EFFECTIVE INTERACTION OR A MAZE OF CONFUSION? – PROBLEM SOLVING IN A MULTIMEDIA ENVIRONMENT

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ABSTRACT

In this preliminary study, the problem solving ability of young adult learners was examined. The problems investigated by novice learners reflected environmental situations associated with river catchment systems simulated through the multimedia CD-ROM product, Exploring the Nardoo. Each of the problems required collection and analysis of data to generate a solution. Thirty Year 8 science students from a comprehensive coeducational city high school were surveyed on their attitudes, opinions and understanding after determining a possible solution to their assigned problem.

Assessment of the written responses of students in this group indicated their perception of a 'correct' answer varied considerably. This is possibly a reflection of the varying views students hold about the problem solving process. Most pairs of students reported they had no difficulty in developing a solution and had clearly understood from the problem statement what they were to do. However from a problem solving perspective their answers did not support this view.

All students exhibited a positive attitude towards the learning environment and were actively engaged throughout the time allocated to the assigned task. The outcomes of this study will have real application at the tertiary level.

KEY WORDS

Interactive multimedia, problem solving.

1. INTRODUCTION

Interactive multimedia technology, using a CD ROM delivery system, has become more common in recent years in an educational setting as a stimulus for both teaching and learning, not only at the K-12 level, but also throughout the tertiary sector (Alexander et al, 1998).

Many of these resources have been developed as an 'interactive' module but in reality are still based on a' textbook' styled approach where the user(s) can read and reflect on a substantial amount of text-based material with supporting video and sound resources as added stimulus. The text material can often be downloaded for further editing or printed directly from the CD and submitted as the student's 'own' work. Other resources have been developed using a constructivist view of learning and have endeavoured to provide the user(s) with a number of problems to solve using the technology to provide stimulus material, in context with the problem setting, to encourage the development of problem solving skills.

In recent years a major growth in the development and application of interactive multimedia resources for learning has occurred through changes in information technology. This technology has the potential to provide a learning environment that allows the user to collect, organise and interpret information in developing their individual pattern of learning. Development of such products, based on sound educational theory, has the potential to enhance 'higher order' thinking skills under the overall banner of 'problem based learning'.

In this context, problem based learning refers to the range of strategies that students use to discover, process and reflect upon information in an effort to provide a response to a given problem. Relevant discussion from a range of contributors to the concept of problem based learning may be found in Boud & Feletti, (1991) and Moses & Trigwell, (1993).

However, the development of higher order thinking skills is a complex process, which is currently the subject of much research and theorising. Constructs such as 'active' and 'inert' knowledge, learner scaffolding and metacognition are frameworks on which these ideas are being developed.

In an effort to develop an understanding of the nature of successful problem solving for children, researchers over a number of years have tended to compare the performances of 'novices' and 'experts'. However, it may be more important to examine more closely children's views of problem solving and the 'theories and actions' they employ in their investigations (Hannifin & Land, 1997).

This paper will report on the initial results of an ongoing study that is being undertaking to examine student perceptions of the problem solving process and the strategies they employ in moving from novice learners to expert practitioners when using an ecology based CD-ROM, *Exploring the Nardoo*, developed by the University of Wollongong Interactive Multimedia Learning Laboratory.

2. A RESEARCH AGENDA

In order to develop an understanding of the students experiences and skill development associated with solving problems in a simulated environment, a series of research questions were developed as the focus of the study. The key questions were:

- What understanding do children have of the problem solving process?
- What strategies do students use in problem solving within an interactive multimedia environment?
- How do 'expert' problem solvers compare with 'novice' problem solvers working in an interactive multimedia environment?
- What strategies do 'novice' and 'expert' problem solvers use in a multimedia environment?
- Are their differences in understanding of the problem solving process between 'expert' and 'novice' learners when completing a specific task?

