COLLABORATIVE LEARNING AND COMPUTING IN THE IRISH SECONDARY EDUCATION SYSTEM

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Abstract

With the publication of the Irish Government's blueprint for the future of Information Technology in Irish schools - Schools IT 2000 - came the promise of major financial investment in education, training and equipment. This dissertation is an attempt to assess the role that collaborative learning, and in particular the WISDEN collaborative learning environment, might play in the future of technological education in the Irish secondary education system.

We first focuse on collaborative learning itself, outlining theories of collaboration in education, and attempting to justify its value to an under-funded Irish education system. Descriptions of three computer supported collaborative learning environments are given, including one implemented on the World Wide Web.

The present situation in relation to quantity and quality of hardware and software in primary and post-primary education sectors is discussed. Attention is drawn to the current status of teacher qualifications, and a review of available courses and qualifications is undertaken.

The WISDEN environment is examined in detail, considering areas such as courseware provided, the Course Management System and the embedded Course Constructor. A student experiment is performed, both to evaluate the appropriateness of the courseware and the suitability of the working environment for the target users.

Results are analysed, and an attempt is made to assess whether the system might be suitable, either in present or modified form, for use in the future in the Irish secondary education system.

Keywords: Collaborative Learning, Computer Supported Collaborative Learning, Collaborative Learning Environment, WISDEN, CAL.

1. Background:

In late 1997, the Irish Government published a document entitled "*Schools IT 2000 - A Policy Framework for the New Millennium*" (Irish Government, 1997). The Government commits itself to address the lack of investment in Information and Communication Technologies (ITCs) and achieve computer literacy throughout the school system by the end of 2001. The inadequate allocation of finance in the Government's ambitious programme, allied to the optimistic expectations in relation to contributions from the private sector make it imperative that the Government's allocation of £40 million and Telecom Eireann's contribution of £10 million are well spent. It is in the above context that this dissertation is undertaken. The Wide-ranging Integrated Services Design Educational Network (WISDEN) is a computer supported collaborative learning environment which may be of assistance in achieving the twin objectives of providing a successful teaching and learning environment and minimising costs.

Collaborative learning, which involves the creation of small teams to tackle a problem, is an inherent part of human learning, where learning results from a sharing of knowledge. It fosters the ability to work constructively and creatively as a team with a common goal. It provides an environment to enliven and enrich the learning process. Computer Supported Collaborative Learning (CSCL) involves the use of computers in the above process. By embracing CSCL, there is a very good chance that we can foster an ethos of co-operation, which promotes the development of good personal relationships. For computer science courses in particular, collaborative learning environments better mirror the team-oriented workplace students find after qualifying.

The WISDEN project was initiated to develop and make available to UK higher education a wide range of interactive computer-based learning material in the area of software design. The primary aim was to make teaching and learning in software design more efficient, and to achieve savings of approximately 25% in total staff contact time. As well as producing courseware, the consortium is also developing a Collaborative Learning Environment (CLE), in which to embed the courseware. A Course Management System (CMS) has been designed to facilitate the management and provision of computer-based learning materials and to provide a group working environment in which to embed and run such materials (Norcliffe, 1996a).

2. Collaborative Learning/Computer Supported Collaborative Learning:

Collaborative learning is defined by Doob (1994) as follows: "*Typically, collaborative learning involves the creation of small teams - three to seven people, in most cases - who jointly tackle a project, a problem, a case study, a group of readings, an essay. Groups may be self-selected or assigned; membership may stay constant throughout a course or change every few weeks*".

Collaborative Learning: Collaborative learning is an inherent part of human learning where learning occurs as a result of the sharing of knowledge among multiple participants. In many collaborative situations, constructive interactions and goal-oriented learning seem to occur in a natural, cohesive and organised manner. As Piaget (1928, 1932) pointed out, collaborative learning has a major role to play in constructive cognitive development. His theory is

consistent with the other popular learning theories, such as that of Vygotsky (1978) and Thomas & Funaro (1990), in emphasising the importance of collaboration. Piaget felt that interaction between peers is equally shared. This contrasts adult - child or teacher - student interactions where usually the former is in control and the latter characteristically follows what the former professes, thus not following his/her own natural learning process.

