



# Web-Based Implementation of the Personalised System of Instruction: A Case Study of Teaching Mathematics in an Online Learning Environment

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## ABSTRACT

*This article presents a case study of a university discrete mathematics course with over 170 students who had access to an online learning environment (OLE) that included a variety of online tools, such as videos, self-tests, discussion boards, and lecture notes. The course is based on the ideas of the personalised system of instruction (PSI) modified to take advantage of an OLE. Students' learning is examined over a period of two years, and compared with that in a more traditionally taught part of the course. To examine students' behaviour, learning strategies, attitudes and performance, both qualitative and quantitative techniques were used in a mixed methodology approach, including in-depth interviews ( $N = 9$ ), controlled laboratory observations ( $N = 8$ ), surveys ( $N = 243$ ), diary studies ( $N = 10$ ), classroom observations, recording online usage behaviour, and learning assessments. The paper aims to increase understanding of whether PSI, supported by an OLE, could enhance student appreciation and achievement as findings suggest.*

*Keywords:* CAPSI; case study; e-learning; Keller plan; online learning environment; online test; PSI; self-paced learning; video-based learning; Web-based learning; WebCT

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## INTRODUCTION

As Online Learning Environments (OLEs), such as WebCT® and Blackboard®, are becoming more widely used, the role of teachers changes as they adapt to their new mode of teaching (Coppola, Hiltz, & Rotter, 2002). It remains a challenge how-

ever for teachers to use these technologies effectively (Hiltz & Turoff, 2002), and benefit from the suggested advantages of OLEs over traditional classroom learning. These include being more learner-centred, providing flexibility as to the time and the location of learning, being cost-effective for

learners, and potentially serving a global audience (Zhang, Zhao, Zhou, & Nuna-maker, 2004). This article arises from the experience obtained in delivering a mathematics module for both computer science and information systems undergraduate students in a U.K. based university. The first term of the module, which focuses on discrete mathematics, makes extensive use of OLE tools, such as online self-tests, video clips and a discussion board, whereas the second term, which focuses on statistics, is taught by a more traditional lecturer based approach. Comparing the data obtained in the two terms during the academic years 2003-2004 and 2004-2005, gives an insight into how students perceive these OLE tools and into how they affect students' learning strategy and the learning outcomes.

The teaching method used in the first term is based on the principles of the Keller Plan (Keller & Sherman, 1974), also known as the Personalised System of Instruction (PSI). Although these principles were already published in the 1960s (Keller, 1968), the observations presented here suggest that they can be highly relevant when teaching is supported by an OLE. The principles of PSI can be summarized as "(1) mastery learning, (2) self-pacing, (3) a stress on the written word, (4) student proctors, and (5) the use of lectures to motivate rather than to supply essential information." (Keller & Sherman, 1974, p. 24). PSI has been applied to courses in various areas such as psychology (Kinsner & Pear, 1988; Pear & Crone-Todd, 2002), physics (Austin & Gilbert, 1973; Green, 1971), mathematics (Abbott & Falstrom, 1975; Brook & Thomson, 1982; Rae, 1993; Watson, 1986), and computer science (Koen, 2005). PSI has received extensive attention in the literature. For example, 10 years after its in-

troduction Kulik, Kulik, and Cohen (1979) could base their meta-analysis on already 72 different papers, and today PSI is still a topic that receives research attention. In all these years teachers have successfully used PSI, although often they have made some modifications so that it fits into their academic environment (Hereford, 1979). The trend towards high marks has been a recurring observation. The original PSI description talks of a self-paced learning approach where students have to prove mastery of learning material that is divided into small learning units. For each learning unit students receive written material, which includes the learning objective for that unit. Students study the material on their own or in groups, and when they think that they have mastered the unit they take a test. An instructor or a student assistant, called a proctor, immediately marks this test in the presence of the students. If they answer all questions correctly, they receive the written material for the next unit. If they fail, the marker provides them with formative feedback and asks them to study their material again before they re-take the test. Passing the test also gives students the right to attend lectures as a reward. This is possible because no essential material is taught in the lectures; only a few lectures being scheduled and their main purpose is to motivate the students. The use of student proctors clearly has both economic and educational advantages, though care has to be taken to avoid misconduct by proctors.

Proctors are not always used as is shown by Emck and Ferguson-Hessler (1981) who reported that at the Technische Universiteit Eindhoven (The Netherlands) the proctors were replaced by a computer as early as 1970. In a mechanical engineering course, the computer randomly selected a

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