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PERSONAL LEARNING THROUGH THE COMPUTER

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Abstract—This paper discusses the role of the computer as an aid towards human learning. A set of computer programs has been developed which interact with the cognitive modelling processes of the participant, helping him to increases his awareness of himself and his understanding of the world.

Conversational heuristics are employed to embody the philosophy of the 'personal scientist' who classifies, categorises and builds theories about his world, testing these against his personal experience, reviewing and revising his theories in order to anticipate events and act effectively.

PEGASUS is an interactive program which acts as a content-free psychological reflector by applying the real-time data processing of the computer to the individual's system of constructs as it is elicited. Continuous feedback commentary is provided in such a way as to act as a participant in a conversation which makes explicit to the user implicit similarities and cross-references in his dimensions of thinking. In this way he is encouraged to build and rebuild a model of any topic in his own terms. This is the basis of learning. Where an area of public knowledge is involved, there is also the facility to compare his model with that of an expert in the field; or to investigate his standing in a group of people. These techniques have successfully been used in a number of educational and industrial studies.

Most of what is called computer assisted learning is indistinguishable from instruction. If the philosophy of the personal scientist is amalgamated with the role of the computer as a tool used by a craftsman to enhance his skill rather than that of a machine which takes from man that essentially human aspect of the process, the learner is offered a facility which allows him to attempt new ventures with a firm basis and support in the system.

THE PERSONAL SCIENTIST

This paper discusses the role of the computer as an aid to human learning. A set of computer programs (FOCUS, PEGASUS, MINUS, CORE, ARGUS and SOCIOGRIDS) has been developed which interact with the cognitive modelling processes of the participant, helping him to increase his awareness of himself and his understanding of the world.

Each human being may be seen as a personal scientist, classifying, categorizing and theorizing about his world, anticipating on the basis of his theories and acting on the basis of his anticipation. Individuals cannot be treated as objects or be instructed how to learn, without the recognition of the autonomy of each person and the invitation to participate in the joint enterprise of learning. Each personal scientist uses himself as participative subject matter and construes and interprets the results in a personally meaningful way. Kelly, in his work on personal construct theory[1], argues that each individual constructs his own version of reality using a hierarchical system of personal constructs. He suggested the technique of the repertory grid to represent the repertoire of experience that the individual has constructed from his personal observations of the world.

A repertory grid or 'construction matrix' is essentially a two-way classification of data in which events and abstractions are interlaced. In Kelly's own terms[2] "it expresses one's own finite system of cross-references between the personal observations he has made and the personal constructs he has erected". The personal observations are known as 'elements' and were originally constituted from the role titles of significant people in the life of the particular individual; the personal constructs are bipolar dimensions which group the elements into varying clusters according to their similarities and differences in the individual's frames of reference. The elements may, however, be people, things, events or experiences, which are related to the particular problem or purpose for eliciting the grid. Figure 1 shows a grid elicited to investigate reasons for including the different subjects in the school curriculum.

CONVERSATIONAL HEURISTICS

In order to embody the philosophy of the personal scientist, it is necessary to use a conversational model which allows the individual to learn from his own experience in his own terms. Pask suggests that participants in a conversation cannot be regarded simply as distinct processors, but recognizes an 'M-Individual' or 'mechanically characterized individual' which may be regarded as a biologically