This initial study will attempt to address the early stages of student problem solving. Analysis of the student survey data will attempt to address the following questions:

- How did students identify the problem(s)?
- How did students solve the assigned problem(s)?
- How did students decide what information would help solve the problem(s)?
- What steps were used in the problem solving process?

3. PROBLEM BASED LEARNING

Analysis of National curricula reflects the importance of problem solving as an essential component of a student's learning experience. In NSW, for example, current Board syllabuses, across a range of subject areas, emphasise student acquisition of process skills and attitudes that will allow them to cope with the rapid expansion of knowledge and technological change in today's society.

Problem based learning is generally considered to be a student-centred, inquiry and/or discovery-based strategy which challenges students to become active participants in the learning process. This process is usually encouraged through group work with the teacher acting as a facilitator or mentor in the learning process. However, the extent to which this challenge is being taken up by students in the conventional classroom setting is very much dependent upon the enthusiasm and knowledge of the instructor. Historically, for effective learning to take place,

> "...the accepted model for instruction was based on the hidden assumption that knowledge can be transferred intact from the mind of the teacher to the mind of the learner" (Bodner,1986,).

In recognising that effective teaching is not necessarily related to effective learning. Bodner goes on to suggest,

> "teaching and learning are not synonymous; we can teach, and teach well, without having the students learn"

If teachers are to assist students in the acquisition of process skills through problem based learning then they need to provide students with the opportunities to experience 'real world' scenarios that challenge and extend their thinking ability. Teachers need to provide a framework to encourage initiative and refine strategies and skills, together with a development of adequate background knowledge, in guiding students towards constructing a solution(s) to the assigned task.

Problem based learning in science involves the development of skills which enable the student to identify problems, form hypotheses, search for and collate information through observation and measurement, interpret and analyse data, and propose a solution. In a sense, the concept of problem solving through a student inquiry approach has strong association with the related developments in the ideas of 'constructivism'. According to this emerging theory, students need to construct their own understanding of each scientific concept presented to them. The understanding that the student develops in any learning situation is influenced by his or her own prior knowledge and experience or belief structure. The student has the responsibility for her/his own learning and the acquisition of knowledge involves construction of meaning from the stimulus material presented and is part of a continuous active process. Once constructed the knowledge is evaluated and either accepted or rejected by the learner thus becoming part of their belief structure.

Within this framework, the primary role of teaching is not in the transfer of knowledge through lecture or explanation, but in the creation of a series of situations that will enable students to cultivate understanding. This understanding will occur through developing the necessary mental constructions in a metacognitive approach to the learning process.

In promoting the development of students, strategies which focus on a problem solving approach, include:

- developing student self-esteem and confidence through greater involvement in the learning process;
- encouraging student centred lessons involving cooperation and communication between group members;
- providing opportunities for student creativity, initiative and persistence; and
- presenting students with challenges that develop new skills.

In a discussion on problem based learning and its links with constructivism Duffy & Cunningham (1996) suggest a series of strategies in the use of problems for learning, including:

> " The problem becomes a vehicle for training thinking skills . . .
> The goal is to develop thinking skills, not only to solve the problem."
> (p.191)

and

> ". . . the focus is on developing skills related to solving the problem as well as other problems like it . . . the skills are developed through working on the problem i.e. authentic activity." (p.191)

As discussed earlier, the steps in the problem solving process involve skills that can be identified and developed in all students. Some of these are quite simple manipulative skills but others involve complex thinking abilities. Teaching the problem solving process requires that the instructor has knowledge of the problem solving abilities that students bring to the classroom and further can develop these skills to the benefit of the student.

