Communication: Computer programs which respond to learning styles

COMMUNICATION

R K Lyall and A H Johnstone*

Centre for Science Education, University of Glasgow, Scotland, G12 8QQ
e-mail: alexj@chem.gla.ac.uk

This paper describes an attempt to design and use a computer assisted learning program which responds to learners of two motivational styles. The program deals with aspects of statistics generally needed by science students. The motivational styles of the students were independently determined by a psychological test before the students were given the program. By interacting with the program the students were offered two distinct routes through it, one in which the students were led through (conscientious) and one in which students were encouraged to explore (curious). Bridges were available throughout to allow students to change from one route to the other. A record of the key strokes was kept to indicate the students' navigation. The results indicate that the choices made, by individual students, of program routes, corresponded well with the learning styles allocated in the psychological test. It is concluded that programs written to take account of learning styles can give new meaning to 'individualised learning'.

Introduction

The term individualised learning has been in use in education for some time. The ideal of a one-to-one teaching situation in which the teacher can respond to the learning of one student is largely unattainable except in the fairly rare tutorial systems of a very few universities. In most cases, larger groups have to be taught by a single teacher and the concept of true individualised learning has to be lost.

What passes for individualised learning is often just learning alone (individual learning), whether by worksheet or computer or some assignment.The idea of tailor-making the material and methodology to meet the learning style of the individual is harder to achieve. As long ago as 1967, Cronback[1] was discussing aptitudes which he defined as "a complex of personal characteristics that accounts for an individual's end state after a particular educational treatment. This may have as much to do with styles of thought and personality variables than abilities covered in conventional tests". He also states in the same article that most schools use tactics for teaching which are intended to minimise the nuisance caused by individual differences so that they can go on teaching the same unaltered goals.

At higher educational level, with increased student numbers and a broader range of entrance qualifications, the possibility of allowing for different styles presents a major problem. Logistically, universities are being driven towards larger classes and fewer tutorials thus reducing further the likelihood of individualised learning; learning taking account of individual learning characteristics.

Some writers, such as Macfarlane[2], see the solution in the increased use of technology.Learning by computer can reduce teaching loads, remove the problems of timetabling and accommodation at fixed times and provide learning opportunities on a one-to-one basis. Although there may be a trend in this direction, not all, or even most, academics are persuaded. Even if this strategy were adopted, it could still result in individual learning rather than in the individualised learning state. Although existing software enables students to go at their own pace and to track back and forth, every student is essentially doing the same programme embodying the same teaching methodology, examples, format and goals.

However, with the sophistication of technology, it should be possible to write software which would offer routes through a piece of learning which would fit the learning characteristics of the individual student.Visual and verbal thinkers could be accommodated in parallel programs; convergent and divergent thinkers could find a congenial approach; different personalities could be satisfied and people of different motivational traits could be stimulated. This would increase the program writing effort and would be justified only if the individual differences were real and the learning gains warranted it.

We set out to explore, in a preliminary study, the possibility of writing material which would take account of motivational styles. We wanted to know if students of different styles actually responded to the program in ways which reflected these styles, but first we had to give some more thought to motivation.

Ausubel[3] stated that "motivational characteristics are sufficiently important in school learning that they should engage our most serious consideration if we wish to maximise classroom learning". Anderson and Draper[4] suggest that motivation is the single factor which most affects learning, though they recognise that motivation is a term much used, but not well understood. Kempa and Diaz[5] looked at motivation in science education and based their analysis on the work of Adar[6].

The present study was based upon Adar's classification of motivation, and upon three particular aspects of it. She describes four motivational types which apply to the stimuli to learn, and are summarised as

Achiever	motivated by a need to achieve – to be top of the class

Curious	motivated by a need to satisfy curiosity for new knowledge
Conscientious	motivated by a need to discharge a duty
Social	motivated by a need to affiliate with others.

No student fits neatly and unequivocally into any of one of these categories, but generally one motivational characteristic predominates. In this study we had to distinguish between 'strongly curious' and 'mildly curious' and similarly for each category. The test materials which were used to categorise students were based upon the work of Al-Naeme[8].

The software

An opportunity arose for us to create a program which would form part of the teaching of statistics to biology students. The program relates to problems of sampling. The specific aim was to help the students to understand how the sampling procedure (in this case of a set of vaccine ampoules) affects the confidence with which the sample is regarded as a reliable sub-set from the point of view of detecting contamination. The principles involved are the same as those used for many problems in analytical chemistry, and so the program could be readily adapted for use by chemistry students. The general approach to programming is, in principle, applicable to almost any chemical topic.