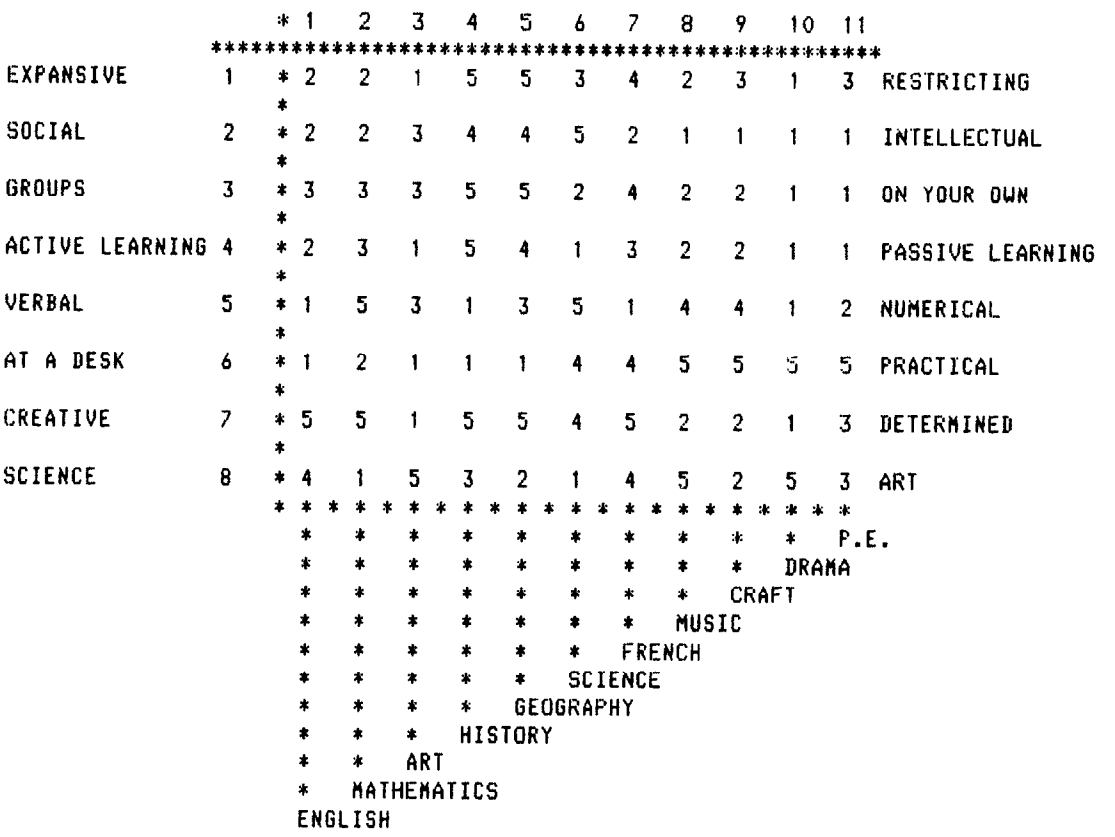

Fig. 1. A grid on school subjects.

self-replicating system and is consequently a hardware distinction; and a 'P-Individual' or 'psychologically characterized individual' which "has many of the properties ascribed by anthropologists to a role"[3], and is therefore a software distinction. Three aspects of conversation are therefore identified[4]. 1. A conversation with oneself which may be generalized to a conversation between several P-Individuals each representing an important aspect of self, all in one M-Individual. 2. A conversation between two P-Individuals in two distinct M-Individuals or processors. 3. A conversation in a group of M-Individuals which constitutes one or more P-Individuals.

The set of programs embodies these conversational methods based on the repertory grid, with the computer acting both as a cognitive mirror and a participant in the conversation.

TYPE I CONVERSATIONS

The quality of a person's models, both specific and general, will determine the level of skill, coping, competence and creativity he will be able to achieve. PEGASUS or 'Program Elicits Grids And Sorts Using Similarities' is an interactive computer program which elicits a grid from an individual, simultaneously acting as a psychological reflector by heightening his awareness and deepening his understanding of himself and his processes. This is done by the provision of continual real-time feedback commentary on highly related elements or constructs, together with the encouragement to differentiate between them. Before choosing his elements the user is asked to think about his purpose for eliciting the grid. This is of great importance for the interaction which is to follow, as it sets both the intentionalities and the universe of discourse. The mutual dependencies of the elements on the purpose, the constructs on the elements and the purpose jointly on the elements and constructs, contributes to the satisfaction and satisfactoriness of the interaction. By using combinations of reviewing the purpose, adding and deleting constructs and elements, a depth of interaction may be achieved which could not at the start have been envisaged. Thus the user is given the opportunity to reflect on his understanding of the area of the universe of discourse to examine and explore his thoughts and feelings in this atmosphere of heightened awareness of personal knowing. His perception may be changed in a way which by other means can take years to accomplish.

