenon.

Except for facts, each of these content types—concepts, procedures and principles—can be represented either by one or more specific cases, which we will call *instances*; or by a statement of the general case, which we will call a *generality*. Hence, instances are specific objects, events, and symbols OR representations of such specific occurrences via pictures, diagrams or other mediated representations. Generalities are statements of definition

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(concepts), steps (procedures), or relationships (principles); which can be applied to a variety of specific situations.

Except for facts, students can demonstrate different levels of understanding with respect to each type of content. While such levels can be subdivided for our purposes let's consider at least four levels: (1) remember-an-instance, (2) remember-a-generality, (3) use-a-generality, and (4) find-a-generality. The remember-instance level means that a student will be able to recall or recognize a particular object or event which was shown during instruction. This is the only level of outcome possible for facts. The remember-generality level means the student will be able to recall or recognize a definition, list of procedural steps, or propositional statement which s/he has been taught during instruction. The use-generality level means that given a previously unencountered instance the student will be able to apply the generality by classifying it (concept), executing the procedure, or explaining the relationship (principle). The find-generality level means that the student will be able to invent a definition for classifying a previously undifferentiated (for him/her) set of instances; derive a procedure for achieving a particular result; or discover a relationship for explaining a given phenomenon. The find level involves areas typically referred to as creativity, problem solving, and discovery.

The TICCIT system was deliberately limited to the use~generality task level for concepts, procedures, and principles. This limitation may seem extremely narrow; however, the choice was deliberate for several reasons. First, in the USA early computer-based learning systems were dominated by drill and memory level instruction. We wanted to demonstrate that a CAI system could teach 'higher level skills.' Furthermore, we wanted it to be difficult for authors to use drill when a higher level of behavior was appropriate. Our intended audience was adult learners and our observation had been that too much memory level instruction dominated college courses. By designing a system especially configured for 'using' level objectives we felt we could promote more adequate instruction.

Second, a careful analysis of the junior college level curriculum (our target population) indicated that objectives were at a concept-classification or rule-using level. Even though the words problem solving, invention, discovery and creativity were sometimes used in course descriptions, most of the content really involved complex rule using which could be targeted at the use-generality level.

We have already indicated that cognitive subject matter can be presented as either generalities or instances. These two levels of representation can be presented to students in two modes-expository or telling, and inquisitory or asking. Combining the generalities and instances with telling and asking defines four primary presentation forms: telling-a-generality which is called 'rule' on the TICCIT system; telling-an-example which is called 'example'; asking the student to identify an instance, or execute a procedure, or explain a particular event; which is called instance-practice or merely 'practice'; and asking the student to remember a generality which is not included as a separate function of the TICCIT system. We have already illustrated these primary presentation forms and their elaborations as implemented on TICCIT.

Component Display Theory (COT) indicates that a unique combination of primary presentation forms is associated with each task level in the outcome matrix (see Fig. 23). TICCIT was designed to implement the use-level for which CDT prescribes as an adequate presentation: a rule display, a set of example displays and a set of practice displays accompanied by appropriate feedback. CDT also suggests some additional characteristics for an adequate presentation at each task level. For the use-level some of these characteristics include (1) isolation and identification of primary presentations. On TICCIT this is accomplished by having each display accessible via a button press which is labeled rule, example, practice or help. (2) A divergent set of instances which adequately illustrates the content component being taught. This involves defining a minimum-critical-subset of instances. Procedures for the selection and sequencing of instances are not apparent to the casual observer of the TICCIT system but are part of the authoring system. (3) Matching of examples and non-examples. This characteristic is also built in to the authoring system and may not be apparent to the casual observer. Usually on TICCIT coordinate concepts are taught where the examples of one concept become no-examples of an associated concept. The sequencing and relationships between example displays specified by this recommendation are built into the system. (4) Alternative forms of representation for generalities. On TICCIT this is accomplished by RULE-HELP and RULE-EASY displays. (5) Alternative forms of representation for instances. This characteristic is also not readily apparent to the casual observer since

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alternative forms are incorporated into the selection and sequencing of the instance files. (6) Use of attention focusing devices. On TICCIT this is accomplished by HELP keys which require every instance to be accompanied by such learning aids.

TASK LEVEL	USE GENERALITY	BY DEFINITION FACTS HAVE NO GENERALITIES				
	REMEMBER GENERALITY					
	REMEMBER INSTANCE					
			FACTS	CONCEPTS	PROCEDURES	PRINCIPLES

**Figure 23 Task/Content matrix**

*In summary*, TICCIT has built-in the recommendations of CDT for the teaching of concepts, procedures, and principles at the use level. Some of the recommendations have been implemented by explicit buttons, others implemented more subtly by requirements of the authoring system. TICCIT has often been criticized as an expensive page turner, and perhaps it is. Nevertheless, there is considerably more involved in the composition of these pages than there is in an ordinary book and while we have demonstrated that CDT can be implemented without a computer the computer does provide a structured authoring, data, and advising system that is considerably more complex than that which is possible in typical settings with large numbers of students.

### **LEARNER CONTROL**

It should be apparent from the foregoing that CDT prescribes instruction which is very rich. A TICCIT lesson has hundreds of possible displays, far more than would be required by a single student to learn the material. However, the means for customizing a presentation for a given student are readily available. However, rather than trying to select and sequence individual displays for the student TICCIT requires the student to select and sequence the individual displays for him/herself.

A reoccurring dream among CAI enthusiasts has been the dream of a maximally adaptive system which could assess a given student's learning style, aptitudes, past achievement, and readiness and then present to the student that content and strategy which is optimally appropriate for him/her to receive at a given moment in time. We felt that rather than being an advantage to education, such a totally adaptive system might be maladaptive, making students system dependent. Such 'spoon fed' students might find that learning from the natural environment was more difficult because the real world is not as adaptive to the individual needs of the student. We were afraid that unless students learned to adapt the instruction to their own needs rather than having the system adapt the instruction, that the dream of adaptive CAT might become a horrible nightmare. A primary meta-objective of TICCIT courseware is to help students become system independent.

When a student learns to select the next best display on the system, s/he is also learning how to select the next best display in non-computer based situations. If our assumption is correct that all instructional strategies really consist of a series of displays, then it follows that conventional instruction also consists of rules, examples and practice displays even though the distinction may not be as clear-cut as when such displays can be called up at the touch of a button on a learner control keyboard. If in a computer based learning system the student can learn to make facilitating choices of display, then it is also possible, when given appropriate directions, that a student can learn to distinguish rules from examples when reading a text or listening to a lecture. If a student can learn to distinguish these displays then s/he can also learn to recognize when the conventional instruction is not providing the information which is necessary for him/her to understand the idea which is being presented. The student is thus in a better position to seek additional information from the instructor or from other sources.

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A learner control system which requires a student to learn to make appropriate strategy choices is very different from a system which caters to the student's needs and aptitudes. In the learner control setting, a student must learn to recognize his/her own learning needs; in an adaptive system instructional decisions may be made on the basis of needs which the student may not even know that s/he has. In the opinion of the TICCIT designers, this difference is crucial for the student's future development.

### REFERENCES

Merrill M. D., Schneider E. and Fletcher K. (1980), *TICCIT*. Englewood Cliffs, NJ: Educational Technology Publications.