4. EXPERT/NOVICE PROBLEM SOLVERS

In an effort to develop an understanding of the nature of successful problem solving, researchers have concentrated their efforts on the comparison of the performances between 'expert' and 'novice' problem solvers. In several subject specific areas, physics (Chi, et al, 1981, Ross & Loftin 1994), chemistry (Comacho & Good, 1989, Altwater & Alick, 1990), and genetics, (Smith & Good 1984), studies were confined to observed differences in cognitive structures between expert/novices in well-structured problem domains. The general theme throughout these discussions is summarised by Smith and Good (1994) in suggesting that differences in the approach to problem solving arise from a number of factors:

- experts within a given domain tend to apply principles from their existing knowledge as part of a well defined method of approach. Novices have a less defined and fragmentary approach;
- experts and novices have different perceptions of the same problem;
- experts tend to spend some initial time analysing and defining the problem – novices are less inclined to do so; and
- experts use more specific strategies that lead to an appropriate solution – novices use strategies that are more general across a range of problems.

5. INITIAL STUDY: SITE AND PARTICIPANTS

To investigate the nature of students understanding of problem solving in multimedia learning environments, an initial study involved a group of twenty eight Year 8 students, all volunteers, from Keira Technology High school was carried out. The students were a designated 'technology' class and had been using computers extensively in their classrooms, across all curriculum areas, for a period of approximately 16 weeks.

The group, consisting of equal numbers of females/males, was asked to work in pairs and given a fifteen-minute instruction on general navigation aspects of the program before being assigned a specific problem to solve. For two weeks prior to this study the class had participated in an interactive Ecogame 'Murder under the Microscope' where students attempt to solve a 'mystery' through a study of catchment and water quality issues. This was the only formal instruction in environmental issues associated with catchment pollution and water management provided to the group. The purpose in administering the study at this time was the associated implication that the environmental problems presented on the CD-ROM had direct relevance to the curriculum being studied.

Each pair of students was assigned one problem to solve. The classroom was arranged so that alternate pairs of students solved a different problem. They were asked to generate a solution to the assigned problem from the data available on the CD-ROM. Minimum guidance was provided throughout the time allocated for problem solving.

The study was conducted in one of the computer rooms at Keira Technology High using Power Macintosh Performa systems (model 5260), each equipped with a four speed CD-ROM drive. All student pairs were allowed two sessions of one-hour duration to develop a solution to their assigned task.

6. DATA COLLECTION PROCEDURES

6.1. PROBLEM SOLVING TOOLS

Exploring the Nardoo incorporates problems that challenge students to become active participants in the learning process. By providing a metaphor(s) relating to the real world, students are encouraged to apply scientific concepts and techniques in new and relevant situations in this ecology-based application, throughout the problem-solving process. In so doing, the learner has the opportunity to become more interested in developing questions, ideas and hypotheses about the learning experiences encountered. As an alternative teaching/ learning strategy in the development of inquiry and problem solving techniques this package incorporates high quality visual materials in the form of graphics, sound, text and motion video together with scientific measuring tools to aid in the construction of understanding through an inquiry approach to problem-solving.

This resource extends the problem solving ability of students by introducing scenarios that encourage greater flexibility from students in their approach to developing a plan to solve the problem(s). Experimentation, lateral thinking, acquisition of stored information, reflection and analysis, or combinations of these processes, are involved in promoting the problem-solving approach and developing students with a higher level of cognitive skill. Problems are presented within the information landscape providing an immediate cognitive link with the metaphor generated at the time. ‘Environmental officers’ within the Water Research Centre inviting the student to assist in finding a solution introduce additional problems. In each of the twelve scenarios of the inland river catchment system, students have the freedom to explore the geographic metaphor and reflect on the information available to them before becoming actively engaged in a specific learning outcome.

Notetaking facilities are provided through the use of a multimedia notebook, the PDA (Personal Digital Assistant). This ‘onscreen’ device allows the user to record data (physical, chemical, biological), write notes, view, listen and collect media information and to reflect on, rework and reorganise the evidence supporting the problem as s(he) proceeds. The PDA also allows the user to navigate through the catchment landscape as well as provide a means to view ‘help’ support provided within the package.

6.2. STUDENT SURVEY

A ten point survey was prepared and submitted to students after they had developed a solution to their assigned problem .Results from this instrument are discussed below.

