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ABSTRACT

The exploratory study focused on the existence, variability, and effectiveness of adult learning styles among participants receiving computer-based instruction in the metric system. A pretest was administered to 75 adults not currently involved in formal educational programs, and 40 participants were selected whose pretest indicated no knowledge or limited knowledge of the metric system. The learning experience was presented by the Plato 4 computer system, which recorded each participant's learner trail (record of moves) and the corresponding time data. A posttest was administered after participants' decision to end the learning; the posttest was followed by an interview to determine learner reactions. The data strongly supported the idea of learning styles, as each participant had a particular way of moving through the lesson (sequencing, pacing, and distribution of moves), and it also was possible to cluster participants according to learning styles. No relationship was indicated between membership in a particular learning style cluster and level of prior knowledge, age, sex, educational level, or recency of education. Approximately one-fourth of the participants were aware of a conscious strategy or plan of study. The high scores on the posttest made it impossible to determine the relative effectiveness of various styles. (EA)

AN EXPLORATORY STUDY OF ADULT LEARNING STYLES

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An Exploratory Study of Adult Learning Styles

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The concept of learning styles is generating interest among educators of adults. As larger numbers of adults further their education, both formally and informally, there is a growing concern for educational experiences that will help adults become independent learners. Helping learners develop effective learning styles is seen as one way of accomplishing this. This study is an attempt to explore the empirical basis for adult learning styles, using computer assisted instruction as a tool for data collection.

PROBLEM

One characteristic of the scientific and technological age in which we live is that knowledge is continually being modified and expanded. It has, therefore, been widely suggested that education should place less emphasis on distributing and storing knowledge and more on methods of acquiring knowledge, that is, learning to learn. Toffler (1971, p. 414) has said:

> Tomorrow's schools must therefore teach not merely data, but ways to manipulate it. Students must learn how to discard old ideas, how and when to replace them. They must, in short, learn how to learn.

In addition to learning to learn, the idea of life-long education has gathered support during the past decade. Faure (1972) has pointed out that there is nothing new in the idea of the continuity of the educational process. Consciously or not, human beings keep on learning and training themselves throughout their lives. What has changed, however, is the necessity or requirement for lifelong learning. Knox (1974) has pointed out a particular need for self-directed learning (i.e., managing one's own learning) among the professional members of our society. He feels that the primary responsibility for continuing professional education must fall on the individual practitioners. Such self-directed continuing professional education should persist throughout a career because of the benefits it provides in the form of improved professional performance.

Tough (1971), in a recent survey, collected data that indicates that a vast majority of adult learning projects are self-directed. Sixty-eight percent of all the projects surveyed were self-directed and another nine percent were partially self-directed.

This growing recognition that adults should continue their education has contributed to a growing need for information on how to help adults become more efficient and effective within their learning activities. Learning effectiveness might include the selection of appropriate and efficient strategies for the acquisition of knowledge, skills, and attitudes. Although there has been some research about the ways in which teachers should design learning experiences and about the relation between teaching style and learning effectiveness, there has been little attention paid to the ways in

which learners themselves acquire and modify their strategies or styles of learning. (The term "learning style" will be used to indicate a distinctive or characteristic manner in which a learner approaches a learning project or episode, regardless of whether it involves implicit or explicit decision making on the part of the learner. "Learning strategy" will be used, in a more narrow or restricted way, to refer to a careful plan or method of learning; i.e., explicit decision making on the part of the learner as to how to proceed through a learning project or episode.)

With the limited theory and research that exists regarding adult learning styles, there was a need for an exploratory study into the existence, variability, and effectiveness of adult learning styles. The objectives of this study were:

1. To determine from observational data if adults have "a distinctive or characteristic manner" of approaching learning episodes; i.e., to see if the data supports the hypothetical construct of "learning style".

2. To gather preliminary data about the stability of learning styles across learning tasks, where the learning tasks are the various sections (objectives) of a lesson.

3. To gather preliminary data about the variability of learning styles across sub-populations of adults, based on the following characteristics: level of prior knowledge of topic, recency of formal education experience, level of education, age, and sex.

4. To gather preliminary data about the extent to which some styles are more effective than others.

5. To determine, through interviews, the extent to which adults employ learning strategies; i.e., consciously attempt to use a plan of study.

METHOD

Participant Selection and Classification

Seventy-five adults who were not currently involved in formal educational programs volunteered to participate in the study. Each of them completed a questionnaire in order to provide relevant biographical data. They were also administered a ten-item pretest in order to assess their general knowledge of the metric system.