The computer is acting as a cognitive mirror, reflecting back to the user his models of construing. The essence of learning is constructive and creative change. Learning is often measured in terms of behavioural objectives devised by the teacher, or one step further removed from the learner—the course designer. For the learner himself, learning is the revision of his cognitive model in order to make his anticipation of events more effective, that is in the way he perceives and construes events and behaves in the situation. PEGASUS actively encourages the consideration and revision of tentative hypotheses of the personal scientist approach, hence supporting the reconstruction of cognitive models and the change which is the 'seeing' and learning of constructive alternativism.

The program is divided into six main sections. The first section is the Basic Grid in which explanation of grids and the use of the terminal are given, and the first four constructs are elicited. Before the user chooses his elements he is asked to think about his purpose which defines the universe of discourse and enables him to choose elements which are relevant and representative of the topic area since the choice of elements largely determines the depth of interaction which can be achieved. The conventional method is then used to elicit the first few constructs, that is to present a triad of elements to be divided into a pair and a singleton indicating the poles of the construct. After the user has named the poles the computer assigns a 1 to the pair and a 5 to the singleton, and he then has to assign ratings from 1 to 5 each of the other elements. These are then retyped in groups to highlight the relative position of each element with respect to the others, and an option to change the ratings is given.

The second section, Construct Match, provides feedback when two constructs are highly related. The user is first asked to add an element which is either at pole 1 on the first construct and pole 5 on the second or vice versa. If he can add a new element it must then be rated on all the constructs so far elicited, but if he cannot split the two constructs this way he is asked if he would like to delete a construct, combine two constructs into one, or just carry on.

When four constructs have been entered, the program moves into the third section and begins to calculate matching scores between elements. Each element is correlated with every other on the basis of the ratings used, and a comment is made on the highest match if it meets the set criterion. The first choice offered is to add a new construct on which the two elements are placed at opposite poles, and all the elements must be rated in the usual way. Alternatively an element may be deleted, or no action may be taken. Section four allows the user to finish at this stage during each cycle. Section five, Review, gives the choice of adjusting or redefining the purpose, and altering the level of match on which feedback commentary is given. There is an opportunity to see a focused version of the grid to date, and to delete any element or construct which is felt to be unsatisfactory. In the sixth section, Alternative Elicitation, the user is given the freedom to add an element or to add a construct without using a triad if he so wishes.

When the grid reaches the maximum size allowed, or if the user chooses to finish before that, the results are analysed using the FOCUS procedure. This is a two-way hierarchical cluster analytic technique which systematically reorders the rows of constructs and columns of elements to produce a focused grid which shows the least variation between adjacent constructs and the adjacent elements. The printout shows the element and construct matching scores matrices, and the trees of the elements and constructs as well as the focused grid with the element and construct labels (Fig. 2).

As a PEGASUS elicitation proceeds this FOCUS algorithm is used to offer to the user a possible explanation and interpretation of his meaning system in the terms of the similar patterns he uses in supposedly different circumstances. Cross-references are mapped across the grid and exhibited to the user in such a way as to offer him the facility to reconsider and change anything he feels to be inappropriate, which enables him to be more aware of the links he is implicitly holding in his cognitive model. Here the conversation can be seen as a feedback loop with the computer acting as the error regulator by re-presenting the content of the conversation and the implicit links within the conversation. In this way the participative analysis extracts and displays the essence of the subjectivity and personally meaningful relationships in the grid.

Educationalists, therapists and trainers who use grid techniques will see this program as a useful grid elicitation package which extends the use and application of the grid by using the real-time data processing of the computer to provide feedback during the elicitation, and the analysis of the results immediately on completion. Although this 'grid-centred' point of view construes the program as convenient and systematic, it misses the full potential of the 'learning-centred' approach of the cognitive model. A personal scientist models reality in order to anticipate events. There is considerable potential in programs such as PEGASUS to enable a person to become aware of his models, and revise them in order to increase his capacity for anticipation. This 'learning centred' approach has recommended PEGASUS to teachers and trainers, industrial inspectors and maintenance engineers, managers and appraisers, in addition to researchers and psychotherapists.

