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## **A Constructivist Multimedia Learning Environment: Learning Opportunities For Teachers**

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### **Abstract**

This paper describes a professional development program involving the use of a multimedia package to develop teachers' understanding of a constructivist epistemology in science education. The workshops were intended, firstly, to empower teachers to become comfortable in using computers in science classrooms, and secondly, to enable teachers to enhance their understanding of, and ability to use, personal and social constructivist approaches to teaching and learning in the computerised learning environment. Teachers' perceptions of the process of learning with the multimedia program and teachers' reactions were assessed using a new instrument, the Constructivist Multimedia Learning Environment Scale (CMLES).

The results of the study suggest that teachers who have participated as learners in the professional development program can understand the context, problems and issues faced by students in the classroom and therefore are able to better facilitate students' needs and enhance their understanding in this learning environment.

### **Introduction**

The purpose of the study was to investigate the potential of using professional development workshops as a means of engaging teachers in epistemological transformation and subsequently influencing their use of constructivist approaches in their teaching practice. Teachers' epistemology refers to teachers' beliefs in pedagogy, the nature of knowledge and student learning. A constructivist teaching approach concentrates on learners constructing their own understandings, and on social interactions taking place in the classroom. This study focussed on teachers' difficulties in modifying their epistemologies to a more constructivist approach which will influence their classroom practice and, subsequently, help students develop higher-level learning. The literature (eg., Salomon, 1996) suggests that, to overcome these difficulties, teachers need to experience the novel learning environment as learners themselves. I believe that as teachers become proficient in the use of the multimedia they can enhance students' more effectively learning using this tool.

#### *Changing Teachers' Epistemology*

Lack of success in changing teachers' epistemologies to a more constructivist approach (Tobin, 1993) led to the design of the teachers' workshop. Salomon (1996) suggested that, in order for the teacher to be an autonomous, confident, widely knowledgeable professional, and a team player, there is a need for in-depth professional

training for teachers. Studies which have investigated constructivist approaches to teaching and learning have substantiated the importance of changing the role of the teacher in the learning process (Hand et al., 1991; Maor & Taylor, 1995; Treagust et al., 1996). Because a constructivist-oriented teaching pedagogy seems appropriate for realising the goals of inquiry-based curricula, the workshop included a focus on teachers' change in epistemology and provided opportunities for learners to reflect on their progress through a software program. This is important for the successful use of computers in promoting problem solving and thinking skills amongst the participant teachers.

#### *The Role of a Constructivist Multimedia Package*

The Interactive Multimedia program used in the professional development is *Birds of Antarctica*, was developed with the cooperation of students and teachers (Maor & Phillips, 1996). The developers were guided by a constructivist view of learning and an intention to create a 'rich' environment for students. Therefore the program was designed to:

- simulate authentic learning environments;
- provide multiple representations of data;
- engage students in a personal construction of 'reality';
- enable the students to generate their own questions and investigations; and
- promote social negotiations between students and provide them with opportunities to reflect upon real-life issues.

Teachers, I believe, need to facilitate the use of the program by building in time for reflection, debriefing sessions and whole-class sharing of ideas and experiences to promote higher-level learning. This aspect of the use of the program was emphasised in the professional development program.

#### *Field of Classroom Environment Research*

In the past three decades, much attention has been given to the development and use of instruments to assess the qualities of the classroom learning environment from the perspective of the student (Fraser, 1998), and one of the many promising applications of these instruments is in the evaluation of learning environments involving the use of computer-assisted learning (e.g., Maor & Fraser, 1996; Newby & Fisher, 1997; Teh & Fraser, 1994).

A classroom environment questionnaire, the *Constructivist Multimedia Learning Environment Survey* (CMLES), was designed for this study. The purpose of this instrument is to assess to what degree students and teachers think that the classroom environment is inquiry-oriented and follows constructivist approaches to learning and teaching. The first part of the CMLES measures students' perceptions of the process of learning with the multimedia program and contains three scales: *Student Negotiation*, derived from the

Constructivist Learning Environment Survey (Taylor, Fraser, & White, 1994) and *Inquiry Learning* and *Reflective Thinking*, derived from the Computer Classroom Environment Inventory (Maor & Fraser, 1996). The second part of the CMLES measures learners' reactions to the Interactive Multimedia program and contains two new scales, *Authenticity* and *Complexity*. There are 25 items in the CMLES, with five items in each scale of the instrument. A description of these scales, together with a sample item from each scale, is given in Table 1.