On the basis of their pretest scores, the volunteers were divided into three groups. Those who scored zero through three were considered to have no prior knowledge of the metric system (a score of two was the chance score for the pretest). Those volunteers who scored between four and seven were considered to have some prior knowledge of the metric system. Volunteers who scored eight and above were considered to be familiar with the metric system and were eliminated from the study.

Twenty volunteers from each of the remaining two groups participated in the study. The mean pretest score for those with no prior knowledge was 2.35. For those with some prior knowledge, the mean pretest score was 5.70. Those with some prior knowledge had attained a slightly higher level of education and had been out of school longer than those with no prior knowledge. There were more females in the no prior knowledge group and more males in the some prior knowledge group. The average age for the groups was almost identical. Aside

from the pretest score, none of the differences between the no knowledge and some knowledge groups was statistically significant.

Learning Experience

The main section of the lesson dealt with conversions between the English and metric systems of measures. The eight conversions which serve as the basis for the eight objectives were selected because of their usefulness in daily adult life.

The PLATO IV computer based education system at the University Of Illinois at Urbana-Champaign was used as the medium of presentation for the learning experience. The terminals, the part of the system with which the participants had contact, consist of a graphical display device (the plasma panel) and a keyboard for entering information. The keyboard is nearly identical to a typewriter keyboard except that there are additional function (control) keys on the sides.

The lesson was divided into two sections: orientation and content. The orientation section was basically a linear programmed sequence, with the learner having control of the rate of presentation. This section served to orient the learner to both the computer terminal and to the format of the subsequent content section.

The format of the content section can best be described as learner controlled. The material in this section of the lesson was separated into objectives, rules, examples, and problems as proposed by Merrill and Boutwell (1973) and explicated by Merrill (1973). Upon beginning the main section of the lesson, the learner was presented with a list of objectives which he or she could study in any order. It was also possible to review any of the objectives at any time.

Once an objective was selected, the learner could choose to see a rule, a set of examples, or a set of practice problems. The level of difficulty (e.g., easy, medium or hard) of any of these options could be varied by the learner. The learner could also request help at any time and he or she would receive additional information. Also, the learner could return to the index of objectives and choose to review a previously studied objective; choose to study a new objective, or choose to take the posttest over all the objectives.

Design of the Study

The purpose of this study was to empirically explore the concept of learning style. There had been a growing body of theoretical literature concerning this concept (Knox, 1971; Merrill, 1973; O'Neal, 1973). However, little if anything had been done to provide empirical support for the hypothetical construct.

Because of its exploratory nature, the study was not intended to be a rigidly controlled experimental investigation. The participants were divided, however, into two equal groups on the basis of level of prior knowledge. The learning experience was identical in format for both groups.

Information concerning recency and level of formal education, age, and sex was also obtained. This information was gathered for use in an exploratory analysis of the data for the purpose of generating hypotheses and isolating relevant variables for consideration in later studies.

Dependent Variables

The following three indices provided the empirical basis for the analysis of learning styles.

Learner Trail. The PLATO IV system automatically recorded every move (choice) each participant made as he or she proceeded through the content section of the lesson, along with the amount of time spent on each objective. Each participant's trail (his or her record of moves) could be analyzed logically and empirically, along with the corresponding time data.

Posttest. A posttest consisting of 20 items was administered to each participant immediately following his or her decision to end the learning experience. The posttest examined the participant's: (a) ability to convert from one system of measurement to the other, and (b) comprehension of the relationship between the corresponding units of both systems.

Interview. Following the posttest, each participant was interviewed. The interview schedule attempted to elicit information concerning the participant's: (a) self-perception of his or her learning style, (b) reaction to the computer technology, (c) reaction to the learner controlled format of the lesson, and (d) fatigue and/or boredom effects on learning style.

General Procedures

After the participant information forms and pretests were administered, all eligible participants were invited to attend an individually administered study session. The participant was informed

that the session would last about two hours and that he or she could choose a convenient time to attend.

Upon arriving at the session, a brief oral introduction was given by the session administrator. The PLATO IV system and terminal were briefly explained, followed by an explanation of the format and purpose of the lesson.

The participant then proceeded through the lesson. Each participant sat at his or her own PLATO IV terminal and worked independently. Upon deciding to end the lesson, the posttest was administered and the participant was interviewed.

