Preface

Deryn Watson and Jane Andersen
Editors

INTRODUCTION

The role of a Preface is to introduce the nature of the publication. The book that emerges from an IFIP Technical Committee World Conference on Computers in Education is complex, and this complexity lies in the nature of the event from which it emerges. Unlike a number of other major international conferences, those organised within the IFIP education community are active events. A WCCE is unique among major international conferences for the structure that deliberately ensures that all attendees are active participants in the development of the debate. In addition to the major paper presentations and discussion, from international authors, there are panel sessions and professional working groups who debate particular themes throughout the event.

There is no doubt that this was not a dry academic conference – teachers, lecturers and experts, policy makers and researchers, learners and manufacturers mingled and worked together to explore, reflect, discuss and plan for the future. The added value of this event was that we know that it will have an impact on future practice; networks will be formed, both virtual and real - ideas will change and new ones will emerge.

Capturing the essence of this event is a challenge – this post-conference book has three parts. The first is the substantial number of theme papers. These represent a proportion of the total number of papers presented at WCCE 2001. All conference presentations are selected after an international refereeing panel has reviewed their value. A further review then takes place to select those papers that should be identified as *theme papers* for the conference and publication in this book. So this book is not a full conference proceedings, but rather a selection to capture the range, essence and excellence. In addition there are two further parts. The *reports from the* *discussion panels,* from which the flavour of the debates and active issues emerge. And then the substantial *Professional Group reports*. These cover key topics of current interest within our community, and report the deliberations, ideas and key issues that emerged.

Keynotes hold a particular place in all major conferences, and they are no exception in WCCE 2001. But true to the nature of our field, no keynote address has a printed paper version, as they all were interactive presentations using the full facilities of the media. A synopsis of their content will however be referred to in the Editorial which follows. But this preface does contain the Welcoming and Opening addresses. Firstly because in the IFIP education community we feel that our post-conference books should reflect as many aspects of the nature of the event itself – and the tone and content of the welcoming addresses contribute to this. And secondly, we are always privileged to attract serious Opening Speakers, whose thoughts and ideas set the tone for the complex issues that we will be discussing for the week. The Danish Minister for Education Margrethe Vestager and Deputy Assistant Director-General for Education, UNESCO, Aicha Bah Diallo presented the formal opening speeches. Not only their presence but also the content of their speeches are evidence that this conference is not just an issue for educators and students. IT, Informations Technology is just as much a political project in both the western world and in the developing countries. And so we are proud to include our opening addresses in the Preface. And finally this is where we can acknowledge the contribution of so many colleagues who made the event, and thus this book, possible.

Six years since the last World Conference on Computers in Education, this IFIP meeting, entitled Networking the Learner, promises to be another milestone in the on-going development, progress and reflection on the relationship between Information Technologies and Education.

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Dimensions of Student Success in Online Learning

Lynne Schrum
Department of Instructional Technology, University of Georgia USA
lschrum@coe.uga.edu

Keywords: learner-centred learning, open flexible learning, electronic communication, collaborative learning

Abstract: Online learning has become a popular method of education. This transition is not a trivial matter, and while faculty members may have support in making this transition in their teaching style and methods, they may know little about how to assist students in succeeding in a new learning environment. Similarly, students may not be prepared to tackle the new demands put upon them. This research sought to identify the characteristics and qualifications of successful online learners, by examining primary screening documents from institutions, mapping these dimensions to the literature base, and weaving personal research projects through the resulting information.

1. INTRODUCTION

Online learning has undergone rapid development. We know the stated reasons for growth in this area: public media have raised individuals' expectations, the digital economy has created a demand for technical expertise, and adults are demanding greater flexibility and control over their learning. Moreover, business and industry have begun to challenge the traditional models of learning and teaching, through corporate universities, for-profit institutions, and other less formal opportunities.

Educational institutions are responding rapidly to learners' demands for 'anytime and anywhere' education by devoting substantial resources to the development of online distance learning. Throughout the world, traditional and non-traditional individuals are taking advantage of these offerings. However, the transition to this online environment is not a trivial matter, and the challenge is to understand the relationships between the user and the technology, the instructor and the participants, and the relationships among the participants (Gibbs 1998, Palloff and Pratt 1999, Schrum 1998). Faculty members may have support in recreating their courses for digital media, yet they may know little about how to assist students in succeeding in a new learning environment and to adapting their teaching style and methods.

In an effort to provide information to assist faculty members to understand the demands their students face in online learning, and to design effective online environments to support these new challenges, this research sought to first identify characteristics and qualifications of successful online learners. Next, data were collected from successful online teachers to investigate strategies they have found useful to ensure student success.

2. PERSPECTIVES

Traditional distance learning environments were based on correspondence through passive media (paper, audio and video broadcast) and were most often conducted as independent experiences, with each learner corresponding only with the instructor. Recent developments in technology and access have offered organisations and universities the opportunity to improve these environments through increased communication, interactivity among participants, and incorporation of collaborative pedagogical models, specifically through electronic networks and groupware (Gerencher 1998, Gibbs 1998, Schrum 1998). Other advantages to using this type of distance learning are the potential combination of instantaneous (synchronous) and delayed (asynchronous) communication, access to and from geographically isolated communities, multiple participation within activities, and cultural sharing of diversity and recognition of similarities among the people of our world.

In this transformed model of distance learning, learners expect interactivity and close to 'traditional' classroom based education. The demand for online courses, enhanced by the ease of access, media attention, and interest from the private sector, has accelerated the rush toward online learning activities. Some of the courses are traditional subject matter courses, often undergraduate, while others are geared more to ongoing professional work activity. These include informal courses, professional development tutorials, and even full degree programs; however, much uncertainty exists about the conditions that are essential to create a successful experience for educators and learners.