The original intention was to produce software which would adapt, in real time, to the individuals' learning styles as they worked through the program. However, for an exploratory study, it was decided to write an interactive program in which the learner chooses a route at the beginning (which might or might not fit the motivational style) but it would be possible to switch from route to route at will. It was hoped that students would settle into the mode most congenial to their motivational style.

The two extremes on offer were a

- 'by the book' approach which offers a suggested linear route through each of 18 pages following each screen in the suggested order;
- 'free-ranging' approach which allows the student to use a non-linear, exploratory and self-driven route through the same 18 pages.

The pages consist of a mixture of text, illustrations and questions. Students interact with the program by answering questions. Different navigation buttons are provided, depending on the mode which has been selected; the free-ranging mode offers greater flexibility.

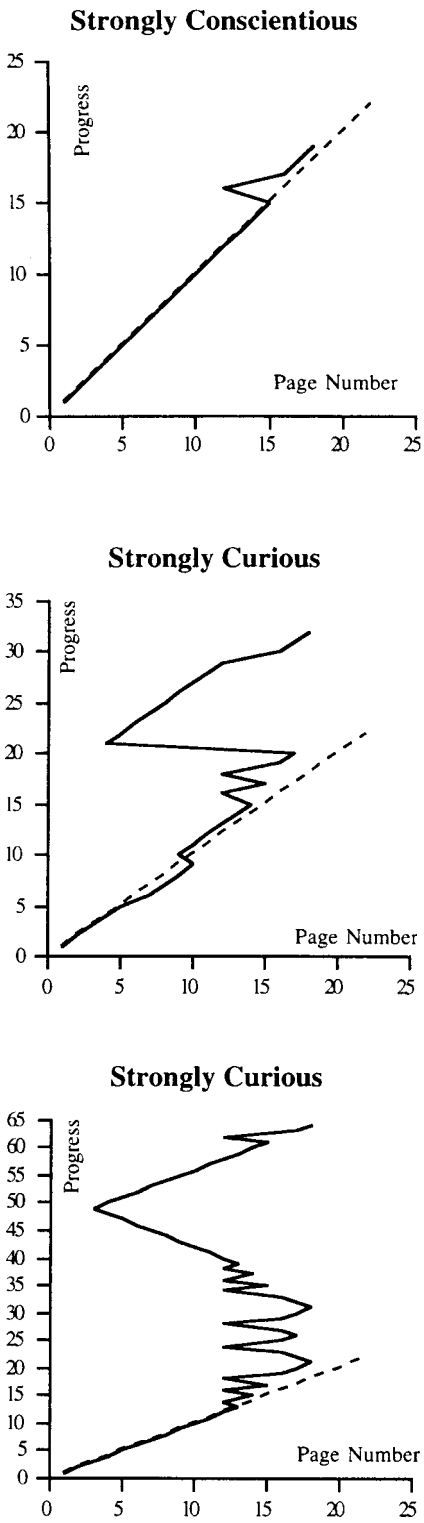
Of course, these are extremes and it was anticipated that students might switch from mode to mode more or less frequently. For example, curious students might take the direct route to see what the program was about before returning to the exploratory mode to pursue their interests.

To keep track of this navigation through the program, the computer kept a record of the screens visited, the order of the visits, the time spent at each and any revisits.

The sample

Since the program used in this study was based on an example designed to appeal to biology students, the main sample of twenty was taken from biology and statistics students. A preliminary sample of five, drawn from a wider range was used to test the 'workability' of the program. The main sample comprised one second year, fifteen third year and four postgraduate students.

Figure 1 Linetracks



The procedure

The subjects carried out three tasks:

- took a test to gain information about their motivational style (this was completed and analysed before the students used the computer);
- worked through the computer program;
- completed a questionnaire to record their experience of the program.

Results

The navigational information yields a list of codes representing the exact route taken. One way to express the results is by a 'linetrack' which gives an immediate visual indication of how directly the student followed the program. A line track is prepared by plotting each step on the vertical axis as 'Progress through the module'. Each page is given a code representing how far into the module it is (page 1 to page 18). This variable is plotted on the horizontal axis as 'Page Number'. Sample linetracks are shown in Figure 1.

A student progressing straight through the program without any deviation, would generate a plot represented by the dotted line; that is one page forward would correspond to one progress step forward.

The prediction was the Conscientious students would go through the program step by step and so generate graphs close to the dotted line. Curious students would deviate sometimes wildly, from the dotted line. The three linetracks shown in Figure 1 are chosen to illustrate the different characteristics for the Strongly Conscientious and the Strongly Curious. Only one example of the Strongly Conscientious is shown because there was almost no variation between all those in the sample who were put in this category on the basis of the test of motivational style; linetracks for all these students follow the dotted line very closely. The two examples of the Strongly Curious depart very markedly from the dotted line; following, backtracking, revisiting and map consulting. This is typical of this group of students.