RESULTS AND DISCUSSION

Learner Trail

The collection, by the PLATO IV system, of every move made by each participant along with associated time data provided a rich pool of information. Up to 700 pieces of information were available for each participant and it was necessary to find ways to put all of these data into perspective.

After inspecting the data using several different analysis techniques, it was decided that three components of each trail captured the essence of learning style. These were: (a) the sequence in which moves were made; (b) the pace at which moves were made; and (c) the distribution of moves by type (rules, examples, problems) and level of difficulty (easy, medium, hard). Empirically, it was these components that evidenced the greatest variability among participants. This classification also seemed to be intuitively meaningful.

Two variables provided information concerning the sequence in which moves were made. These were the order in which the participants proceeded through the objectives and, within each objective, the order in which they requested various types of moves (rules, examples, problems).

Sequence of Objectives. When a participant reached the content (learner controlled) section of the lesson, he had to decide in what order to proceed through the eight objectives. By reviewing a participant's trail and reviewing his response to the first item of the interview schedule, it was possible to determine how and why he proceeded as he did.

The most common criterion used by the participants was the order in which the objectives were listed on the index page or display. Twenty-four participants went through the objectives exactly as listed. (Five of the 24 opted to take the posttest for the eight objectives before completing all objectives and one reviewed all of the objectives a second time.)

In addition, one participant started with the second objective and proceeded in the order listed, returning to the first objective after completing the other seven. Another participant started with the third objective, returned to the first and then proceeded in the order listed. Overall, 26 out of the 40 participants (65%) went through the objectives generally in the order listed. All 26 stated in the interview that the order in which the objectives were listed was the controlling factor in their decisions. These people used an external or contextual factor (the format of the index) as a basis for their decision making.

Six participants reported that they studied the objectives with which they were most familiar first. Their trails confirmed their verbal responses. For example, two of the six started with the conversion from yards to meters because sewing patterns presented linear measurements using both systems of measurement. Two additional participants reported that they intentionally selected objectives with which they were least familiar. Both of these individuals had some prior knowledge of the metric system and first selected objectives about which they were uncertain. Together, eight of the 40 participants (20%) used degree of familiarity as the criterion for selecting objectives.

One participant chose to study the conversion from yards to meters, first, because she saw it as being potentially the most useful. She currently used "yards" on a regular basis and thought that a knowledge of meters would be necessary within the near future.

Five participants' trails exhibited no particular pattern as far as order of objectives. When interviewed, these five said they had proceeded randomly through the objectives.

Of the fourteen participants who did not proceed through the objectives generally in the order listed, eight did go through the objectives in pairs of related conversions. For example, they studied the objective that dealt with conversion from yards to meters with the objective that dealt with conversion from meters to yards. They did not consistently begin with the English or with the metric unit, however.

None of the independent variables showed a strong relationship with the order in which a participant proceeded through the objectives. A potentially interesting relationship might exist between level of prior knowledge and random selection of objectives. Four out of the five participants who proceeded randomly had no prior knowledge of the metric system.

Order of Moves. Once participant selected an objective, he or she then had to decide to access a rule, example or practice problem related to the objective. This was done by pressing the appropriate key. By pressing the various keys each participant had total control over which types of displays were presented, the level of difficulty of the display and the amount of time spent viewing the display.

Exactly half of the participants (20) maintained a relatively consistent pattern of accessing a rule, followed by examples, and concluded with practice problems. This was the order in which the options were listed across the bottom of the display (Fig. 1). The format of the display was explicitly given by five of the 20 participants as their reason for proceeding as they did.

Fifteen additional participants (38%) generally used a rule-practice pattern. Many of these participants initially viewed the examples for one or two objectives and then stopped using them. Three of the 15 did not access a single example throughout the lesson. (Of course, the completed problems might be serving the same function as the examples would.) Many of these 15 participants stated that they felt the examples were less useful than the rules and problems.

OBJECTIVE 3: The learner will be able to change length in yards to length in meters by using the appropriate conversion factor.

Obj: 3.

FUNCTION	Rule	Example	Practice	Easy	Med.	Hard	Help	Index
KEY	ANS	DATA	LAB	e	m	h	HELP	BACK

Fig. 1 PLATO screen showing order in which functions were listed.

The remaining five participants used various patterns and were less consistent with their patterns. All five participants who exhibited these variable patterns reported in the interview that they were deliberate in their decisions. They perceived themselves as having patterns, but their trails did not support that contention.

The data did not indicate a relationship between the independent variables and the order in which people requested various types of moves within each objective.