Development of an online educational environment is a complex task. Faculty members have had an especially difficult time changing the ways in which they teach, regardless of these educators' own personal use of electronic media (Candiotti and Clarke 1998). In an electronic environment the role of faculty changes in many ways, and in particular, each instructor must give up some control of the classroom environment. Faculty members are forced to develop and design their activities and interactions in new ways, and may be frustrated without the ability to recognise when students are puzzled (Schrum and Berge 1998). Kember (1995) urged designers to work toward deep learning, which requires moving away from excessive assignments and shallow assessments, and toward some individual freedom in activities. These challenges go far beyond the need to be comfortable with the reliance on technology to support their courses. Wiesenberg and Hutton (1996) identified three major challenges for the designer to consider: increased time for delivery of the course (they estimate two or three times what is necessary for a traditional course), creating a sense of online community, and encouraging students to become independent learners. They also reported fewer interactions than expected from participants of an online course. These issues all have implications for faculty members and students in an online environment.

3. METHODS

These data derived from a variety of sources. To begin, an examination was made of over seventy institutions from around the globe that currently offer online learning opportunities. While many more institutions do offer online courses, only those that appeared to have an educational focus, and other components that seem essential for post-secondary education (library facilities, student support personnel, etc.) were considered. The original group was narrowed again, so that only those that provided potential students the opportunity to investigate their own suitability for this environment, through a substantive needs-assessment, which included advanced organisers, surveys, or other materials designed to provide potential students with necessary information were ultimately included.

A document analysis was then completed on those needs assessment or pre-enrolment instruments. Standard document analysis techniques were employed to compare the similarities, distinguish the areas of divergence, and identify the various functions of presentation, scoring, feedback, and supporting documentation (Miles and Huberman 1984). After the analysis was completed, a substantial literature review was undertaken, to verify the practical field analysis and to identify areas or characteristics that were missing from that analysis. The literature was thus woven through the resulting characteristics of successful students.

In addition, the author has completed several research studies that investigated various perspectives of online learning (Schrum 1992, Schrum 1998, Schrum 2000, Schrum and Berge 1998). In each study, completed primarily at the author's institution, an ongoing focus of investigation was the identification of factors that influenced student success, gathered from students' perspectives. These experiences were analysed through constant comparative methods, and were woven into the material presented in this paper.

Finally, this information was aggregated and presented to experienced online educators. These individuals verified these seven characteristics, and provided rich descriptions of the ways in which they ensure student success, as related to these dimensions. These data were also analysed using constant comparative methods (Lincoln and Guba 1985).

4. DIMENSIONS

Seven dimensions were found to impact the success of adults who enroll in distance learning courses and degree programs. Of course, not all dimensions are significant for each student, and only the individual will be able to determine those that are most pertinent and essential in his or her life. Moreover, while these dimensions are presented separately, in reality they do not function independently. Rather, they are interconnected, as are the pieces of a puzzle, and work together to support or challenge the online learner. The seven significant dimensions that emerged from the data included:

4.1 Access to tools

The first dimension concerns tools that students must have readily available. Research has demonstrated that easy access to technology, at home and perhaps at work, is one of the most significant contributors to success in online learning environments (Bonk and Dennen 1999, Schrum 1998). Access to all these tools is essential in a convenient and timely fashion, however, any discussion of specific tools is subject to revision almost immediately. Yet it is worthwhile to create a minimum standard for hardware and software, plus peripherals. An institution can provide a highly successful way of testing the equipment by offering potential students a free mini-course to experiment with the components and also to demonstrate exactly what an online learning experience might be like.

4.2 Technology experience

While having convenient access to the tools is the first step, experience using the tools for personal or work related activities is also important. More than one study has suggested that students who have little technological experience would delay learning new content while they learned the tools (Schrum 1998, Yakimovicz and Murphy 1995). Important experiences for new online learners include the ability to write documents using a word processor, printing, sending email on a regular basis, sending and receiving files via email, conducting searches through the World Wide Web, and accessing online information.

Students who are comfortable and adept at these tools will be able to solve small technical problems, such as rebooting their machine, installing software, resolving printer questions and cartridge changes, and answering simple configuration issues. They will also be able to distinguish between the problems they can solve and those problems that are not related to their individual hardware and software, and thus know when to contact the system administrator or institution to report difficulties and request assistance.

4.3 Learning preferences

Students may be concerned that they might miss traditional face to face instruction. It is true that each person learns in a unique way – in general, people know the ways in which they are best able to remember a phone number or address. Some people will write it down, others will say it several times, and still others will make a rhyme out of it. Each is appropriate for the individual who uses it. It is important to recognise that when one learns off campus, individual strengths and weaknesses may be amplified (Bonk and Dennen 1999).

4.4 Study habits and skills

One of the greatest benefits of learning at a distance is also one of its greatest challenges. Learners appear to appreciate the greater control over their learning, yet with that control comes substantial responsibility for completing assignments and being prepared. It may be more difficult to stay focused on those assignments so it is essential that students adopt a model of self-directed learning.

An individual's study habits play an important role in the success of that student. Learners must be able to turn off the television and concentrate on their work in a timely fashion, in order to stay on track in turning in assignments. It is fairly clear that those students who do not keep up with the

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Students' Perceptions of the Technological Supports for Problem-based Learning

Willie Yip
The Hong Kong Polytechnic University, Department of Computing, Hung Ham, Hong Kong, China
cswiyip@comp.polyu.edu.hk

Keywords: problem-based learning, support tools, students' perceptions, technological supports

Abstract: This paper reports students' perceptions of the technological supports that assist problem-based learning (PBL). There are a number of tasks in the PBL processes, which can be supported by technological advances. A Web-based system has been developed to support the problem-based learning strategy. The system provides facilities to both teacher and students to facilitate learning and teaching. These include on-line teaching materials retrieval, a discussion area for problem analysis and brainstorming, a facility for project planning and monitoring, a private group area for the purposes of discussion, a facility for the submission of development work and learning resources, and a posting area to display good work to motivate students. The progress of the students can be monitored and feedback can be given to them. This paper presents a pilot study of student views of and preferences for various technological supports used to enhance learning effectiveness.

1. INTRODUCTION

The author undertook a learning and teaching project in the autumn of 1999, with the aim of promoting problem-based learning in the subject Information Systems Analysis. The PBL approach was introduced for the first time to teach Information Systems Analysis to second year students in the Higher Diploma in Information Systems programme. It was the only subject in the programme that used the PBL approach, with which students had no prior experience. However, it was envisaged that students would learn better with the PBL approach, which is facilitated by technological advances.

