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SELF PACED LEARNING WITH VIDEO

FOR 140 FIRST YEAR STUDENTS

by

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## **Self Paced Learning with video for 140 first year students.**

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### **Introduction.**

The Keller Plan for self paced learning (also known as the Personalized System of Instruction or PSI) was introduced in the 1960's and quite widely used in the early 1970's. It relied on printed 'units' with one to one tutorials and a diagnostic test on each unit to provide feedback and ensure that each unit was thoroughly mastered before the next was attempted.

Many practitioners found it to be extremely effective, improving exam performance by at least one grade but it seems to have fallen out of favour, perhaps because it is regarded as too expensive.

This paper claims that with the systematic use of video-cassettes and interactive computer tutorials involving self testing, the Keller plan can be both cost effective and educationally superior to traditional methods, particularly. with problem classes involving a varied student intake and conceptually difficult material.

The main advantages of the system over traditional teaching is the greatly improved quality of the students' work. It should not be seen as a cheaper or easier alternative to traditional methods, but as a superior way of teaching.

Unless the system is to be used at more than one institution, the effort involved is only justified in particular circumstances :

(a) a problem class                      *and* (b) the course should have a life of at least five years.

If, on the other hand, the system is to be taken over as a whole by another institution it could be extremely cost effective as no lectures are needed and Brunel could provide training and supervision for local tutors; the multimedia nature of the system also opens up possibilities for use in distance learning, provided the videos and tutors are available in study centres.

### **A multimedia Keller Plan.**

F. S. Keller, a psychologist, was asked early in the 1960's to produce a totally new, student centred teaching program for the University of Brasilia. He based his program (1), on behaviourist principles, aiming to provide an ideal environment for the learner.

By 1974 when the Keller plan handbook (2) was produced the system was as follows

(i) The material to be taught is broken up into units (typically 20) each representing at most one week's work. Printed material suitable for self study is handed out on each unit.

(ii) Tutorial help is given on a one to one basis, preferably by senior students (who are

themselves rewarded by course credits for doing this teaching).

(iii) When a student feels he has mastered a unit he takes a diagnostic test on the unit. This test is marked by a tutor and if it is passed (the pass mark being high, say 90%) the student goes on to the next unit; if not, he or she continues working on the unit and subsequently retakes the test.

(iv) There is a final examination which counts for about 30% of the marks, the rest being given for passing the unit tests.

(v) Occasional lectures are given as a reward to those students who have passed sufficient units.

There is a large literature claiming the superiority of the plan over conventional teaching (4), (5). In (4), a survey of 75 studies, a statistically significant improvement of 8% in students marks over those obtained after conventional teaching is recorded; what will not surprise anyone who has used the method is that, this superiority is even more marked if students are tested 3 months after the end of the course. The plan is shown to be particularly effective in science and mathematics teaching, producing an average improvement of 9% which goes up to 12% after three months.

#### *The Plan as modified for British Universities*

It was not found practical to use senior students as tutors in most British Universities and a variant of the plan was produced (6) in which each student has two hours of tutorial per week in a group of 15. These hours are used for answering student questions, doing diagnostic tests and discussing the results of these with the individual students. Attendance at these is not compulsory but strongly encouraged in order to build up a relationship between the students and the tutor.

There is a mid-session exam which counts towards the final mark. This is essential to discourage procrastination which is a major problem with self paced learning (3). It also provides useful feedback to staff and student.

The unit tests usually do not count towards the final assessment and the number of units is reduced so as to lessen the amount of marking.

#### *The use of video cassettes for Mathematics teaching at Brunel.*

The plan has now been in use for 11 years, always with either computer assignments or videos as an extra - something of this sort seems to be essential to provide variety. It is currently in use for teaching a first level course in Discrete Mathematics for 140 students who are taking degrees in Computer Science or Mathematics and also a follow on course in applicable algebra.

Video's of the solutions to all the exercises in the units are now available for students to watch whenever the library is open, and these have proved to be extremely valuable.

These videos are simply made, with an overhead projector and a camera focussed on the screen. The questions - which are in the unit and should be attempted by the student before watching the video - are written out on a prepared roll of acetate and the video shows them being solved in a gap left on the acetate. Another camera focused on the lecturer is used and the tape switches to that at suitable moments (this can be done automatically when the lecturer looks up). This method allows all the advantages of seeing a lecturer solving problems: the gradual build up of the argument, the explanatory asides, use of tone of voice, above all it is personal, unlike computer delivered solutions. The producer (George Nordhoff) claims that it encourages the student if the presentation is as much as possible like an actual lecture. No editing was used and a half hour tape took about 1 hour of studio time to produce.

The effect on the students' work is dramatic.

The video offers two great advantages:

- (i) repetition is possible,
- (ii) it is possible to stop if one loses the thread, or to give time for reflection.

One their own these two factors instantly satisfy no less than six of Bligh's list of twelve requirements for learning which are not satisfied by lectures (7).

Simply put: one cannot stop, rewind or fast forward a lecturer.

If one then adds the ready availability of the tutor, and the diagnostic test to clear up misunderstandings and give feedback, one satisfies another two of his criteria.

Every unit now has a half hour tape of solutions. No printed solutions are given out so as to encourage the students to watch the videos.

In addition each unit has a half hour tape consisting of a lecture summarizing the content of the unit. These are not so useful as the tapes solving the exercises, but probably worth having.