The CMLES exists in two versions, an 'actual' version, in which respondents are asked to rate their current learning environment, and a 'preferred' version, in which respondents rate their preferred learning environment.

The questionnaire was developed to provide a new, widely-applicable instrument for use in future studies of constructivist multimedia learning environments. In this study, it was designed to focus on the use of the computer in the science classroom. The questionnaire results also provide a skeleton on which to build further analysis of qualitative data. This analysis of the learning environment was drawn from teacher interviews during the workshop and consequently during the action research activities. This was done to monitor the extent to which teachers adopt and support constructivist and inquiry-based approaches in the science classroom when using the interactive multimedia program.

Table 1. Descriptive information and a sample item for each scale of the CMLES

Scale name	Description	Sample item
Student Negotiation	Extent to which students have opportunities to discuss their questions and their solutions to questions.	In this class, I get the chance to talk to other students.
Inquiry Learning	Extent to which students are encouraged to engage in inquiry learning.	In this class, I find out answers to question by investigation.
Reflective Thinking	Extent to which students have opportunities to reflect on their own learning and thinking.	In this class, I think about how I learn.
Authenticity	Extent to which the information in the program is authentic and representative of real life situations.	Working with this IMM program, I find that I am presented with realistic tasks.
Complexity	Extent to which the program is complex and represents data in a variety of ways.	Working with this IMM program, I find it easy to navigate.

## Research Procedure

### *The Teachers' Workshop*

A series of workshops was conducted with secondary school science teachers. The workshops were designed to guide teachers in the use of the computer program and to promote a constructivist approach to teaching and learning when using the program. Following the workshops, a classroom-based study investigated the development of students' higher-level thinking skills. Throughout the classroom-based study, workshop teachers were expected to use constructivist approaches to learning.

The aim of the workshop was to let participating teachers experience the interactive multimedia as learners. In the action research component, the teachers had to act as teacher-researchers. This distinction between teachers as learners and teachers as researchers also provided a framework to analyse data collected during the workshop.

During the workshop sessions the participants used the curriculum material to help them to navigate through the multimedia program. While the teachers were using the program they examined it for its usefulness and its applicability to their classroom teaching. Their interaction with the program also provided feedback for the developers for further improvement of the software. The workshop consisted of three separate, three-hour sessions conducted over a period of three weeks, with one session per week. Teachers came to the University computer laboratory after completing their normal school day. Ten teachers participated in the workshop. As a result of the workshop, two teachers implemented the program in their science classroom which enabled the research to be extended into their science classrooms.

In the study reported in this paper, the following specific research questions were investigated:

1. What are teachers' reactions to, and perceptions of, the new multimedia learning environment as experienced in the constructivist multimedia workshop?
2. To what extent did the workshop influence the teachers' role in their classrooms?

Four major data sources were used to answer the research questions:

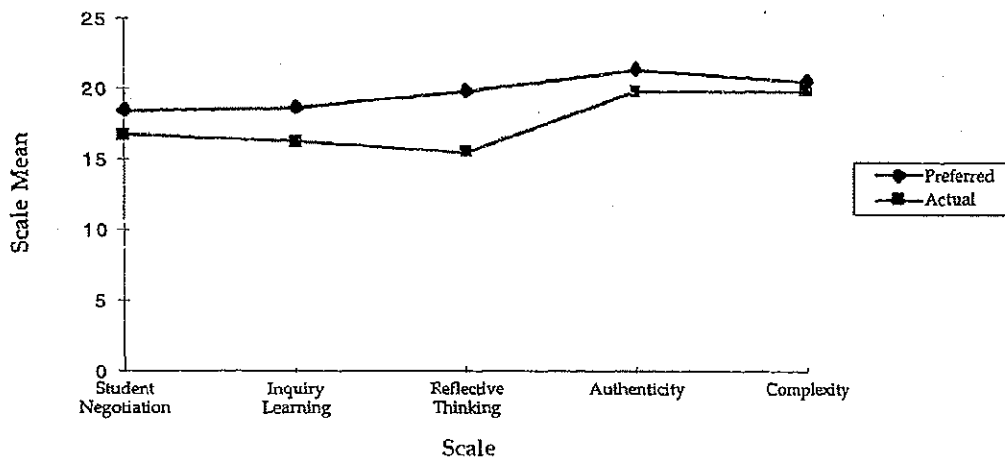
- Teachers' responses to actual and preferred learning environment questionnaires;
- Audio recording of workshop discussions;
- An analysis of a video recording made during the 'hands on' sessions with the interactive multimedia; and
- Interviews with participant teachers.

## Results

### *Teachers' Perceptions of the Constructivist Multimedia Learning Environment*

To identify teachers' perceptions of the constructivist multimedia learning environment during the workshop, actual and preferred forms of the CMLES were administered to the ten teachers who participated in the workshop. Teachers were asked to respond to the questionnaires as learners in a new situation, namely, in a constructivist multimedia learning environment.

Following the administration of the questionnaires during the workshop, individual teacher scores were collated and displayed on an overhead projector for analysis and discussion by the teachers. The mean scores were calculated for each scale of both actual and preferred versions of the CMLES. Because teachers responded to items on a five-point scale, and there are five items in each scale, the maximum score for each scale is 25. To facilitate comparison between teachers' actual and preferred perceptions, the mean scores for each scale of both actual and preferred versions of the CMLES are presented graphically in Figure 1.



*Figure 1.* Scale Means for Actual and Preferred Versions of the CMLES

The data presented in Figure 1 indicate that, in comparison with the actual environment, teachers prefer an environment with higher levels of Negotiation, Inquiry Learning, Reflective Thinking, and to a less extent, Authenticity and Complexity.

The greatest discrepancy between teachers' actual and preferred perceptions is seen to exist in the Reflective Thinking scale, a measure of the extent to which the teachers as learners perceived opportunities to reflect on their own learning and thinking. Discussions

with the teachers indicated that the ability to reflect during the workshop was given different interpretations by individual teachers. Some teachers argued that although they had the opportunity, they were not engaged in reflective thinking as they were trying to learn how to use the program. Others suggested that they engaged in reflective thinking even at the level of learning how to use the program. From this, it was interesting to note that although teachers worked in pairs, there were, in some cases, obvious differences of opinion between teachers grouped together. Comments from teachers indicated that the concept of Reflective Thinking required more clarification:

I think that the differences in the reflective learning are because teachers have different perceptions of what it really means. It's something that we have always done as teachers and probably students do it but it's hard to pinpoint...  
(Teacher workshop, May 97)

It was clear from the data that teachers preferred more opportunities for themselves as learners to discuss their questions during their interactions with the program and to engage in inquiry learning during this time. In relation to the Student Negotiation scale, the teachers' interpretations also varied according to the specific task they were asked to complete. Julie explained:

I did get the chance to talk to other students, I answered it but I know if I wanted to or needed to I could... I knew the opportunity was there to do so even though I answered 5 (out of 25)

However, to a question regarding whether the program encouraged the user to discuss issues that emerged from the program the answer was:

I think it's a different issue because I think there are other factors that cause you to talk and not to talk rather than just the program. There's another factor not being measured. Like being familiar or unfamiliar, some people like to talk more than others and some persons don't like to look to others. They like the opportunity to think (Julie, Teacher Workshop, May 1997).

It is interesting to note from the graph that most of the teachers agreed that the multimedia program should be Complex and Authentic. This reflects the design of the program which attempts to implement constructivist characteristics. Also, this reflects the constructivist nature of the environment which aims to promote students' negotiations, reflective thinking and inquiry learning.