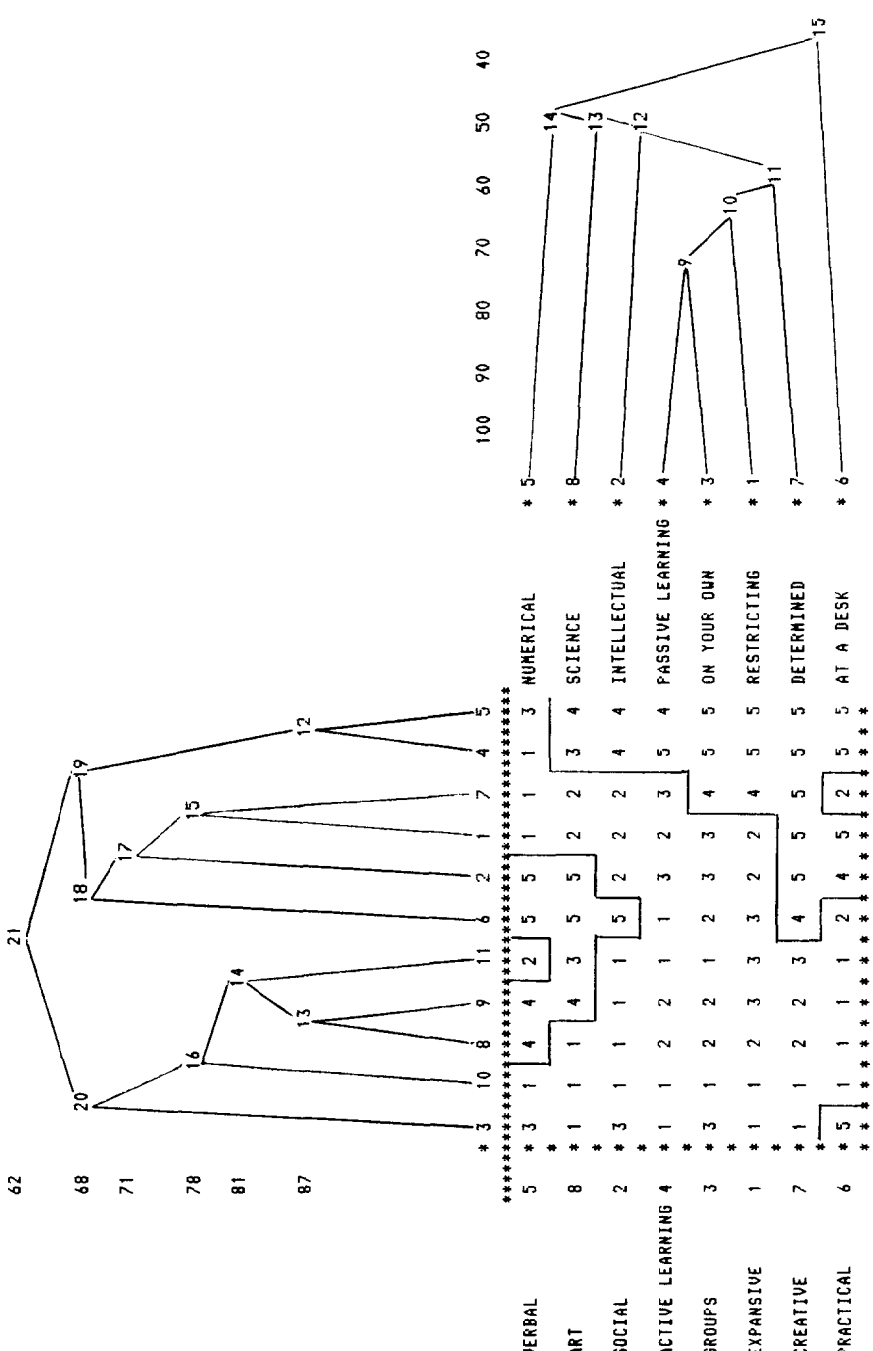

Fig. 2. The FOCUSed grid with element and construct trees.

ARGUS or 'Alternative Roles Grids Using Sociogrids' is a development of PEGASUS in which the conversational domain is articulated through the computer within which a group of P-Individuals in one M-Individual can interact[5].