Pace. Three variables provided information concerning the pace at which the participant moved. These were the total time spent in the lesson, the total number of moves made, and the time spent per move.

The average time spent on the entire lesson was 45.96 minutes. The range was from 13.2 to 111.1 minutes. Level of prior knowledge did impact on the time spent on the lesson. For those with some prior knowledge, the average time spent was 41.61 minutes. For those with no prior knowledge, the average was 50.32 minutes. This difference is statistically significant at the .01 level.

The number of moves (decisions which accessed new information) ranged from six to 169. The mean for all participants was 78.75 with a standard deviation of 37.91. There was no statistically significant relationship between level of prior knowledge, age, sex, recency or level of formal education and number of moves.

The average amount of time a participant spent per move ranged from 16.05 to 72.00 seconds. The overall average was 34.27 seconds per move. There was no evidence to indicate that any of the independent variables impacted on time per move.

Distribution of Moves. The total number of moves was distributed by type (rule, example, practice) and by level of difficulty (easy, medium, hard). For the entire sample of 40 participants, practice problems accounted for 51 per cent of the moves. Examples accounted for 30 per cent and rules accounted for the remaining 19 percent. Most of the moves occurred at the medium level of difficulty (79 percent). The fact that a majority of moves occurred at this level is partially explained by the fact that every time a learner entered a new objective, he was automatically started at the medium level. A decision was required to change to a different level of difficulty. Three per cent of the moves were at the easy level of difficulty, and the remaining 18 per cent were at the hard level. The distribution of moves was not related to any of the independent variables.

Posttest

A 20-item posttest was administered to each participant upon his decision to end the learning experience. The posttest was criterion referenced and the scores were consistently high. The mean score was 18.52.

The test yielded two subscores; a conversion score and a comprehension score. The mean conversion score was 15.4 out of a possible 16.

The mean comprehension score was 3.12 out of a possible 4. The comprehension score did vary with level of prior knowledge. Those with no prior knowledge had a mean comprehension score of 2.80, while those with some prior knowledge had a mean score of 3.45. This difference is significant at the .05 level. The comprehension score also varied by sex. Males had a mean comprehension score of 3.50 compared with a score for females of 2.88.

The Interview

The interviews following the posttest provided much useful information. Some of it, dealing with the reasons people proceeded in certain ways, has already been presented. In general, there was a high degree of congruence between what people said they did and what their trails showed that they did. The implications of this high level of congruence are discussed in the next chapter.

When asked if they studied differently over time, 20 of the 40 participants said that they did. Most of the specific examples given involved ending the use of examples. Thirty-five out of 40 indicated that they became better acclimated to the lesson over time; i.e. they felt more at ease with the format and technology.

Seven participants mentioned being anxious or apprehensive at first. This feeling did not last very long for anyone. There was some minor confusion on the part of a few people as to the labeling of the function keys. This was due to the special use certain keys were being put to for this lesson and could be easily remedied by relabeling

them. For example, the 'ANS' key could be labeled 'RULE' and the 'DATA' key could be labeled 'EXAMPLE'.

In general, the interviews confirmed that the PLATO IV system was practically transparent; i.e. the terminal and computer did not interfere with the lesson by confusing and/or frightening the participants. This finding is particularly interesting because the study dealt with adults, at least 75 per cent of whom had never before seen the PLATO system.

The participants were generally positive concerning the learner controlled format of the lesson. Only nine people stated that they were indifferent and no one was negative. Positive factors included being able to review, feeling a sense of freedom (control over the lesson), and the sense that the lesson was an efficient format for learning.

Existence of Learning Style

The first objective was to ascertain from observational data if adults have a distinctive or characteristic manner of approaching learning episodes; i.e., to see if the data supports the hypothetical construct of learning style. The current study provided a large amount of data on how the participants proceeded through the lesson. The question was how to look at all of the data for a participant simultaneously, to see if a pattern or style emerged.

It was decided that since there was no existing empirical research dealing with learning styles or appropriate statistical techniques for

dealing with the amount or complexity of the current data, that an attempt would be made to begin inductively from the current data and to develop appropriate techniques and a conceptual framework for the data. One of the first tasks was to determine a method for data reduction in order to deal with up to 700 bits of information per participant.