Problem-based learning is a promising recent development in tertiary education, which recognises the need to develop problem-solving skills as well as the necessity of helping students to acquire necessary knowledge and skills (Boud and Feletti 1997). The amount of direct instruction is reduced in problem-based learning, as students assume greater responsibility for their own learning. Students are given ill-structured problems through which they develop high-order thinking and problem-solving skills. The shift in the teaching and learning process is more student-centred than teacher-centred. The teacher as knowledge provider becomes less important as students learn from other students, the World Wide Web (WWW), and from other information resources. The role of the teacher is to encourage student participation, provide guidance to students, offer timely feedback, and also assume the role of learner (Roblyer et al. 1997). A problem case, unlike a case study, provides less information to students and requires them to do more information searching. There can be alternative solutions to a problem, through which students learn to make evaluations and justifications. Problem cases, which require students to tackle ill-structured problems, not only develop interpersonal communication and social skills, but also stimulate critical thinking, creativity, and problem-solving skills.

Many universities around the world are using the WWW in direct support of teaching and learning, as both a primary means of information delivery and a supplement to classroom teaching (Harasim 1999). The use of the Web as a teaching resource can benefit students (Milheim and Harley 1998, Sloan 1997). Students can learn better when the pedagogical process of PBL is supported by technology to foster teaching and learning. Learning and teaching courseware is available (Blumenstyke 1999, Frederickson 1999) and the author's university has been using WebCT as the teaching platform since September 1999. Nevertheless, WebCT features are unable to support the various PBL processes, in particular project planning and controlling, and private discussion facilities for collaborative learning, which are important processes within PBL. Thus, a Web-based system has been developed to support PBL instead. The technology provides facilities for both teacher and students to facilitate learning and teaching. This paper presents a pilot study of student perceptions of the technological supports used to enhance learning effectiveness.

2. HYBRID PBL APPROACH TO EFFECTIVE LEARNING

The introduction of a hybrid approach to PBL may be more appropriate for undergraduates. A full PBL approach with less lecturing, more students working in small groups, and more self-direct learning, may not be appropriate initially for two reasons. First, most undergraduate students are accustomed to teacher-centred learning and they may need a short period to get used to the PBL setting. Another consideration is that their academic achievements may not be the best. Expecting students to be able to read well and provide answers to ill-structured problems initially may not be workable. Second, every subject is time-tabled and designated with both lecture and tutorial hours. As such, this is an institutional constraint, because teaching activities need to follow these patterns. However, there follows a gradual reduction in formal lectures for knowledge dissemination, with the replacement of more discussion activities that take place during lecture hours.

A number of PBL strategies have been tried in learning and teaching (Tang et al. 1997). The author used the hybrid problem-based learning strategy, with students working in teams of six, as follows.

- Teaching materials can be accessed on the Web and students prepare for classes
- Students are given problem cases that simulate real-life situations
- Brainstorming sessions are held to identify learning issues
- A group project plan is formulated
- Students undertake self-directed and collaborative learning
- Each group of students presents their findings (report writing and presentation)
- Exemplary work is posted on the Web for experience sharing
- Students reflect on what they have learnt through feedback.

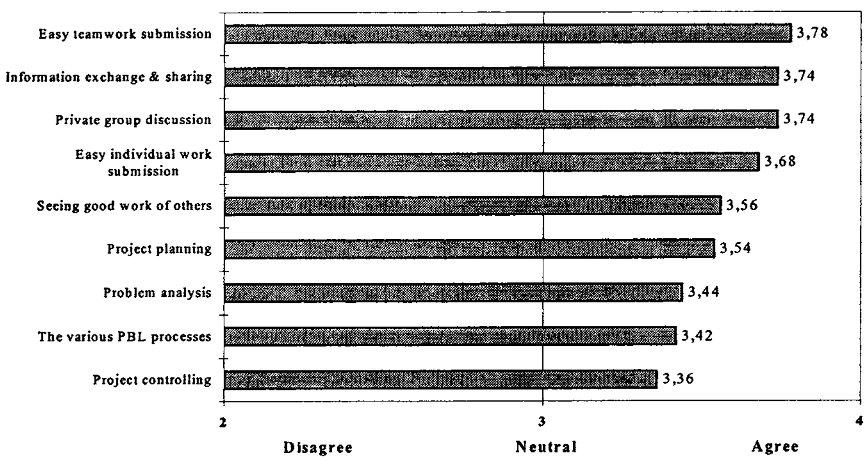
The Web-based system provides functionalities to support the various PBL processes are shown below.

PBL processes	Technological supports in the Web-based system
Problem cases	Posted on problem case area
Identifying learning issues	Problem analysis
Group project planning	Group project plan
Self-directed learning	Reading – Teaching materials are posted on the Web (Teaching materials area)
	Searching – Information search through the WWW
	Understanding – Individual work submission

Collaborative learning	Group discussion
Report writing and presentation	Teamwork submission
Reflection	Feedback, posting area (showing good student work), bulletin board

3. STUDENTS' PREFERRED TECHNOLOGICAL SUPPORTS FOR PBL

Table 1. Students' preferred facilities on the Web site



Student learning can be enhanced when the pedagogical process of PBL is supported by technology. A Web-based system provides functionalities to support the various PBL processes. Teaching materials, problem cases and PBL guidelines are posted on the Web. Facilities such as private group area for discussion and brainstorming, a problem analysis area for identifying learning issues, a simple table for group project planning, individual work and teamwork submission facility for on-line work submission, and a posting area for displaying the exemplary student work – are all intended to enhance better learning and teaching. Students were requested to rate their preferred facilities on a scale of 1 to 5, with 5 being the highest score and 1 the lowest. Table 1 presents students preferred facilities on the Web site. The following sections describe in detail the students' perceptions of the technological supports.

3.1 The author's views on posting teaching materials on the Web

Students are interested in receiving the teaching materials available on a course Web site (Holmes 1999, Weible 1999). They can download subject information (subject syllabus, teaching plan) and teaching materials (lecture notes, review questions, references, problem cases and problem-based learning guidelines). Students are encouraged to develop the habit of making preparations for lectures. They are also encouraged to raise questions for discussion in class and there is little doubt that they will understand the subject better. As students participate more in class discussion, the atmosphere of a lecture session is enhanced. The usual one-way method of communication that most teachers use is dull and uninteresting. Since the teaching materials are stored in PDF format with four pages of materials printed on a page, the content is legible but paper is saved in printing. Teaching materials are useful to students and can be updated easily. The Web-based system also solves the problem of photocopying overhead projector transparencies in the production of handouts.