6.3. STUDENT SOLUTIONS

Each pair of students was allocated one of the following problems to solve:

Problem 1: Locals ill after swimming in River.

Problem 2: Water Plants and Weeds choking the river.

Each problem had general hints to help in starting the problem solving process. They were then asked to proceed to prepare their solutions with minimum guidance from the supervising teacher. The prepared responses from all participants were printed for further analysis. The author of this paper conducted this quantitative analysis and evaluation for all participants. The degree of success of each group was based on a strategy proposed by Meier (1992) (refer appendix 1).

7. DATA ANALYSIS

7.1. STUDENT SURVEYS

Did you understand what you had to do from the information in the problem statement? Explain.
The majority of groups thought they clearly understood what they had to do from each of the problem statements provided with the two problems. Two groups were unsure and asked for additional clarification of the statement before proceeding

Did you find it difficult to develop a 'solution' to your assigned problem? Explain . . .
In solving problem 1 four groups commented that they did not find it difficult while three groups reported difficulty as they 'could not find anything that led us to the source of the problem'

With problem 2, three groups had no difficulty while the others reported some difficulty due to the number of 'possible solutions' they had found in exploring the issues.

How did you and your partner develop a solution to the problem?
All participants expressed views that indicated some degree of problem solving ability. Comments such as 'thought about and developed a solution', 'gathered information and developed a solution'; 'listened to people and brainstormed', 'looked around, gathered data, took notes and samples, asked guides', ' researched the information and put the clues together' were used.

What information did you find to help you with the solution?
In each problem answers were varied and somewhat vague. Some responses seem to reflect a misinterpretation of the question. Others commented on different sections of embedded information they had found.

Where did you find your information, exploring the environment or from the Water Resources centre?
In both problems the majority of responses indicated they used both sources for information. Four groups only used the WRC while another two groups developed their solution to the problem from within the environment.

Did you use the advice provided by the guides in the WRC?
In both problems, five groups replied in the affirmative, although the written responses from the groups did not support this.

Do you feel comfortable in solving this type of problem using a CD-ROM?
All groups replied in the affirmative.

What part(s) of the CD-ROM did you enjoy the most?
Two groups preferred using the simulation for water use even though this had little bearing on the possible solution to the assigned problem. Five groups reported they enjoyed the video/ radio clips on the various people's views within the assigned problem. The remaining groups comments included: 'the reality of it all'; 'the graphics'; and ease of use.

What have you learnt from solving environmental problems using a CD ROM multimedia environment?
A range of views were expressed here, some students reflecting on environmental problems others commenting on the general theme was that it was 'fun' learning with computers.

7.2. STUDENT SOLUTIONS

All students exhibited positive attitudes towards working in an interactive multimedia environment. The majority of students appeared to be competent users of the technology, however, from brief general observations it appeared that there was a range of problem solving skills within the overall group in terms of defining the problem and developing a plan of action. Little evidence of re-checking or detailed analysis of the problem was observed.

From the survey analysis, students felt they had identified the problem through the problem statement but this did not seem to be reflected in their solutions. Students generally considered they had solved the problem assigned, this ‘success’ possibly due to the comfort they felt in having control over the learning experience. In a simplistic sense their answers provided a single ‘solution’ to solve the problem without any thought to what implications their ‘solution’ would have on other users of the catchment system.

From direct observation each pair of students seemed to explore the metaphor(s) for information and spent their time accessing the media information available. There was little evidence of notetaking during or after students had accessed each piece of information as if they were all mentally absorbing the details of the information presented.

In the responses to Problem 1, student answers showed varying degrees of development. Responses were generally incomplete in that supporting evidence has been omitted (or had not been accessed by the students to help them with their data collection). The solutions to the problem indicated a lack of understanding of the problem and lacked clarity in the presentation of arguments to support the solution(s). The answers submitted illustrated a somewhat simplistic view in that students proposed a single remedy to the environmental problem under investigation with little recognition of the possible consequences to other river users. One pair of students accessed many of the supporting articles (four from seven) from within the catchment as well as information from the Water Resources Centre. This pair of students then attempted to develop a solution through some analysis but their response lacked clarity in the presentation.