TYPE II CONVERSATION

Another version of the PEGASUS program is PEGASUS-BANK; two people may come to an 'understanding' of each other through the computer by each interacting conversationally with the other's constructs which are stored as an adaptable bank. There are two ways in which it can be used: to explore shared construing of an area, and to interface with an area construed by an 'expert'. The first use assumes that the two participants have equally valid views of the area; one produces a PEGASUS grid which is stored as a bank to be accessed by the other. As the second person elicits his own grid, comparison is made between his constructs and those already in the bank, high similarities provoking comment. The bank may then be modified in the light of the interaction before the first person, or possibly a new participant, uses it again. In this way it is possible to build up a coherent view of the universe of discourse, with an indication as to the amount of overlap between the participants.

Whether or not the grids have been elicited on separate occasions, if the element and construct labels are the same in both grids they can be compared with respect to the similar or different uses of these names by examining the differences in the patterning in each grid. CORE 'Comparison Of Repeated Elicitations' is an interactive program which allows the user to investigate the extent and content of shared understanding exhibited by two grids. The computer successively reflects back the areas of most difference which are then removed from the grids at each stage thereby increasing the similarity of the remaining portions. If these grids have been elicited from the same person at two separate times, CORE reflects a measure of change over the time interval; whereas if the two grids are from two different people, the reflection is of the degree of understanding between them. By exchanging constructs through the computer and learning to use them in the way another person intended them to be used, the levels of understanding and empathy may be increased.

LEARNING OR INSTRUCTION?

Most of what is called learning in terms such as 'theories of learning' or 'computer-assisted learning' is more often interpreted as teaching or instruction. The individual is manipulated without the recognition of his autonomy, and much of the learning which takes place seems inappropriate to the learner's world. Jahoda and Thomas[6] put forward a 'science of learning conversations' in which the learning experience can be viewed from different perspectives.

Purpose	Learner	Teacher
Prospective	1	2
Retrospective	3	4

Quadrant 1 represents the learner's anticipation of the event, where the learner either has identical purposes to the teacher, or at least partially suspends his own values and judgement in order to take on those of the teacher temporarily. In this case instruction is a very efficient way of enabling the student to learn. The learning in Quadrant 2 represents the teacher's objectives being emphasized, and is the type of learning mostly used in programmed instruction. Quadrant 3 denotes the learning which being retrospectively valued by the learner is largely unexpected and unplanned. Unfortunately, this type of learning is not always associated with formal educational practice, but usually takes place outside the classroom. Quadrant 4 indicates that learning which often surprises and pleases the teacher on seeing the changes which have taken place as a result of the event. The general technique of CAL is based on the desirability of individual tuition, rooted in the tradition of the tutorial system which operates at the universities of Oxford and Cambridge, but CAL is too often indistinguishable from CAI. However, if the perspective of the learner were realistically incorporated, if the philosophy of the personal scientist and the conversational method were to be used, the learner would have available a set of tools which allow him to become aware of what he can do, and to do it more effectively. The computer is then able to offer the tutorial support which is so necessary when change is taking place. Academic learning is merely a subset of personal learning. If the learner can become aware of his own models of a topic, he can clearly see his own strengths and weaknesses and seek help where he feels it necessary. At this level learning,

psychotherapy and counselling may be the same operation, reflecting back to the student/client the implications of his theories about the world and offering him the opportunity to construct and reconstruct his models of reality.

CONCLUSION

The repertory grid is only the beginning of a technology for eliciting and developing personal models of the world, and helping each individual to be more effective in his aim to become a personal scientist. Many techniques have potential for developing this work beyond the structure of the repertory grid, especially data structures from computer science, graph theory and optimization from operational research, mathematical structures and forms such as Q-Analysis[7], the concept of cybernetic entities like P-Individuals, developments in computer graphics, and the application of fuzzy sets to personal constructs[8]. The computer can be used in a new and responsible way being truly interactive and content free but supporting a structure which is amenable to mathematical treatment thereby allowing the reconstruction of the conversational content.

The recent development and availability of microprocessors indicates that the 'personal computer' may soon be commonly available to the ordinary person. There is no technical reason why the techniques described here could not be run on these personal computers, offering to all people for the same cost as a pocket calculator these tools for raising personal awareness of one's cognitive models and processes, making explicit relationships on the world in a non-directive and supportive way, and enabling the individual to have an overview of his system in such a way as to allow him to review and revise his models in a non-threatening manner.

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