Computer Supported Collaborative Learning (CSCL): CSCL could be defined as: *"The use of computers to support and promote shared experience, peer exchange, interaction among equals, the development of shared mental models, shared purpose, common practices of interaction and communication and the formation of bonds."*

The basic objective of CSCL is in the area of learning. However, the absence of a precise definition leads, according to Crawley (1997), to "*an umbrella term which serves a useful function by bringing together…in meetings and workshops, a variety of researchers with different backgrounds and techniques, where they can discuss their work*".

In general, CSCL systems could be employed to augment real-life collaborative learning situations. Training technicians to operate/troubleshoot machinery (electronic troubleshooting systems), training students to advance their learning to practical applications (collaborative language learning systems), and training commercial employees to perform complex tasks (teaching procedures of a task) are some examples of applications of CSCL technology. Software Engineering is another area where CSCL could be put to effective use.

A climate of rapid technological change has created new challenges for education. In the increasingly competitive arena of further education, it is vital that institutions of higher education constantly review and reassess approaches to teaching in terms of ensuring the quality of teaching methods, keeping pace with technology, and maximising precious resources. Consequently, there is a need for the role of information systems as an aid to teaching within higher education to be researched and evaluated (Shankararaman & Heyter, 1996).

3. Computing In Irish Secondary Schools:

Historical Perspective: Educational computing began in Ireland in the early 1970's. At that time, computers were extremely expensive, not very powerful, and way beyond the resources of schools. The Department of Education began organising in-service courses for teachers in 1971. In 1973, a one-year part-time course, the Diploma in Computers in Education was initiated by Trinity College, Dublin. This course was replaced for one year (1977/78) by a part-time M.Sc. course, which was completed by a small number of teachers.

Teacher Education: Dublin City University (DCU) has taken up the role of educating teachers in the computing area. Through it's Centre for Teaching Computing (CTC), DCU offers an M.Sc. in Computer Applications for Education, which is a two-year part-time post-experience programme for teachers and a Graduate Diploma in Computer Applications for Education, which is a one-year part-time post-experience programme consisting of the first 7 taught modules of the M.Sc. programme, and which runs in conjunction with it.

The Future: A future curriculum in computing is in a position to benefit from the most recent developments in technology and methods of education. It can also focus on the current requirements of higher education institutions, on the demands of commercial enterprises in respect to school leavers, and on the expectations of the electronics and software development companies. Collaborative learning techniques have at least two benefits in this scenario; cost effectiveness in an expenditure-conscious environment and proven success as an educational tool. The WISDEN collaborative learning environment is a successful SCSL tool and could possibly have a major contribution to make to the future of computing at secondary level in the Irish education system.

4. The WISDEN Collaborative Learning Environment:

The WISDEN consortium is involved in the production of courseware, which includes modules on structured methods, formal methods, object-oriented methods and real time systems, as well as a Course Management System (CMS) with an embedded Course Constructor.

Pedagogical Approach: The consortium was able to concentrate at an early stage on developing the common approach that had been identified as a project objective. This common approach it was felt would ensure high usage of materials within the consortium and help to achieve good take-up rates generally in the rest of higher education. The consortium agreed that what was needed was material that could easily be tailored and customised to suit local needs. Short lessons of material, thought of as 'bricks', were therefore developed, out of which courses could be built (by academics at user sites). Standards were laid down for these basic building blocks early on in the project by the consortium's standards group.

WISDEN Lessons: These always consist of a series of sections, in a given order, and each section comprises a number of screens. Navigation between screens and sections is prescribed, and there are guidelines for look-and-feel, text, font size, colours and the use of hot words, etc. A topic is a collection of one or more lessons and a course is a collection of one or more topics. What lessons constitute a topic, or what topics make up a course, is really down to academics to decide at user sites, although helpful suggestions will usually be found in the courseware. Lessons are also developed taking into account well-known learning theories and the learning approach adopted by the consortium has been the Universal Picture, Definitions, Rules, Illustrations and Problems (UDRIP) approach.