There is no doubt that these two groups of students have responded very differently to the program and very much in line with the motivational style revealed in the psychological test. This cannot be explained by their being locked into a route by their initial choice, because students switched between routes and revealed their exploratory or non-exploratory styles as they progressed through the program.

As might be expected, the linetracks for the Social category cannot show up their characteristic 'need to affiliate with others'; they showed their style by wanting to work together. Linetracks for the Mildly Curious and for the Mildly Conscientious deviate from the extremes of this type, and therefore overlap. There was only one Achiever in the sample.

Table 1 shows that the Curious are much more inclined than the Conscientious to revisit pages, and that this is reflected in the longer time they spent on the program.

Table 2 shows the responses to the post-exercise questionnaire.

These results are encouraging in the first five questions. In the last item, the polarity shifts towards disagreement indicating little interest in group interaction. Two of those in the 'agree group' were 'Mildly Social' students according to their response in the psychological test.

Students were observed during their interaction with the program and only two of them entered into frequent discussion. Both of them had been rated Mildly Social.

Table 1 Percentage of revisiting of pages and of time spent on program as a function of motivational style.

Motivation Style	*Percentage of Revisiting*	*Average time spent on Program/min*
Strongly Conscientious	13.7	18.7
Mildly Conscientious	8.5	19.1
Strongly Curious	56.3	26.1
Mildly Curious	26.5	20.6
Mildly Social	27.2	21.2

Discussion

With a sample of 25 (of whom 5 were in the preliminary testing group) we cannot arrive at hard conclusions, but a sufficiently clear pattern has emerged to suggest that there is potentially a new field of science education for exploration.

Table 2 Responses to the questionnaire

Statement	*Frequencies*		
	Agree	*Neutral*	*Disagree*
I enjoyed working through the module	20	0	0
I would welcome computer based material of this type as part of my course	20	0	0
I found this software easy to use	20	0	0
The instructions on each page were clear	20	0	0
The software gave me freedom to do as I wanted	17	3	0
I would have preferred to work through the module as a group, with time for group discussion	3	9	8

It is fairly safe to arrive at the following conclusions based upon our experiments.

1. Students, who were rated Conscientious or Mildly Conscientious in this sample adopted a low-risk working style, choosing to assimilate the material according to the recommendations and shape of the program. They navigated the most direct route through the program, visiting most screens only once. They rarely revisited pages and hardly every consulted the map to see the overall pattern of the program. They tended to interact with the program in a minimal way.

2. Students, who were rated Curious or Mildly Curious displayed a more exploratory or high-risk working style. Their routes were generally non-linear giving rise to jagged linetrack diagrams. They repeated activities more often than the Conscientious, were more interactive and used the map more.

3. It has to be admitted that there were some cases which were not clear-cut either in the psychological test or in their performance in the program, but this is not unexpected since we are trying to press highly idiosyncratic people into categories to make our thinking and our research easier and not always succeeding.

4. There is enough evidence to indicate that there are possibilities here for making individual learning into individualised learning. This work has investigated only one dimension of learning style: motivation, but there is no reason why other dimensions should not yield equally promising results. Indeed, work in progress on visual versus verbal thinking in computer assisted learning in engineering, is showing interesting results and attracting student praise[9].

Perhaps Macfarlane's[2] view of the university of the future might have more chance of success if programs, which took cognisance of human learning styles, became the norm. However, education is probably at its best when lively minds interact in ways which cannot yet be emulated by technology.

References

1. Cronback L J, How can instruction be adapted to individual differences (ed. Gagné RM) *Learning and individual differences* 1967, Columbus, Merrill Books.
2. Macfarlane AGJ, *Teaching and Learning in an expanding Higher Education System*, 1992, Edinburgh, The Committee of Scottish University Principals.
3. Ausubel DP, Novak JD, Hanesian H, *Educational Psychology*, 1978, London, Holt Rinehart and Winston.
4. Anderson A, Draper SW, An introduction to measuring and understanding the learning process, 1991, *Computers in Education* **17**(1), 1-11.
5. Kempa RF and Diaz MM, Motivational traits and preferences for different instructional modes in science, Part 2, *Int.J.Sc.Educ*, 1992, **12**(2), 205-216.
6. Adar L, A theoretical framework for the study of motivation in education, 1969, Jerusalem, Hebrew University.
7. Good T, Power CN, Designing successful classroom environments for different types of student, *Curriculum Studies*, 1976, **8**(1), 45-60.
8. Al-Naeme FF, The influence of various learning styles on practical problem solving in chemistry in Scottish secondary schools, Ph.D. Thesis, 1991, University of Glasgow.
9. Badock K, CALF project, 1996, University of Glasgow.