3.2 Students' perceptions of receiving teaching resources on the Web

Despite the tremendous efforts that have been used in preparing the teaching materials and posting them on the Web at the beginning of the semester, it is surprising to find that students do not, in general, use this facility to its best potential. Table 2 presents the students' views of receiving teaching resources on the Web. With the teaching materials available on the Web, students do not make use of the resources in making preparation for lectures. They download the lecture notes for lectures without much preparation. As such, they fail to learn how to prepare for lectures. The number of questions raised in class is the same as with the traditional teaching approach. However, some students do make preparation for lectures and posting teaching resources on the Web can improve their learning style, as they need to print the lecture handouts for lectures. They also find the supplied references useful for obtaining more information.

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Teacher Scaffolding: An Exploration of Exemplary Practice

Jennifer Masters and Nicola Yelland
Faculty of Education, Queensland University of Technology, Brisbane, Australia
j.masters@qut.edu.au

Keywords: classroom teaching/practice, integration of ICT, primary education

Abstract While computers have increasingly been used in classroom over the last twenty years, their application has often been mundane; being merely used to reinforce existing educational practices rather than as a catalyst for educational innovation. An effective way to bring about change may be to identify instances of best practice and then study associated strategies that may be useful for teachers trying to use computers in new and meaningful ways. This study investigates strategies used by a teacher deemed to be exemplary at using computers and associated technology in her classroom. It involved observing and recording teaching sessions conducted by the teacher. This paper discusses the learning task, the children's progression through the task and the teaching strategies used. In particular, it looks for instances of teacher scaffolding as a strategy for supporting children working with computers.

1. BACKGROUND

One of the most significant directions evident in education in recent times has been the restructuring of education catalysed by technological innovation. An integral and core part of the restructuring process is a change to instructional practices. New models for teaching and learning incorporate a focus on problem-solving, collaborative learning, real purpose tasks and transformed teacher roles (e.g. Jonassen 1996). As teachers are expected to adopt new models, they also need to reassess their approach towards educational processes and the integration of technology tools (Bork 2000). It seemed that the advent of technology-based school reform demanded new attitudes from teachers, different strategies and even that teachers adopt a new teaching paradigm.

Even though policy was requiring a new approach to teaching with computers, research indicated that resistance to change was still an impediment. While transformation in practice was demanded, it seems that teachers were finding it difficult to make the adjustments required. Sandholtz, Ringstaff and Dwyer (1997) suggested that rather than blame teachers for their reluctance to use technology in new ways, the problem should considered from the teachers' perspectives. Teachers have a responsibility to foster learning for their students and they need to be reassured that using computers in constructive ways will promote positive learning outcomes. Research from the Apple Classroom of Tomorrow (ACOT) project (Sandholtz et al. 1997) found that although teachers initially relied on traditional teaching strategies when using computers, over time, with supportive teacher development, they did adapt to more constructivist approaches.

Campoy (1993) suggested that the use of computers and especially software that promotes constructivist learning might actually be a catalyst to encouraging teachers to teach in more constructivist ways. This was supported by Hannafin and Savenye (1993) who felt that the show-casing of success stories of teachers using computers in meaningful ways would encourage others to try new methods. Additionally, in a report on the use of technology (President's Committee of Advisors on Science and Technology 1997) it was identified that teachers need to be provided with pedagogical support, including opportunities to observe within the classrooms of successful technology-using teachers.

A major component in the attempt to bring about effective computer use in schools is the type of activity that teachers are initiating in their classrooms. Research over the last twenty years has shown that using computers for traditional educational tasks, in traditional teaching styles has not significantly changed educational outcomes (Jones, Valdez and Nowakowski 1995). Instead, effective computer implementation is hinged on new learning tasks that promote "engaged, meaningful learning and collaboration involving challenging and real-life tasks, with technology as a tool for learning, communication and collaboration" (p. 1). Therefore, when examining teaching practices, we must also be cognisant of the type of activity that the children are engaged with. In particular we need to seek 'rich tasks', i.e. tasks that are designed to engage children with "knowledges, fields and paradigms that have power and salience in researching, analysing and interpreting the world" (Education Queensland 2000).

In previous research (Yelland and Masters 1999) we have identified that teacher scaffolding is a key aspect of effective computer use by children. The term 'scaffolding' was first described by Wood, Bruner and Ross (1976), who defined it as "a process that enables a child or novice to solve a problem, carry out a task or achieve a goal which would be beyond his unassisted efforts (p. 90)". The concept arose out of a consideration of Vygotsky's theories in which he hypothesised that guided interactions with an adult or a more capable peer could assist children to develop at a higher level of operation. Vygotsky suggested that this support allowed a child to extend through the Zone of Proximal Development. Consequently, when scaffolding is provided, a child may not only accomplish the task at a higher level but also internalise the thinking, strategy or mechanisms used to be able to approach similar tasks. (Rogoff 1990).

Research has shown that although the nature of the scaffolding is dynamic and must be modified according to the task and the learner, several key characteristics of scaffolding can be identified (Beeds, Hawkins and Roller 1991). First, the interaction must be collaborative, with the learner's own intentions being the aim of the process (Searle 1984). Second, the scaffolding must operate within the learner's zone of proximal development. Rather than simply ensuring the task is completed, the scaffolder must access the learner's level of comprehension and then work at a slightly beyond that level, drawing the learning into new areas of exploration (Rogoff 1990). The third characteristic of scaffolding is that the scaffold is gradually withdrawn, as the learner becomes more competent. Palincsar (1986) suggests that this notion re-inforces the metaphor of a scaffold as used when constructing buildings in that the means of support is both adjustable and temporary.