The Collaborative Learning Environment of WISDEN: There are two components which make up the CLE; a Course Management System (CMS) designed to facilitate the management and provision of computer-based learning materials to the desktop, and a group working environment in which to embed and run the learning materials.

The Course Management System (CMS): The CMS functionality is as follows:

- to allow a tutor to create an on-line course - or indeed any piece of learning material - made up from a variety of learning resources
- to enable the tutor to use resources such as simple text, word processed documents, images, sound files, video files, interactive CAL material, or Web pages for this purpose
- to enable students to access the courses and learning materials created by tutors

- to provide structured and secure management of courses and learning materials

The *course viewer* allows students to view courses relevant to their programmes of study.

Issues of Good Practice: With respect to issues of good practice regarding quality and take-up of materials produced, the consortium has identified the following as being important:

- standard authoring packages have been used (Authorware and Toolbook), allowing easy modification of source code if needed
- bespoke courses, incorporating both WISDEN and other materials, can be created at user sites, thus helping to combat the 'not-invented-here' syndrome
- courseware has been developed with a commonality of approach, to agreed standards, using well-known learning theories
- materials have been authored on both PCs and Macs; advances in technology should soon allow all courseware to be delivered on either platform to meet the future needs of all computing departments.

5. Experiment with Software Engineering Resources:

This experiment involved the use of the CAL modules in the Formal Methods section of the WISDEN courseware. Having perused the courseware, this material was chosen as it was deemed to be the most suitable material for the subjects of the experiment. The users were secondary school students of fifteen or sixteen years of age. Circumstances dictated that all were boys.

Objectives of Experiment: Our objectives in performing this experiment are twofold. Firstly we want to assess the suitability of the material for the target users. Secondly, we want to see if the working environment could constitute a suitable framework for the presentation of topics in computing to students of this age group.

Set-up of Experiment: The students were divided into groups of four, which were chosen at random. The group size of four was based on the fact that only three machines of adequate and similar specification running Windows 95 were available, although there is evidence to suggest that groups of size three or four may be the most suitable in any case. The students were give all the time they needed to become familiar with the software, and were encouraged to take the full ninety minutes (less start-up time) on each of the three Formal Methods courseware modules i.e. Sets in Z, Relations in Z, and Sequences in Z.

Conduct of Experiment: The experiment consisted of approximately six hours working with the material, spread over four days. The author observed at all times, and took notes on these observations.

The Questionnaire: According to Barker & King (1993), the evaluation of learning design in interactive courseware can involve a range of different dimensions of interest. In the Barker & King approach to evaluation, it was decided to use a category-based method, with just a few basic categories of evaluation. A list of 12 basic categories was drawn up. Our questionnaire is based on these categories, which embody the essential principles of good learning design, using the novice level format of the questions. The questionnaire focused on

the overall exercise, and did not request a view on the material in individual modules. Whereas each of the recommended categories was included, some questions within categories were omitted or altered slightly to provide yes/no answers. For example, questions involving the use of sound were not relevant, and the language used in other questions was not suitable for the participants. The questions involved were based on engagement, interactivity, tailorability, appropriateness of multimedia mix, quality of interaction, mode and style of interaction, quality of end-user interfaces, learning styles monitoring and assessment techniques, built-in intelligence, suitability for single user/group/distributed use and outstanding strengths and weaknesses.

The Course Management System (CMS): The CMS is a system that allows learning resources such as digital video, sound, animations, text, lecture notes, computer-based tests, Web pages, in fact any PC executable files, to be managed and "glued" together into courses. To begin with, the teacher collects together all learning resources. Some may have been personally produced, such as text documents for lecture notes, or some kind of video demonstration. Alternatively, material may have been obtained from colleagues, from libraries, from CD-ROMs or from the Internet. All this material needs to be placed in a file system. TheCMS consists of the following components:

- **The Resource Database:** Because the standard file system is rather limited with respect to the information it can provide on the files stored within it, the CMS uses an integrated database to keep further details such as who owns the file, who was the original author, what subject area it is in, etc. These details are very useful later when one starts building courses. All resources or bricks of material must be registered in a Resource Database, of which there may be more than one. Each record in the Resource Database contains fields for location, name, author, subject and optional comments.