After several approaches were tried unsuccessfully, an intuitive technique was developed. Eleven key variables were identified which captured the three major components of learning style. The components and variables were: (a) sequence (order of objectives and order of moves); (b) pacing (number of moves, total time, and the time per move); and (c) distribution by type of move (rule, example, practice) and by level of difficulty (easy, medium, hard). For both sequence variables, it was possible to divide the participants into three natural groups that were evident in the data. The mean and standard deviation were calculated for the three pacing variables and the six distribution variables. Since the only norms available for these nine variables were those generated in the current study, it was decided that the standard deviation would be used as an indicator of variant pacing or distribution of moves.

Figure 2 shows a chart on which it is possible to represent each of the eleven variables as a digit between one and three. It is then possible to visually inspect each participant's chart to see how he or she is similar to and different from the other participants. This

Participant ____________

COMPONENTS OF PARTICIPANT'S TRAIL

Component		Scale 3	Scale 2	Scale 1
SEQUENCE	Order of Objectives	•	•	•
	Order of Moves	•	•	•
PACING	Number of Moves	•	$\bar{X}$=78.8 SD=37.9	•
	Total Time	•	$\bar{X}$=45.9 SD=22.2	•
	Time per Move	•	$\bar{X}$=34.4 SD=12.8	•
DISTRIBUTION OF MOVES	% Easy Moves	•	$\bar{X}$=3 SD=8.8	•
	% Medium Moves	•	$\bar{X}$=79 SD=15.7	•
	% Hard Moves	•	$\bar{X}$=18 SD=14.3	•
	% Rules	•	$\bar{X}$=19 SD=10.4	•
	% Examples	•	$\bar{X}$=30 SD=14.8	•
	% Practice Problems	•	$\bar{X}$=51 SD=15.4	•

EXPLANATION OF SCALES

Order of Objectives:
1. Order Listed
2. Familiarity/ Usefulness
3. Random

Order of Moves:
1. Order Listed
2. Rule/Practice
3. Variable

Pacing and Distribution of Moves:
1. More than one Standard Deviation Below Mean
2. Within one Standard Deviation of Mean
3. More than one Standard Deviation Above Mean

Fig. 2. Chart for displaying eleven components of participant's trail. The mean and standard deviation are given for appropriate variables.

was done for each of the participants. (This technique was an attempt to deal with the concept of learning style in a holistic way. The data analysis would have been far simpler if the various components of learning style had been dealt with independently. However, it was felt that much of the potential richness of the concept would have been lost with a more segmented approach.)

These data do strongly support the idea of learning styles for the following reasons. First, each participant had a characteristic manner of moving through the lesson. It was exhibited in their approach to sequencing, pacing, and distribution of moves. Second, there was a great deal of variability among individuals. This is evident in the data by the range for several of the variables. This indicates that not every adult employs the same style or strategy. Third, there were similar styles exhibited by some participants and it was possible to cluster participants according to learning style (the section on variability of learning styles across sub-populations deals with this in more detail).

Stability of Learning Style

The second objective was "to gather preliminary data about the stability of learning styles across learning tasks." The evidence from this study indicates there is stability across tasks, where the tasks are sub-sections (objectives) of a lesson. Following some exploratory behavior early in the lesson, most of the participants found a comfortable style at least by the time they began their fourth objective and maintained it until they completed the lesson. The greatest stability was evidenced in the sequence and distribution of moves. The pace

increased, for several of the participants, as they moved further into the lesson. This may be due to feeling more comfortable about the format of the lesson and/or boredom. Both were mentioned in the interviews.

It should be kept in mind that the various sections of the lesson were very similar in format and type of content. No implications can be drawn concerning the stability of learning styles across more varied tasks or across lessons.

Variability of Learning Styles Across Sub-groups

The third objective was to "gather preliminary data about the variability of learning styles across sub-populations of adults", based on level of prior knowledge, recency of formal education experience, level of edcuation, age, and sex. Figure 3 shows a chart on which two participants' (H2 and L4)[1] data have been plotted. Since the scales on each variable are unrelated to each other, the participant's profile has no significance in and of itself. It is simply a means of graphically representing a large number of variables in a format which can be inspected and analyzed visually.

It is then possible to compare a participant's profile with every other participant's. Each comparison can yield a score which is calculated by summing the difference between participants across variables. In the case of Figure 3, the difference on order of ob-

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[1]Each participant is represented by a letter followed by a number where the letter represents level of prior knowledge (L=low; H=medium) and the number is alphabetical position within one of the sub-groups.