In our own research (Yelland and Masters 1999) we have identified that scaffolding with computers can also be classified into categories. In addition to *cognitive* scaffolding where a teacher can support children when constructing understanding, we also found that scaffolding may be *affective*, with the teacher supporting the children emotionally, and *strategic*, in which the teacher can provide task management support. A final category that is especially pertinent to using computers and associated technology is *technical* scaffolding. In this situation the teacher facilitates the operation of both the hardware and the software, in order for the students to focus on the learning aspects involved.

2. THE SETTING

The classroom chosen for this investigation was somewhat special. The research school was designed to be a state-of-the-art technology institution and was purpose built with facilities to support the integration of information and communication technologies in the classrooms. The infrastructure of the school incorporated at least four networked multimedia computers in each classroom with ceiling wiring to enable them to be situated in central hubs. Each double classroom also had a large screen monitor on a movable trolley that could be connected to any of the computers. Additionally, the students had access to peripherals such as still and movie digital cameras and scanners. A full time technology co-ordinator supports classroom teachers at the school.

Woodcrest College opened in 1998 as a primary campus and in 2000 extended its scope to incorporate a P-12 curriculum over a lead-in period, which will reach capacity in 2004. Another feature of the school is the Teacher Development Centre, which provides professional development for teachers in effectively using technology in classroom teaching practice. The centre runs a program in which teachers from other schools can visit to observe the teachers using technology with students and to participate in discussions about staff development, and school change. The stated learning outcomes of the project are that participants are presented opportunities to develop an understanding of:

- Constructivist classroom practice
- The role of educational technology in supporting effective learning and teaching
- Strategies to integrate educational technology into classroom practice
- A range of applications of educational technology to support a student centred constructivist approach to learning and teaching.

The class we observed in this study was a double year two/three group, with 52 children aged between 6 and 9 years. The group occupied two large adjoining rooms, separated by a sliding panel that could be closed or opened as required. The setting had been arranged so one room served as an activity area with very little furniture, while the other was used for seated activities, with tables for groups of children. There were eight computers located in pairs across both rooms, with four moveable workstations in the activity area to allow for maximum adaptability.

There were two teachers with the class who had both been teaching at the school since it was opened (3 years). One teacher, Angela was a graduate when appointed, while the other, Gillian, had previous teaching experience and was completing a Masters degree specialising in computers in education. Both teachers were recognised as having expertise with integrating computers into classroom activity and both regularly hosted visitors from the teacher development program.

3. THE ACTIVITY

The class had been investigating 'mini-beasts'. This topic had been integrated across the curriculum and the children had been examining the lifestyle and habits of various mini animals such as insects, arachnids and small reptiles, e.g. geckos. The culminating activity for the theme was for the children to work in groups of five or six and use the computer to produce a modelling clay animation (a quick-time movie) depicting a sequence in the life of a chosen mini-beast. In the animation they needed to illustrate the mini-beast's home, the food source and its mechanism for movement. In order to conceptualise their animation, the children had examined a 'Wallace and Grommit' movie, a popular children's series that uses a modelling clay technique to produce animation.

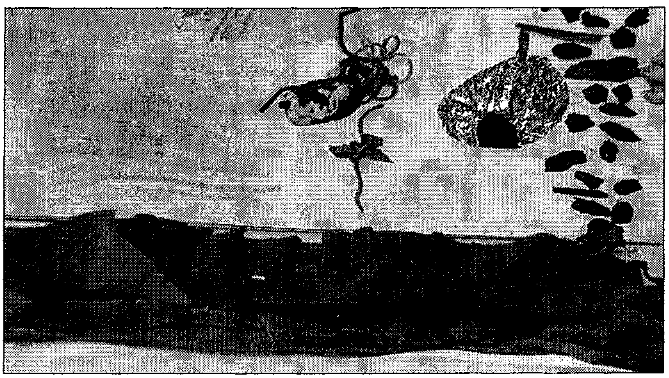

Figure 1. Bee set with bee, hive and flower

The activity was broken down into a number of tasks:

- Decide on the mini-beast and define the home, food and movement for that beast.
- Use a storyboard to plan the sequence. The sequence should include at least six stages.
- Design and produce the props. Produce a mini-beast using modelling clay and develop the set for the movie. This will include a backdrop, a foreground and any objects on the set.
- Film the sequence. Assemble the set and set up the digital camera on a tripod. Take a series of still shots of the mini-beast on the set in order to develop the animation.

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SelMa – New Perspectives for Self-guided Learning in Teaching Mathematics at Senior High School Level

Wolfgang Weber and Kristine Fankhänel
Landesinstitut für Schule und Weiterbildung, Paradieser Weg 64, D-59494 Soest, Germany
wolfgang.weber@mail.lsw.nrw.de

Keywords: classroom teaching, curriculum change, learner-centred learning, open flexible learning, secondary education

Abstract: How can new media make the teaching and learning of mathematics more exciting? How can school prepare for lifelong, self-guided learning? It is questions like these that the project 'SelMa – Selbstlernen in der gymnasialen Oberstufe – Mathematik', which is supported by the Federal Republic of Germany and the state of North Rhine-Westphalia, addresses. The aim of the project is to show ideas and possibilities for the ways in which mathematics can be taught if student activity and self-guided learning are supported, and how the idea of self-guided learning in general can be integrated into daily school routine. SelMa is run in close co-operation with schools.

1. GENERAL INFORMATION

The pilot project 'Selbstlernen in der gymnasialen Oberstufe – Mathematik' (SelMa) is one of 25 pilot projects taking place in Germany within the framework of 'Systematic Incorporation of Media, Information and Communications Technologies in Teaching and Learning Processes' (SEMIK). The aim of the SEMIK programme is to support the permanent integration of new media in all types of schools and at all levels. SEMIK includes various projects that make use of new information and communications technology. New media are to be integrated in teaching and learning processes and to help to put into practice innovative concepts of teaching. The main focus is upon problem-orientated, self-guided and co-operative learning.

The four-year SelMa project, which is funded by the federal government and by the state of North-Rhine-Westphalia, started on February 1, 1999.