- **The User Tool:** The CMS is designed to be able to access different resource databases, and is also designed for multiple users. So before creating or viewing courses, the system must know who the user is, and what resource database to use. The user tool is used for this purpose, and has a simple dialogue, with a field for user name and one for database name.

- **The Admin. Tool:** At the present time, it is not possible to simply type in the name for a new author or subject when new resources are being put into a database. New author and subject names have to be registered in a separate operation using the Admin. Tool. This seems unnecessarily cumbersome, but once located, the tool is extremely easy to use.

- **The Course Viewer:** This is the tool which is used to view courses that are developed in WISDEN. It is a cut-down version of the course constructor for student use. It allows browsing and use of the course material, but it does not allow editing. It is not supplied with the CD-ROM, but can be downloaded from the WISDEN Web site.

- **The Course Constructor:** A course is constructed by registering resources into the resource database, and then building the course using these resources. The Course Constructor is the tool used for performing these tasks. The Course Constructor tool offers a comprehensive graphical editor giving the teacher control over how to present the various resources that make up a course. The WISDEN course management system comes with a comprehensive tutorial which guides course constructors through the steps

involved in the construction of a course. Extensive use was made of this tutorial to construct a course for evaluation purposes. A description of this process is not presented here, but can be found in Morris & Steele (1995).

Observations on the Experiment: From the author's observation, none of the students seemed to have any difficulty loading and operating the system. The inexperience of the students in collaborative learning soon became obvious, as basic indiscipline came into play. The students had to be advised to share usage of input devices. Rushing into things was another reflection of inexperience, as was over-eagerness to impose their views on the part of some of the students. Contrary to how some of the results panned out, the students seemed to collaborate far more effectively than they suggested themselves in their answers. The author fears on reflection that, although the material was new to the students, the level may have been too basic to encourage co-operation and collaboration. There did not seem to be much need to question and discuss.

The Experiences of Others: The WISDEN environment underwent a long process of development, with changes being made on an ongoing basis in response to ongoing critical evaluations. According to Norcliffe (1996a), all of the courseware produced to date has been reviewed, albeit informally, for academic respectability by staff external to the project at consortium sites. The feedback has been positive and comments received have been taken on board. Informal feedback from academics on the quality of materials produced, obtained at workshops and conferences where the courseware has been demonstrated, has also been positive.

Feedback from student trials has been obtained in a variety of ways. Tailored questionnaires, based on the Barker & King approach, have been used to obtain feedback on lessons at most sites; at Sheffield Hallam, general comments on using Computer Based Learning (CBL) were obtained from students who presented reports that were formally assessed.

From the above surveys, features of CBL materials which students regard as important are interactivity, clear guidance on how to use the material, regular testing of understanding, and the need for feedback when the answers to questions are incorrect. Overwhelmingly, it seems that students regard CBL as fun and would wish it to be available as an additional learning resource. They would not, however, wish it to be used as a total replacement for lecturer contact. Students regard CBL/CAL as an excellent resource for revision purposes.

The Future of the WISDEN Project: According to Norcliffe (1996b), support will be available via the project's Web site. Informal help on using the courseware and software will be given on the telephone or by e-mail as a matter of course from the relevant academic sites. The long term aim will be to set up a user network where good practice in using the project's products can be aired and shared, and where feedback received can be used in the design and delivery of later versions. Plans for the commercial phase of the project also include the provision of training courses on how best to use the project's courseware and course management system.

6. Conclusions:

As we attempt to draw some conclusions from our deliberations, we must keep in mind that our experiments were never intended to be subjected to rigorous statistical analysis. The time-scale for this dissertation did not allow for the setting up of tests that would satisfy the pre-conditions necessary for such treatment of results. We are also at times somewhat constrained due to the lack of a modern syllabus in computing.

Collaborative Learning: Many researchers consider collaboration as the most natural form of learning. We mentioned some benefits of collaborative learning in general, such as Gokhale's enhancement of critical thinking skills (Gokhale, 1995)and Doob's promotion of co-operative spirit. Johnson & Johnson (1986) discovered achievement at higher levels of thought and retention of information, and Totten et al. (1991) emphasised the opportunity to engage in discussion and take responsibility for one's own learning. All of these attributes should make a positive contribution to the education of young people, and give them transferable skills which will be with them for life.