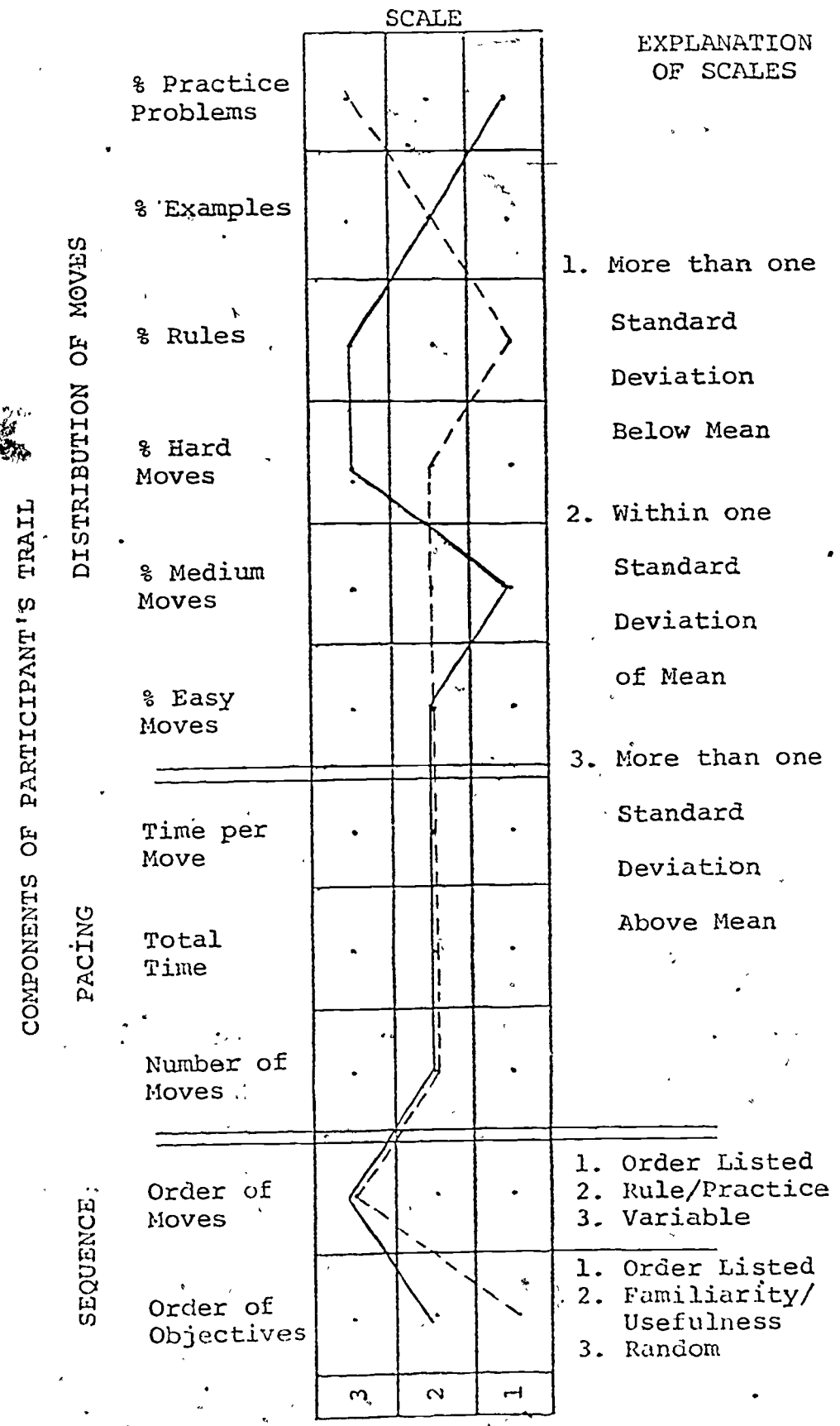

Fig. 3. Overlay of the 'profile' of two participants across eleven key variables.

jectives is one, on order of moves is zero, on number of moves is zero, etc., for a total of seven (Table 1). Quantifying the difference between profiles in this way allows the sum to be used as a criterion in determining similarity of styles.

Table 1

Comparison of H2 and L4 Difference Score and Raw Data Across Variables.

Variable	Difference Score	H2 Raw Data	L4 Raw Data
Order of Objectives	1	Usefulness	Listed
Order of Moves	0	Variable	Variable
Number of Moves	0	109	79
Total Time	0	65.4	54.6
Time per Move	0	34.3	39.7
Percent Easy	0	11	7
Percent Medium	1	56	76
Percent Hard	1	33	17
Percent Rules	2	35	12
Percent Examples	0	34	22
Percent Practice	2	31	66
Total Difference Score	7		

By inspection it was determined that difference scores of seven or less indicate a strong similarity between profiles. This similarity was confirmed by comparing the raw data of participants. Table 1 makes this comparison for H2 and L4. Table 2 compares H11 and H15 who had a difference score of two.