#### *The Multimedia Program: A Qualitative Perspective*

Qualitative data obtained from workshop discussions, extracts from the teacher's journal, and interviews with teachers provided insights into the influence of the workshop on participating teachers. Specifically, the data were gathered from three individuals: Dan, Mark and Julie.

One of the first pedagogical issues that arose, which related to the complexity of the multimedia, was the type of the curriculum material that was used to help the user to navigate through the program. In the first meeting of the workshop the teachers used a Guided Tour which was open-ended and constructivist in nature (Maor & Cooper, 1997a). This style of tour provides little assistance to the user regarding navigation through the program and resulted in some criticism from teachers, as described in Mark's journal:

My initial use of this program was under the direction of an open-ended guided tour. I found this very frustrating and quite frankly a waste of time....The lack of clear explanations as to where and what everything was, made progress very slow and laborious – it simply could not be done in this way with a classroom of average students. (Teacher's Journal, Dec. 97)

Mark further suggested this in his journal writing:

A similar approach in a classroom would result in rejection of the program by students. Only highly motivated and academically talented students could hope to cope with this approach (Teacher's Journal, Dec. 97)

Julie also expressed this notion of frustration and uncertainty in the following way:

I'd like a little bit of guidance to start off with, just to show what's available and not necessarily what to do with it, just what's in there.

A user-friendly program was a necessity according to the teachers. But as suggested by Julie, the program should still be complex to some extent and not too easy for the students.

As a result of the feedback from the teachers I changed the curriculum material to enable the teachers to quickly become familiar with the program and to be able to navigate successfully before being able to engage in higher-level tasks. Although I wanted to introduce the curriculum material in a constructivist way, I realised that I had to find the happy medium in which the user becomes familiar with the multimedia and not discouraged by their first experience.

Dan, in his analysis suggested that the use of the two guided tours, the instructivist and the constructivist, helped him to compare the merits of the two teaching approaches.

### *The Learning Process*

The first data source came from Dan, who is a full time postgraduate student and participated in the workshop to obtain credits for his degree. As part of his assignment he analysed a video recording segment of himself and Mark while they were interacting with the multimedia program during the workshop. His analysis of the video and his self-reflection provided an excellent insight into the hands-on section of the workshop. In particular, he emphasised the benefit of the program to his own professional development.

I believe that the opportunity given to Dan to reflect on his own learning enriched the study and substantiated my interpretations.

Dan's critical self-reflection analysis included his thoughts about working with the program and about working with a partner. He suggested that the cooperation with Mark was a valuable experience enabling him to solve problems in consultation with his partner:

Working cooperatively with a partner throughout the multimedia program Birds of Antarctica was very useful because we could share thoughts and explanations, and we complemented each other at times. Discussion helped us clarify certain things which we could not have done if we worked individually. It gave me a sense of relief, when I reached a dead end on something, Mark would offer a suggestion which led me to see the problem clearer and closer to a solution.

Nevertheless, Dan was also critical of the teamwork. He felt he had to give up some of his individual plans in order to follow the common goal. His self reflection included the following comments:

However, there were times when I felt confined to doing only those things that were of common purpose between us. This meant that some of my insightful thoughts were not pursued further. (Dan, self reflection, Dec. 97)

This paragraph demonstrates Dan's role as a learner in the computerised learning environment. He enjoyed the cooperation but was also aware of the limitations of being in a group situation.

In order to answer Research Question Two, 'To what extent did the workshop influence the teacher's role in the classroom?', I studied two of the teachers who conducted research in their classrooms.

Mark was involved in the workshop and, consequently, conducted an action research project in his classroom. Mark used journal writing to document his reflections from the workshop as well as some impressions from his classroom-based research. His notes and the interview conducted with him were used to provide information regarding the extent to which the workshop influenced his classroom practice. Mark claimed that he was familiar with the principles of constructivism as presented in the workshop, but he found the concept of teacher as researcher very valuable. Mark used six critical questions, suggested in the workshop, to analyse the research conducted in his classroom.