Table 1 illustrates the general level of success for students assigned to solving the first problem:

Table 1

Problem 1 Results

Student Pairs	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Degree of Success
1				•				unsuccessful
2				•				unsuccessful
3			•					successful
4				•				unsuccessful
5								unsuccessful
6				•				unsuccessful
7				•				unsuccessful

With Problem 2, students demonstrated similar lack of understanding of the problem with associated shortcomings in their answers. Again several groups (four) indicated a somewhat simplistic view in their proposed solution to the problem assigned. From their answers two pairs of students demonstrated some analysis and interpretation of their collected data although their answers also lacked clarity in their ideas. Two pairs of students, one from each group of problem solvers, had some difficulties in recovering saved files from their computer for printing. These students have not been included in the analysis of data in Table 2.

Table 2

Problem 2 Results

Student Pairs	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Degree of Success
1			•					successful
2				•				unsuccessful
3				•				unsuccessful
4			•					successful
5						•		unsuccessful
6								unsuccessful
7				•				unsuccessful

8. DISCUSSION OF RESULTS

In interpreting the results of this study the following limitations should be noted:

- Little preliminary investigation had been done to evaluate the problem solving ability of students.
- No specific guidelines were given as to the amount of data collection that was required.
- Some students remarked on having insufficient time to fully investigate the environment before preparing a solution to their problem.
- Direct observation of students in checking their problem solving processes was limited as there was only one supervisor acting as a facilitator.
- No ‘tracking’ facilities were used to determine what data had been accessed by the investigating pairs of students. Therefore evaluation was based solely on what students had printed out and submitted for assessment.

Assessment of the written responses of students in this group indicated their perception of a ‘correct’ answer varies considerably. This is possibly a reflection of the varying ways in which students make decisions so as to match their own individual learning patterns. Most pairs of students reported they had no difficulty in developing a solution and had clearly understood from the problem statement what they were to do. However their general answers did not support this view.

As this was a preliminary study, more information needs to be collected and collated on the problem solving ability of novice learners in a multimedia environment. In the domain of environmental education I believe that if students are instructed in the general techniques of problem solving strategies then they will achieve at a level more in line with those of the designated ‘expert’ problem solver. I now propose to review the answers submitted with the class group in an effort to develop their problem solving ability. Through class discussion this will provide the students with the opportunity to reflect upon their solutions and reinforce their problem solving ability. Students will also be given opportunities for further practise on other illstructured problems in developing their skills.

It would seem that for the group studied there was no ‘maze of confusion’ in terms of exploring the metaphor(s) within the multimedia environment and in the students’ self assessment of their own success in solving the assigned problem(s). However, whether or not there has been ‘effective interaction’ is still open for further investigation.

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10. APPENDIX 1

Evaluation of problem solving processes

Level 1
The solution is 'complete' and provides a clear and accurate explanation of possible solution(s) to the problem. It includes references to supporting media, identifies relevant information and clearly communicates/presents the evidence to support their argument in a logical and coherent manner.

Level 2
The response is fairly complete and includes a reasonably clear understanding and possible solution to the problem. Arguments are presented, together with supporting evidence but ideas are not as clearly expressed as in level 1.

Level 3
The response is satisfactory but is lacking in supporting evidence and lacks clarity in the presentation of ideas.

Level 4
The response is incomplete in that supporting evidence has been omitted. The answer does not show full understanding of the problem or lacks clarity in presentation of arguments to support possible solution(s).

Level 5
Student attempts problem but cannot analyse/interpret/construct a possible solution. Shows little understanding of the problem solving process.

Level 6
Little attempt at construction of possible solution – lack of evidence to support development of possible solution – little evidence of problem solving skills.

Level 7
No attempt at the development of a possible solution.