Table 2

Comparison of H11 and H15 Difference Score and Raw Data Across Variables.

Variable	Difference Score	H11 Raw Data	H15 Raw Data
Order of Objectives	0	Listed	Listed
Order of Moves	0	Rule/Practice	Rule/Practice
Number of Moves	1	38	59
Total Time	0	29.3	39.3
Time per Move	0	43.3	37.7
Percent Easy	0	0	0
Percent Medium	0	73	78
Percent Hard	0	27	22
Percent Rules	0	32	23
Percent Examples	0	9	10
Percent Practice	1	59	67
Total Difference Score	2		

Using the criterion of a difference score of seven or less, each participant's profile was compared with every other one. This procedure yielded eleven styles or groups ranging in size from two to six members. Each member of a group had a difference score of seven or less when compared with every other member of his group.

In none of the groups did the data indicate any relationship between the five independent variables and learning style employed. The independent variables did relate to the dependent variables individually. For example, those participants with some prior knowledge spent

significantly less time on the lesson on the average than those with no prior knowledge. However, when the participants were clustered by style, membership in a particular style cluster was not related to level of prior knowledge, age, sex, level of education, or recency of education.

Effectiveness of Learning Style

The posttest was criterion referenced and the scores were consistently high (the mean was 18.52 out of a possible 20 points). Because of the high scores and small group size, it was not possible to differentiate between the effectiveness of the various styles based on the overall posttest score. However, the comprehension sub-score (four items dealing with the relationship between corresponding units of measurement) did yield some interesting results. Out of a possible score of four, ten participants (25%) scored two or less. (Incidently, nine were female and eight had scored in the no knowledge group on the pretest.) Three of those scoring low on the comprehension sub-score were scattered across styles. The other seven were concentrated in three style clusters that had one characteristic in common - an emphasis on rules and examples and a deemphasis on practice problems. This may be of some significance and should be observed in future studies. If a strong correlation was established between using practice problems and comprehension of the relationship between units of measurement, then it would be worthwhile to study, in a more controlled experiment, the impact of various levels of practice on comprehension. The practice problems may allow the learner to concretize his understanding of the relationship.

Style vs. Strategy

The fifth objective was "to determine, through interviews, the extent to which some adults employ learning strategies; i.e. consciously attempt to use a plan of study". Nine participants explicitly expressed a conscious strategy for studying the material. Examples would be: (a) "I began with objective three because sewing patterns are now using both yards and meters." and (b) "I stopped using examples because I did not find them useful." The remaining people were able to accurately recall and describe what they had done, but stated no justification or rationale for it. The fact that approximately one person in four employs a learning strategy (is reflective about their behavior while learning) is very interesting. It could be that helping adults become more aware of their options could facilitate their learning.

SUMMARY AND CONCLUSIONS

The first objective was to determine if adults have a distinctive or characteristic manner of approaching a learning task. The data does strongly support the idea of learning styles for the following reasons. First, each participant had a particular way of moving through the lesson. It was exhibited in their approach to sequencing, pacing, and distribution of moves. Second, there were similar styles exhibited by some participants and it was possible to cluster participants according to learning style.

The second objective was to gather preliminary data about the stability of learning styles across learning tasks. The evidence from this study indicates there is stability across tasks, where the tasks are sub-sections (objectives) of a lesson. However, it should be kept

in mind that the various sections of the lesson were very similar in format and type of content. No implications can be drawn concerning the stability of learning styles across more varied tasks or across lessons.

The third objective was to gather preliminary data about the variability of learning styles across sub-populations of adults, based on level of prior knowledge, recency of formal educational experience, level of education, age, and sex. There were eleven styles that accounted for two or more participants. In none of the groups did the data indicate any relationship between the independent variables and learning style employed.

The posttest was criterion referenced and the scores were consistently high. Because of the high scores and small group size, it was not possible to differentiate between the effectiveness of the various styles based on the overall score. However, the comprehension subscore did yield some interesting results. Out of a possible score of four, ten participants (25%) scored two or less. Seven of those who scored low on comprehension were concentrated in style clusters that had one characteristic in common - an emphasis on rules and examples and a deemphasis on practice problems.