Installation and Support: Whereas the installation process is unnecessarily cumbersome, it should not taken as a major drawback to the use of the WISDEN environment. However, there seems no reason why the installation process can not be remodelled, making for seamless integration into most computer systems. In terms of support, the User Guide gives comprehensive instructions in relation to software installation. However, the claims of support through e-mail, Web site and user club never materialised for the author, who tried unsuccessfully to make contact over a long period of time using e-mail, Web search and fax. This scenario would not instil confidence in obtaining support by users of the system.

The Courseware Experiment: The student experiment was an attempt to gain information on how acceptable the design of the chosen modules might be for the age group concerned. In the overall context, the design approach seemed very favourable to the majority of the students. The level of the material was deemed suitable, and most students were happy with the performance of the courseware in relation to usability, enjoyment, maintaining interest and challenge. The dissatisfaction with the level of help is something which could be overcome, and could be explained by the fact that the age group concerned were not the target group in the original design.

Many students reported problems with setting levels at which to work, which would have to be considered a serious drawback to successful learning. Furthermore, these comments were in relation to material from what the author considered to be the less complex modules of the courseware on offer. A majority of students reported that the software did not encourage or facilitate co-operative learning. However, this is at variance with the author's observations in the course of the experiment, where collaboration was present, albeit in a somewhat unstructured way. Also since the level of the material seemed easily handled by the individual students in any case, perhaps one should not dismiss this benefit without further study.

The Course Constructor/Course Management System: Despite the complexity of installation, this is an area where the WISDEN environment could be very suitable for use in the development of courses. The design of the system allows the drawing together of such diverse resources as text files, video clips, bitmaps, sound files, etc. and facilitating the amalgamation of these into bespoke courses that can then be provided for student use under

the Course Management System (CMS). Resources can be drawn from such sources as local hard disks and network servers to the Internet. The emphasis on network facilities in it's design will give it great versatility in relation to implementing the WISDEN environment in a large range of locations. However, the design of a more user-friendly interface is something which should be considered if the system is to make an instant impact on the average user. Some of the drawbacks can be considered nothing more than minor irritations in such a powerful course construction facility. Perhaps some simplification of the course construction process and the resource registration system could be considered.

If an initiative was taken by the Irish Government in relation to courseware development for a syllabus in computing using WISDEN, a large range of resources for teachers could be built up very quickly. However, such an initiative would have to be accompanied by training courses, given the lack of tradition in this country in relation to the development of sophisticeted educational software by teachers.

The Different Learning Environments: The WISDEN collaborative learning environment was developed for the higher education sector, whereas we are investigating it's use in the secondary sector. Issues here involve course content, level of difficulty, age, intellectual maturity and the ability of students to apply themselves in an environment which would be new to them.

Although formal assessment has not been possible, it is the author's view that most of the WISDEN courseware would be unsuitable in content for courses in secondary school, but that new courseware could easily and quickly be developed. Collaborative learning is being practised by students of all ages and in many disciplines, and there is no reason to suggest that students cannot adapt to it in our context. Indeed, a new approach could be a breath of fresh air for students, who may take to it in a manner we might least expect.

Summary: The success of collaborative learning techniques and computer support have been illustrated by reference to the work of Gokhale, Doob, Johnson & Johnson Tollen *et al*. and Pea (1994). The use of the WISDEN environment has produced major savings where it has been used in U. K. higher education (Norcliffe, 1996a), and could be an effective approach in the Irish system, where lack of financial resources is commonly cited as a problem.

The subject matter of the WISDEN courseware may not be suitable for the secondary sector, but the degree of difficulty of some of the material was not a problem. The sophistication of the Course Constructor would make it possible to construct suitable courses fairly quickly in any subject, and the Course Management System would be an ideal environment for the creation and management of courses, given some improvement to the user interface.

All of the above considerations make the use of collaborative learning and some course creation and management system worthy of further study. The author's reservations centre around the real level of commitment which the producers of WISDEN have in relation to the future of the project itself.

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