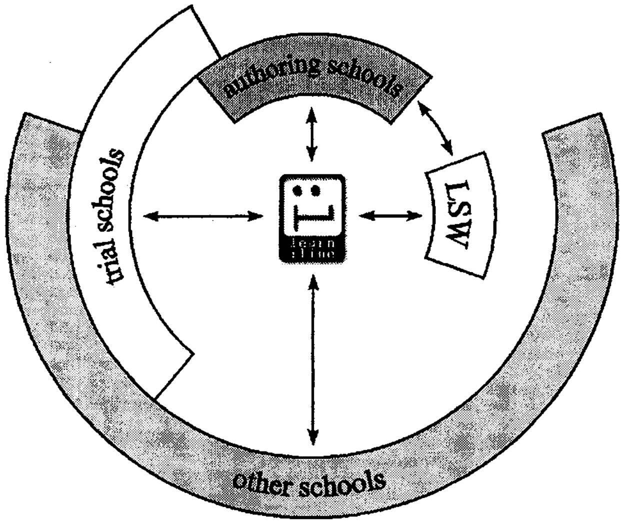

Figure 1. The SelMa structure

SelMa is monitored by the LSW (State Institute for School and Further Education). The aim of the pilot project is to show what teaching mathematics at senior high school level can look like if self-guided learning and activities are supported by the use of new media. Special importance is placed on integrating aspects of self-guided learning in everyday teaching.

Learning, mathematics and the use of new media – these are the pillars on which SelMa stands. Special emphasis is placed on the delivery of the new curriculum for mathematics, which focuses upon aspects of self-guided learning and must be integrated in everyday school life. The purpose of SelMa is to give teachers orientation and impulses for their own teaching.

Scenarios and materials for self-guided learning phases in teaching mathematics at senior high school level are being developed in five 'authoring schools'. These learning arrangements are accessible for teachers for trial purposes on the North-Rhine-Westphalian web-site 'learn:line'. learn:line provides an information, communication and co-operation environment for this purpose. Pupils can contact a 'teacher on demand'. learn:line also encourages the exchange of information and experiences between teachers, and initiates discussions with experts.

The development of materials by the authoring schools is to take place in an 'open workshop', so that other schools can also try out them at an early stage and regularly report on their own experiences. A special role is played by ten 'trial schools' which systematically try out and evaluate the materials which have been developed to see whether they work in everyday usage. Their feedback will be incorporated in the on-going development of materials.

Furthermore, authoring and trial schools are to disseminate their practice so that networks of schools can be created in the different regions and the materials on learn:line can be further developed. In this way the scenarios will be used in an increasing number of schools. Publishers are to be included at an early stage. This is expected to lead to high-quality (offline and online) media which will support phases of self-guided learning in teaching mathematics.

2. IMPORTANT ISSUES

Based on the focus upon learning, mathematics and use of media, the pilot project addresses various issues. The work of the authoring schools is monitored by academics and experts. Some of the aspects of methodology that are pertinent to learning/self-guided learning are:

- Which topics are suitable for phases of self-guided learning?
- How must the topics be presented?
- What different kinds of support do teachers need?
- What different kinds of support do pupils need?
- How can progress in learning be monitored?
- How do pupils acquire and use their knowledge?
- How can knowledge be consolidated by means of intelligent practice?
- How are media used by pupils?
- How does the use of media improve the quality of learning?
- What off-line and on-line materials must be provided?
- How can communication between the pupils be encouraged?
- What kinds of support are requested?
- What role does a 'teacher on demand' play?
- What opportunities for co-operation exist?

These questions show the broad range of issues the SelMa pilot project addresses. The measures taken to qualify teachers so that they can profitably incorporate both the individual learning process and the use of new media in their teaching should not be forgotten, either.

3. WEB-SITE

The current state of affairs can be viewed on-line on the NRW educational web-site learn:line (http://www.learn-line.nrw.de/angebote/selma/index.htm). The web-site offers a wide range of opportunities for information, communication and co-operation in the fields of self-guided learning, mathematics and use of media.

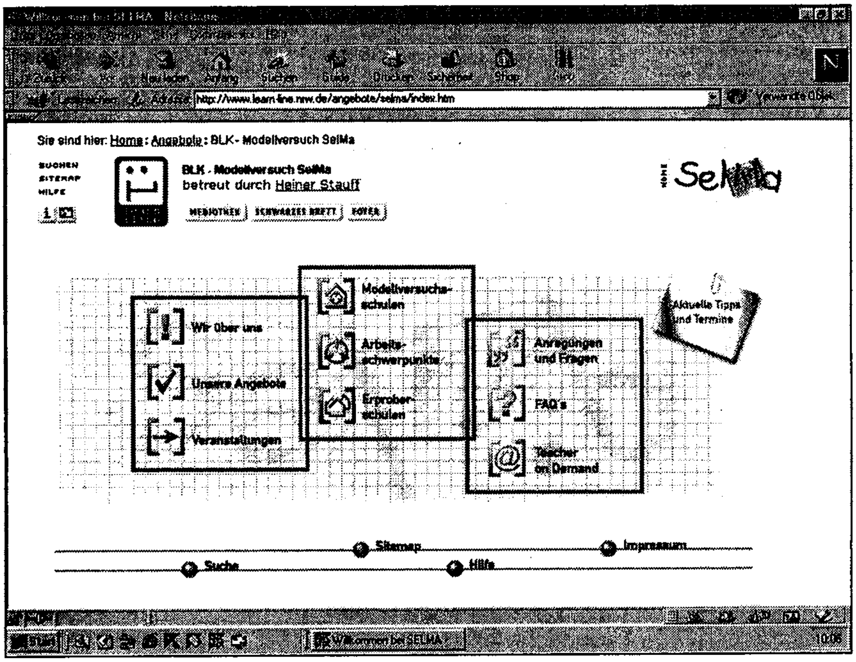

Figure 2. Home page of the SelMa web-site

The contents of the SelMa web-site are arranged in three blocks which are marked in different colours.

The left-hand 'red block' contains information which the SelMa-LSW team has compiled. This is where general information can be found on the pilot project as well as material on the topics of self-guided learning, mathematics, use of media. In addition to transcripts of talks, this section also offers references to literature, software and internet addresses.

The right-hand 'green block' offers a wide range of opportunities for communication which are supported by the 'teacher on demand'. For questions and suggestions relating to mathematics and self-guided learning users can have a look at the FAQ section. Of course, users can also leave their own messages on a message board.