*Interactive Computer instruction and self testing.*

The first unit of the first level course is now available to the students in a fully interactive computer delivered version with a self testing facility. This has dramatically improved the performance of those students who are poorly prepared.

As with the videocassettes use of this is entirely voluntary, but strongly encouraged. It is available to the students to use in their own time in a room of networked PCs open 16 hours daily.

It was produced using the MENTOR authoring system at considerable expense (with the help of an assistant for 6 months).

The CALM project (8) has produced 24 units of computer delivered tutorials on basic calculus, designed to be used in conjunction with traditional lectures. They are claiming a 15% increase in marks over those obtained by students taught similar material by conventional methods. The most popular - and useful - feature is a self testing facility which the students treat as a game, playing to increase their score.

It is hoped to produce similar material to back up the Keller Plan with a hypertext package such as hypercard or Guide - this should be relatively easy to do. Two units have already been put on hypertext by teams of students as their third year computer laboratory projects.

The use of computer delivered tests on the units should be able to clear up many misunderstandings before students attempt the diagnostic tests so that the face to face tutorials become more effective.

One might hope that combining the CALM approach with the Keller plan could see the improvement in marks obtained by each separately, aggregated to an order of magnitude jump in student performance.

*Cost effectiveness of videos over computer tutorials.*

In general computer tutorials are still much more expensive to produce than the videos described above. They can, however, be very valuable because they can give instant feedback and can be revised. Videos have the advantage that they are very close to what the lecturer is used to doing and can make direct use of classroom experience. They are usually not thought of as particularly appropriate to mathematics, but it is the present authors' experience that they are indeed very appropriate, having nearly all the advantages of the lecture - with some considerable advantages of their own. Mathematics is very much a two dimensional rather than one dimensional affair; one needs voice *and* diagram or formula. The British Open University has, similarly, found that audiocassettes are extremely effective for teaching mathematics when combined with suitable visual material.

The wide availability of video tape players even in the third world make them ideal for use in study centres.

It is often forgotten that students tend to watch the videos in pairs so that in fact a useful dialogue between members of the class is encouraged.

*Computer controlled videos.*

There is much talk of convergence between video and computer, but this is still rather expensive to use and probably only valuable in mathematics as attractive gimmickry.

*The tutorials.*

These cannot be in groups of more than 15. The time is mainly spent on going through students' tests with them; they are not marked, but the tutor reads them with the student sitting at his side. Subtle points are included in the tests so as to give an opportunity for discussion with the brighter pupils.

Attendance is a problem; often weak students are also poor attenders, and have to be pursued via their tutors. Greater use of interactive computer tutorials which are very popular with the students should improve this situation.

There is no doubt that the 2 hours per week format is very far from ideal. About two thirds of the class make sensible use of it but others appear only to take the tests and then do not like to wait until the tutor is free to go through it.

Perhaps the answer is to have a large bank of questions so that students do individualized tests in their own time and then make an appointment to see a tutor for discussion. A solution that has often been used is to give credit towards the final assessment for passing the unit tests. The system described in (1) gives only 25% of the marks for the final exam. On the other hand, when this is done the pass mark on the unit tests is usually very high (90%).

It is very important however to build up a continuous relationship between each student and an individual tutor; this does happen with about two thirds of the class who become known as individuals very rapidly. The staff student interaction that takes place seems to be of a much higher order than with lectures and group tutorials.

*Results of 7 years teaching Discrete Maths to a first year class by this method.*

The system is not particularly popular with students who sometimes complain, asking for lectures. One student even complained that it prevented her working at her own pace.

The answer to this is that exam results have been extremely good.

year	class size	average mark	failures	
1	12	70	0	
2	32	71	0	
3	83	76	0	
4	94	69	2	
5	126	67	8	***note 1
6	132	59	10	
7	142	59	10	***note2

*note1.* In the fifth year the class gained about 40 new students on a "Computing with Business" course, many of whom do not have A level mathematics. They had previously been taught by the Computer Science department with a failure rate of 30%.

*note2.* The examination has grown progressively harder over the years so the average mark

is coming down.

The printed material is not very different from ordinary lecture notes and only three units have been extensively modified for the new intake.

It is hoped to gradually rewrite all the units; ideally in collaboration with another institution.

### **Discussion.**

The learning that takes place seems to be very different from that in traditional teaching, and it would be interesting to investigate whether 'deep' as opposed to 'surface' learning is taking place. Gow and Kember in (9) claim that much traditional teaching tends to promote a surface approach, and many of the disadvantages of traditional teaching are absent from the method presented here. It is clear that a substantial number of students successfully complete the course who would have failed a traditional course. (10) investigates the "determinants of students burn out in Universities" and concludes that flexibility of learning resources and student involvement are the most important factors in promoting the quality of the learning experience .

In (11) Baxter investigates students' perceptions of a 'resource based' course in engineering. Student reactions - and performances - are very mixed. One feature of this course is that there is less staff student contact than in a conventional course. The method described above, however, clearly involves more staff student interaction than conventional teaching.

There is increasing cooperation between Distance Learning institutions such as our Open University and Conventional Universities (12). The use of video described here is perhaps one that has not been tried in a distance learning environment. In (13) Bates describes the virtues of video cassettes and expresses surprise that they have been so little used in Distance Learning. Possible reasons he gives are the distrust of educators for this new resource, and the fact that not every home can be expected to have a player. There are now signs that this situation may be changing (14), (15). It is clear that a Distance Learning Institution based on study centres could easily use videos with tests and tutorials as described here.

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