...the use of 'real life' data and data analysis through inquiry learning as proposed by Birds of Antarctica package addresses the issues of relevance, motivation and scientific method. Through the use of such packages I hope I can further move my class towards student centred learning with my role continuing the change from teacher to guide. (Teacher's Journal Dec. 97).



Reflecting on the learning process in his class, Mark was pleased that students were asked to take ownership of their questions, and he suggested that they should do short presentations for the class.

The group work was a great success and highlights the need for more regular use of this style of teaching (Teacher's Journal, Dec. 97).

The group work was greatly encouraged in the workshop, and therefore the project gave the teacher the opportunity:

to take the class into a different style of learning ...it also initiated further discussion within the class room on the nature of learning. (Follow-up Interview)

In a conversation with the teacher he suggested that he would attempt a move towards a more constructivist, student centred approach to learning.

I will also continue to develop an understanding as to the philosophy of learning with my students. (Follow-up Interview)

These excerpts illustrate that the workshop had significant impact on Mark's classroom practice. Although he was critical about the slowness of the program and its robustness, Mark suggested that:

The use of the real data and open ended investigations does however appeal to me as a science teacher (Follow-up interview)

Julie, who participated in the workshop and enabled us to conduct research with her students, provided the third set of data. In Julie's class, a research assistant and I conducted the research and therefore the teacher had a passive role in her class. Although Julie actively engaged herself along with the students in the use of the program, the fact that we carried out our study disempowered her from making decisions or guiding her students. A follow up interview with her enabled me to examine the nature of the program and students' involvement in the process of learning with the multimedia. Julie was willing to participate in this research project because she wanted the science students to use this form of technology, and she wanted something useful "that did not have to end in assessment but which could be used for assessment if desired". She also suggested:

I had been looking for some interactive technology program that was not looking at science content. The process of science could be utilised from the data (Follow-up interview, Dec. 97).

Therefore, the workshop encourages teachers to provide their students with a program which involves inquiry learning. Julie found that this type of learning and teaching process in the class had changed during the two weeks interaction with the program:

students worked with minimal teacher's supervision, they became more motivated, they were able to ask questions or conduct investigations (Follow-up interview, Dec. 97).

During the use of the multimedia program students, as the teachers at the professional development, worked in pairs and enjoyed the opportunity to discuss and help each other to answer questions. This form of learning was not common to them in the science classroom and Julie acknowledged that the students had more opportunities for developing scientific investigation skills and creative thinking than before.

### Summary and Conclusion

The potential of Information Technology to enable students to learn is grossly under utilised in schools. This study, which looked at teacher professional development in terms of developing an understanding of a constructivist epistemology, may be a step towards understanding the problems that are still unsolved in terms of utilising IT in schools. In this particular experiment teachers engaged in a constructivist multimedia learning environment in which they were exposed to the use of the multimedia and the constructivist theory of learning.

Based on the CMLES data gathered during the professional development workshop it is clear that the teachers preferred more opportunities for themselves as learners to negotiate their ideas during their interactions with the computer program and to engage in inquiry learning. They were also given more opportunities to reflect on their own learning and thinking. Teachers became aware of the need to promote critical reflection and discussion among students. This raises the important question as to whether teachers give their students enough opportunities to negotiate with other students, to engage in inquiry learning and to reflect on their own learning.

The teachers' perceived the program to be authentic and complex and this reflected the design of the program and the constructivist nature of the environment. Because of the complexity of the program, a guided tour was necessary to familiarise teachers with the program and help them to navigate through the program. Teachers preferred the instructivist guided tour rather than the constructivist one and the clear instructions enabled them to become familiar with the interface possibilities before they develop inquiry skills in subsequent use of the program.

The personal reflections of the three teachers who were part of a group involved in the workshop suggested that the professional development program was rewarding and useful.

During the professional development program, the teachers experienced as learners the constructivist multimedia learning environment. As a result they:

- became familiar with a constructivist multimedia learning environment;

- understood the context, problems and issues that students face in the classroom; and
- were better able to facilitate students' needs and to enhance their understanding in this learning environment.

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