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THE USE OF A COMPUTER BASED ADVISORY SYSTEM AS A TEACHING AID IN STATISTICS

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1. Knowledge based systems and learning

There has been much research into the use of artificial intelligence in computer aided learning. One area that has already shown promise is the use of knowledge based systems (KBSs). These systems, which attempt to emulate the decision making processes of an expert in a particular subject domain, have a number of potential applications in education.

Briggs (1988) has suggested five ways in which they might be used:

1. *As curriculum resources*

The ability to use knowledge based systems to store the expertise of humans should imply that it could be possible to store, for example, the knowledge of an expert in physics or medicine and to make this available to all students. However, not all knowledge or expertise can be expressed using a rule based methodology but it may be possible to use KBSs to store some parts of our knowledge.

2. *As part of intelligent tutoring systems*

Intelligent tutoring systems (ITSs) are computer programs that attempt to emulate the learning situation by representing knowledge about the subject matter, teaching styles and learner knowledge. The way in which knowledge is represented is of fundamental concern, and KBSs offer one solution. However, although fairly simple in concept, there have been, and still are, many problems with ITSs, especially in the construction of adequate models of the ideal learner and in the assessment of the understanding of the user of the system.

3. *KBSs as simulators*

Simulations have existed in a variety of different guises, from role play to games, but computer simulations tend to share the common feature that they have an inability to explain their reasoning. With KBSs, the

learner can see how the conclusions have been arrived at, and the systems can explain all the stages between input and output.

4. *Principles of knowledge based systems*

KBSs are playing an increasing role in industry and commerce and are now considered one of the 'mainstream' software applications. As such, it is now a truism that many of those leaving our colleges will come into direct contact with KBSs. Teaching the principles of knowledge based systems in the education sector is now a valid subject in its own right.

5. *Exploratory tools*

Finally, KBS shells can be used as tools to explore other subjects by allowing the students to act as experts (or to become experts if they don't know enough about a domain) and to restructure their knowledge using these systems. (Galpin, 1989; Griffin, 1992; Lippert, 1989; Webb, 1990). The process of knowledge engineering by which subject knowledge is restated in a suitable form for the KBS could be a powerful learning process

2. The possible need for a statistical advisory system

All students at Chester college take two main subjects in their degree courses. At present most undertake a large project or dissertation in both these subjects in their final year. For many of them this includes either some field work or experimental work that generates data for analysis and interpretation. Subjects such as Psychology, Biology, Geography, Sports Studies and Health and Community Studies all generate small research projects of this kind.

Many of these Science and Social Science students have had no formal teaching in statistics and most have not studied mathematics beyond the age of 16.

In order to help those students with their problems, a statistics lecturer has set up a STATISTICS CLINIC. This is well attended and at peak times there are more students needing help than can be sensibly dealt with. The statistics lecturer therefore decided to investigate the possibility of providing help for these students via a computer based advisory system.

The main question asked by students attending the statistics clinic is: WHAT DO I DO WITH THESE RESULTS? (How to do it is sometimes their second question). This has determined the scope of the proposed system.

The potential users of the system include all undergraduate students.

Different students will have varying amounts of computing expertise. In order to ensure that the proposed system was suitable for this group certain requirements were established. These requirements are:

1) It must be easily accessible by students with limited experience of computers, and
2) It must use simple language. Any technical terms must be explained to users as they go along.

Both of these requirements influenced the design of the user interface. It was assumed that students:

(a) either already know how to do the calculations involved (or can look this up in text books), or
(b) have access to a computer package that will do the necessary calculations.

As a result of these design considerations it was decided to investigate the use of knowledge based systems as a tool in which to develop the advisory system.

3. Development of the advisory system

A final year student (Carpenter, 1992) taking mathematics and computer studies at Chester College undertook the development of this advisory system, choosing statistical tests as her final degree project. The client who specified the requirements of the system was the lecturer in statistics at the college. The student used the Leonardo KBS development environment.

The development process itself proved to be an invaluable learning experience for that student. Together she and the lecturer had to develop the logical structure of the system, choose the order of the questions to be asked and plan the pathways users could take through it. The lecturer acted as the expert and the student as the knowledge engineer.

The resulting knowledge based system initially asks the user to think about what they want to find out from the data, i.e. what is the question being asked? Help is given in deciding what kind of data is available, and the level of measurement used, i.e. nominal, ordinal or interval. The KBS then advises the student on which simple statistical technique might be used. The system is designed with our particular clientele in mind and suggests only simple analyses.

4. Using the advisory system

Once the KBS had been fully developed and tested for reliability, it was decided to evaluate its use as an aid to solving problems. The target group of students were undergraduates studying subjects such as Physical Education, Psychology, Biology and Geography. The majority of these students have only studied mathematics to age 16 and none of them had studied it as part of their degree course. These students take an optional course in introductory statistics that makes considerable use of computer software to teach simple EDA techniques, non-parametric and parametric tests.

Evaluating the system

Students taking the first year "Statistics for Scientists" optional course were split into two groups. Both groups were given a series of three problems to consider with reference to a data set provided. They were not asked to do any calculations but to correctly identify which statistical analysis was required to help answer each problem. This was both a learning task and an assessment task. Students were told that the exercise was designed to help them in their revision (but their performance would not affect their grades).

Group A consisted of students who had to complete the task using their own lecture notes, and text books provided for this purpose. Group B consisted of students who had access to the KBS at individual work stations.

Both groups of students performed equally well on the three problems. Their mean scores on a total of 9 questions (3 per problem) are shown in Table 1.

	Mean score out of 9	Mean number of techniques correct
Group A	5.07	1.78
Group B	4.60	1.35

Table 1

There were no significant differences between these mean scores. As Group A students were able to refer to their own notes as and when they wanted to, and Group B students were faced with a computer system they had never used before, it is encouraging that the latter group were able to gain a similar degree of support from the advisory system.

5. Future developments

The pilot project just outlined, raised a number of interesting questions that have suggested further areas of improvement.

The development of a more user friendly interface (possibly WINDOWS based) to which the users may more easily relate, is one such area. Comments from the subjects suggested that this would be advantageous.

New users of the system will also need a tutorial on how to use the knowledge base with a full explanation of the facilities offered. Once these amendments have been made, it is proposed that the evaluation will be repeated again. We would expect that there will be a further improvement in the results achieved by users of the knowledge base and we eventually plan to install this on the college computer system thus making it available to all students.

Bibliography

Briggs J.H. (1988), *Learning With Expert Systems*, the Advisory Unit for Microtechnology in Education, Hatfield, U.K.

Carpenter N. (1922), *A Knowledge Based Statistical Advisory System*, Unpublished Dissertation, Chester College, England.

Galpin B. (1989), *Expert Systems in Primary Schools*, British Library Research Paper 73, British Library, London.

Griffin J. (1992), *Using Expert Systems to Enhance Learning*, Unpublished MSc Thesis, University of Keele, England.

Lippert R. (1989), Expert Systems, Tutors, Tools and Tutees, *Journal of Computer Based Instruction*, 16(1), pp. 11-19.

Webb M. (1990), Learning by Building Computer Based Qualitative Models, *Computer Education*, 66, November, pp. 27-32.