The 'blue block' in the centre is linked to information about and from SelMa schools. This is where the pilot schools present information on themselves and their projects. Up to now five authoring schools have developed projects for Year 11, and additional projects will be following soon.

4. PROJECTS

The self-guided learning scenarios and materials which are being developed by the authoring schools are at the core of the SelMa. Various models of self-guided learning have been used as a basis. Materials for use in self-guided learning centres, collections of exercises for use in everyday teaching, and suggestions and materials for learning at stations using different approaches are included. Each project is accompanied by a project description.

4.1 Materials for the independent learning centre

The work of a SelMa authoring team is closely related to further developments in their school. In an independent learning centre, pupils work on their own, on mathematical topics specified in the curriculum for Years 11 and 12. The material which is prepared for the independent learning centre consists of courses on the one hand and of collections of problems on the other. Graded aids for learning relating to the pupils' existing knowledge provide both food for thought and initial approaches towards solving the problems. Suggested solutions to the problems allow the learners to check the progress they are making. The computer provides opportunities for simulation and visualisation of mathematics.

Pupils normally meet in groups of two or three in the independent learning centre and discuss individual problems. The aim is for the individual pupil to establish as precisely as possible those areas where practice is most necessary. Under no circumstances must the pupil's personal speed of learning suffer from group pressure.

In practice it has been found that pupils can contribute a lot of help and suggestions when it comes to designing the materials. In further projects, pupils who are already experienced in using the materials should be involved even more closely as co-designers.

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PC Interfacing by Example

John Fulcher
School of Information Technology and Computer Science, University of Wollongong, Northfields Ave, Wollongong NSW 2522, Australia
john@uow.edu.au

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Abstract: A laboratory environment for the teaching of microcomputer interfacing and real time computing is described. An Integrated Development Environment (IDE) running on the host PC facilitates the writing of software for a target 68HC12 microcontroller, which connects to host via the latter's serial port. Students are encouraged to learn by doing, including learning from their mistakes – hence necessitating good debugging facilities within the IDE. This approach is in keeping with that of situated learning (Lave and Wenger 1991). To put it another way, knowledge as such is not *taught*, but rather imparted through a process of apprenticeship. In this context, the role of the educator is primarily to provide a nurturing environment in which students are able to get their hands dirty and attempt to interface to real-world peripheral devices. Lecturing staff are used as consultants or last resort trouble-shooters, with students encouraged to perform the bulk of their own software development and debugging. Experience has shown that students respond admirably to such an approach, commonly experiencing the subject as "it's a lot of work, but very enjoyable – I learnt a lot".

1. INTRODUCTION

We have a tradition at the University of Wollongong of designing our undergraduate subjects to be very much laboratory-based. This is particularly the case with the Microcomputer Interfacing and Real-Time Computing subject which students can elect to undertake during their third and final year of their Bachelor of Computer Science study. We believe students learn by doing, *especially* by getting their hands dirty and learning from their own mistakes (Fulcher 1990). Furthermore, they best learn underlying principles by having to apply these to real-world problems (Fulcher 1991).

Another emphasis – in both subjects – is the exposure of students to what lies under the hood of the computer. In other words, they gain an appreciation of what is contained within this black box called a computer.

Introductory subjects in computer architecture, computer systems and/or assembly language programming tend to use simulators (e.g. Gray 1987, Patterson and Hennessy 1994). By contrast, we have recently shifted the focus of our introductory computer systems subject to that of PCs in general, and the Pentium processor in particular (Duntemann 2000) – one reason for this, by the way, is that this is the first time the author has encountered PC assembly language programming covered not only from a DOS perspective, but also for Linux.

The shareware assembler NASM forms the common link between DOS and Linux in the PC environment (an entire NASM-IDE in the case of the former). The inbuilt (16-bit) `debug` is used in the DOS environment, whereas the (32-bit) `gcc` debug tool – `gdb` – is used under Linux (which causes a slight trauma in students migrating from the Intel-style syntax of `debug` to the AT&T syntax used in the `gcc` tool suite!). Furthermore, reliance on BIOS software routines under DOS shifts to standard C library function calls under Linux.

The PC emphasis of the earlier Introduction to Computer Systems subject is expanded upon in the third-year Microcomputer Interfacing and Real-Time Computing subject. In the latter, students are given ample opportunity to control real-world devices (not just *simulations* thereof). Feedback from students is invariably positive – they typically cite this subject as one of the best they undertake during their entire 3 years Bachelor of Computer Science degree studies.

Enrolment numbers are typically between 30 and 40, compared with 120 to 150 in the first-year Introduction to Computer Systems subject.

2. LABORATORY SETUP

Previous incarnations of the Microcomputer Interfacing Laboratory were based around the 8-bit Motorola MC6800 (via Heathkit ET3400 trainers – Fulcher 1989a), and the 16/32-bit MC68000 (via firstly Motorola's Educational Computer Board, thence the Applix 1616 – Fulcher 1989b, Fulcher 1990, Fulcher 1991). In each case, the basic microcomputer trainer interfaced to individual experiment pods via in-house expansion circuitry.

In choosing individual (plug-in) experiment pods, we were conscious of making the laboratory assignment work both interesting and accessible to the students. Typical experiments include:

1. LCD/Dot Matrix displays
2. timer/music
3. serial communications
4. bar code reader
5. x-y drill positioner
6. slot car controller
7. model train scheduler, and
8. turtle robot controller.

In each case, heavy emphasis is placed on students writing their own (rudimentary) software drivers for the hardware controllers provided. To quote from the preface of an earlier accompanying textbook (Fulcher 1989a): "Interfacing peripheral devices to a microcomputer involves three important factors. *Firstly*, we need to know the basic operating principles of the peripheral device we're attempting to interface to the computer. *Secondly*, we need to know the characteristics of the particular peripheral support chip we're using for this task. *Thirdly*, we need to write the control software."

The immediate feedback provided to students by having LEDs flash on/(off), interrupts being generated, and the actual movement of real world devices greatly assists students in their learning experience.

A few years ago we decided to migrate our existing (MC68000-based) experiment pods to a PC platform. One motivation behind this decision was to impart skills to students which they would be able to take *beyond* the classroom laboratory setting and into the real world following completion of their formal studies.