The fifth objective was to determine, through interviews, the extent to which some adults consciously attempt to use a plan of study. Nine participants explicitly stated a conscious strategy for studying the material. The remaining people were able to accurately recall and describe what they had done, but stated no justification or rationale for it.

Limitations

Every project operates under certain constraints, both anticipated and unanticipated. This section attempts to point out several limitations which, in retrospect, had a major impact on this endeavor.

The decision to approach the current study as exploratory in nature impacted directly on the outcome. A large number of dependent variables were explored in order to assess their relevance to learning style. Immense amounts of data were collected and sorted through. Several approaches to data reduction and analysis were tried. For example, for any given position in the lesson it was possible to determine the probability of each participant's next move. That is to say, it was possible to calculate for participant H7 that the probability was .65 that she would select a medium practice problem and .35 that she would select a hard practice problem if she had just answered a medium practice problem correctly. After exploring this and other possible methods for data reduction and analysis, the technique described in the earlier section was selected. It had face validity and allowed for simultaneous consideration of several variables. However, the data analysis technique used in this study should be seen as an exploratory approach to dealing with very complex data. Hopefully future researchers will explore alternative approaches.

The holistic approach that was used, where learning style was viewed as a participant's profile across eleven dependent variables, made data reduction and analysis a tedious process. Dealing with the individual components of style, separately, might have led to more concrete results. For example, it was shown that level of prior knowledge

was related to amount of time spent on the lesson. However, it was felt that the interactions between components might be a key aspect of learning style. By focusing only on total time, for example, the sequence in which decisions were made would be lost. Messick (1971) had stressed the possible importance of sequence when dealing with complex cognitive processes. Recent work in cognitive style mapping also stressed a holistic approach.

The format of the lesson and the delivery system imposed limitations on the current study. Are rules, examples, and practice problems always as discrete as they appear in this lesson? Do learners ever really have the ability to structure and organize a learning episode when they don't have a sophisticated computer system at their disposal? Knox (1971) had listed nine dimensions of cognitive style. Did the learner controlled format or the content of the lesson allow for each of the nine to be operationalized or exhibited? It would be possible to get an indication of reflectiveness vs. impulsivity by measuring the time spent at decision points, but either the format or content or both would have to be changed to see if a relationship existed between breadth vs. narrowness of categorization and learning style, for example.

The use of a criterion referenced posttest and the high scores generated on it placed some limitation on the study. It made it impossible to determine the relative effectiveness of the styles. Perhaps if the participants had to recall the conversion factors there would not have been such a strong ceiling effect. Certainly there should be a rich enough pool of instruction available so that potentially everyone can reach criterion. However, the task should be difficult enough

so that the effectiveness of various styles can be determined. Hypothetically not every style should automatically bring each participant to criterion. The task in the current study probably was too simple for the participants, in that a similar operation was required for each section of the lesson.

Having the various sections of the lesson so similar in format and content made it difficult to talk about the stability of styles across more varied tasks. These limitations should be kept in mind when designing related research studies and when attempting to apply these results to various practical problems.

LIST OF REFERENCES

Faure, E., et.al. Learning to Be. Paris: UNESCO, 1972.

Knox, A. B. Adult Learning Strategies, a proposal submitted to the National Center for Educational Research and Development, 1971.

Knox, A. B. "Life long self directed education", in Blakely, ed. Fostering the Growing Need to Know. Washington, D.C.: U.S. Government Printing Office, 1974.

Merrill, M. D. Premises, Propositions, and Research Underlying the Design of a Learner Controlled Computer Assisted Instruction System: A Summary for the TICCIT System. Provo, Utah: Brigham Young University, Division of Instructional Services, Working Paper No. 44, 1973.

Merrill, M. D. and Boutwell, R. C. "Instructional development: methodology and research", in Kerlinger, F. N., ed.. Review of Research in Education: Vol. 1. Itasca, Illinois: F. E. Peacock, 1973.

Messick, S. "Multivariate models of cognition and personality: the need for both process and structure in psychological theory and measurement". Princeton, New Jersey: Educational Testing Service, 1971.

O'Neal, F. Learner Control of Instruction: Requirements and Potentials. Provo, Utah: Brigham Young University, Division of Instructional Services, Technical Report No. 2, ICUE, 1973.

Toffler, A. Future Shock. New York: Bantam Books, 1971.

Tough, A. M. Adults' Learning Project. Toronto: Ontario Institute for Studies in Education -- Series No. 1, 1971.