In order to ease the transition to a PC environment, we developed an in-house ISA expansion card, which allowed direct connection to our pre-existing (MC68000) range of experiment pods. The following year saw these older experiment pods replaced by a single development platform based around a Motorola MC68HC12 microcomputer.

3. LABORATORY ASSIGNMENTS

The first PC-based laboratory assignments were undertaken on the PC itself, using the Open Source DJGPP C/C++ Compiler (in fact a complete Integrated Development Environment – http://www.delorie.com/djgpp).

Open Source software was chosen rather than commercial, in order to kept costs low (e.g. Microsoft Visual C++ – Buchanan 1996).

Extensive use is made of interrupts – both hardware (from external peripherals) and software. The latter focuses on BIOS library function calls, with which students become familiar during the (first-year) Introduction to Computer Systems subject. It is only in the later-year subject however that the separation of functions contained within the *highly integrated* PC support chips becomes clear. Indeed, a complete system can be constructed using just three (highly integrated) peripheral support chips:

1. i82439 System Controller (DRAM, SRAM/cache, ECC),
2. i82371 PCI/ISA Xcelerator (IDE, PCI-ISA bridge, Priority Interrupt Controller, timers, plug-and-play, mice, USB root hub), and
3. i82091 Advanced Interface to Peripherals (2 serial, 1 parallel, FDD).

In the later-year subject, interfacing is approached from a *functional* perspective, but again with a focus on interrupt-driven IO and buffering.

The mode of operation of the laboratory equipment was subsequently changed from code development on the target machine (i.e. the PC itself), to a PC host/68HC12 target configuration. A locally developed 68HC12 Monitor-in-RAM provides students with rudimentary functionality, although not as comprehensive as that contained within the PC BIOS:

D<from, nbytes>	-	Display memory
F<from, nbytes, data>	-	Fill memory
T<from, nbytes>	-	Test memory
G[addr]	-	Go from address (i.e. start executing from)
L	-	Load record (i.e. *.S19 executable file)
H	-	Help (i.e. list of available commands)

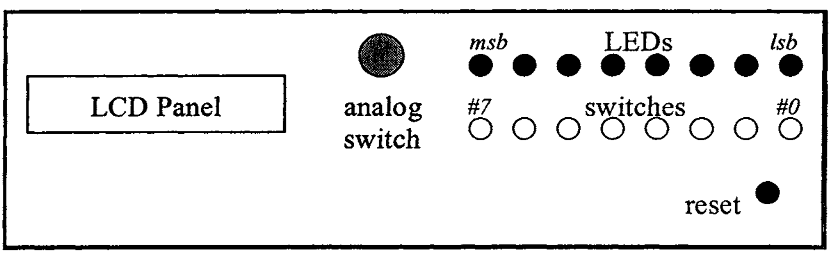

Figure 1. MC68HC12 Target Microcontroller Front Panel

The 68HC12-based microcontroller is shown in Figure 1. It cost around $600 per unit to produce, and incorporates the following peripherals (with associated 68HC12 ports – see Figure 2):

1. 8 switches Data Register=Port-D 0x05 Data Direction Reg-D=0x07

2. 8 LEDs Port-J 0x28 DDRJ 0x29
3. (2-line*8-digit) LCD Panel *Data:* Port-H 0x24 DDRH 0x25
   Control: Port-T 0xAE DDRT 0xAF
4. 5 timer channels (3-7) Port-T 0xAE DDRT 0xAF
5. Serial Interfaces (2 asynchronous SC0(1) + 1 synchronous SP0)
   SC0(1): 0xC0-C7(0xC8-CF) SP0: 0xD0-D5
6. 8-channel (8-bit) Analog-to-Digital Converter Port-AD 0x70-7E
7. USB interface *(under development)*

The HC12 interfaces to the PC via the latter's RS232 serial port (an upgrade to USB is currently underway).

The 68HC12 microcontroller cross development platform takes the form of the ImageCraft C-compiler – ICC12. As with the DJGPP C/C++ Compiler, the Integrated Development Environment adopts the usual Borland style (i.e. integrated editor, compiler, linker and debugger, all accessible from the same Graphical User Interface).

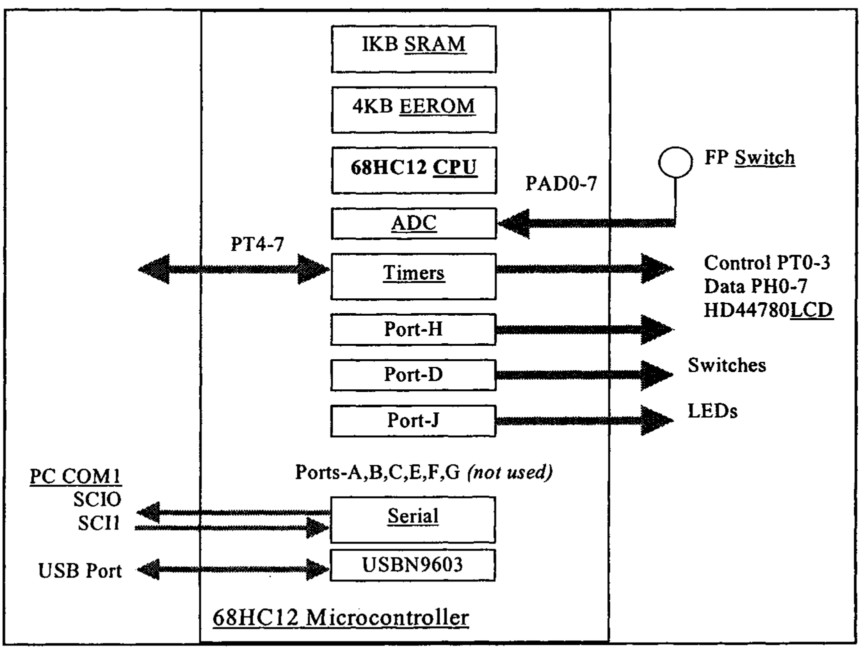

Figure 2. Motorola 68HC12 Microcontroller

Typical assignment tasks include the following:

1. Simple IO (switch input; LCD output):
   – activation of least significant (software debounced) switch(#0) → print name on LCD