USING DIGITAL VIDEO TO ENHANCE AUTHENTIC TECHNOLOGY-MEDIATED LEARNING IN SCIENCE CLASSROOMS

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ABSTRACT

Over the past decade, the field of educational technology has endorsed constructivism as a suitable referent for the development and meaningful use of appropriate software in education. Examples in science include the constructivist use of multimedia such as video-based laboratories and student multimedia authoring, microcomputer-based laboratories (MBLs) and microworlds. When used in peer learning environments, students can use representations from these programs as ‘conversational artifacts’ (Pea, 1993), articulating their own views, reflecting on others’ ideas and negotiating shared meanings.

This paper will give an overview of this area before presenting the main findings and future directions emerging from a recent study in this field. The study focussed on two secondary science classes using an interactive multimedia program that incorporated sixteen digital video clips showing difficult, expensive, time-consuming or dangerous demonstrations of mostly real-life, out–of–classroom scenarios. The program used the predict–observe–explain (POE) strategy to structure the students’ engagement with each scenario—the clips acting as stimuli for the sixteen POE tasks. The findings have implications for authentic technology-mediated learning in science classrooms.

KEY WORDS

Digital Video Multimedia Authentic Science Learning Predict–Observe–Explain Strategy

INTRODUCTION

Constructivist learning theory emphasises that learners construct their own knowledge, strongly influenced by what they already know. Social constructivists view learning as an inherently social process, using peer discussions as an opportunity to share alternative viewpoints, to challenge others' ideas and help develop alternative points of view. Over the past decade, the field of educational technology has endorsed constructivism as a suitable referent for the development and meaningful use of appropriate software in education. Examples in science include the constructivist use of multimedia such as video-based laboratories and student multimedia authoring, microcomputer-based laboratories (MBLs) and microworlds. When used in peer learning environments, students can use representations from these programs as 'conversational artifacts' (Pea, 1993), articulating their own views, reflecting on others' ideas and negotiating shared meanings.

The study reported in this paper used constructivism as a theoretical perspective to explore issues relating to the classroom use of multimedia-supported predict–observe–explain tasks. This interpretive study investigated two secondary science classes using an interactive multimedia program that was designed for use in small groups to elicit and promote discussion of students' pre-instructional physics conceptions. Findings indicated that students participated in meaningful collaborative discussions at the computer, while the multimedia nature of the program offered new opportunities that mark a significant development in the use of the predict–observe–explain strategy in science education. Future directions with this line of research should further explore these developments.

CONSTRUCTIVISM AND COMPUTER-MEDIATED LEARNING IN SCIENCE EDUCATION

Background

Jonassen and Reeves (1996) advocated that students learn *with* computers (rather than *from* computers) under a constructivist learning framework. Computers can serve as a catalyst for facilitating constructivist environments if used in ways to promote reflection, discussion and problem-solving. "Technology is best used as a cognitive tool to learn *with* rather than a surrogate teacher. Pedagogy and content matter most; technology and media are only vehicles, albeit powerful ones" (Reeves, 1998, p. 53. Italics inserted). From a social constructivist perspective, students working in groups can construct consensual meaning through discussions and negotiations. This process may involve students articulating their own views, listening to and reflecting on others' ideas, and reflecting on the viability of their own ideas. Students also receive an opportunity to practise the discourse of a given domain in their peer groups.

Computer Representations as 'Conversational Artifacts'

Computer representations such as video clips, graphs, photos, diagrams and animations can act as 'conversational artifacts' (Pea, 1993) for learners, providing them with a focus for meaningful peer discussions: "Technologies may play special roles in augmenting learning conversations by representing dynamic concepts (e.g., light rays) that enable the establishment of common attention to referents or coreference among participants in these conversations" (p. 271). The 'surface features' of these representations (such as colour coding, graph labels, lines in a graph) also can support the students' processes of appropriation, negotiation and convergence towards shared understanding (Kozma, 2000). Indeed, in the domain of science, real scientists use and discuss representations of nature (or 'inscriptions') in their everyday practice of science: "Much of the work of bringing about new scientific knowledge [by practising scientists] happens in conversations about these inscriptions" (Roth, 1996, p. 173). Hence, as these inscriptions make for a large part of the social organisation of science, they are appropriately used as foci for discussion in science classrooms.

Examples from Science Education

In his 1992 Millikan lecture, Robert Fuller emphasised the "ah-ha" experience as common for students who are intrinsically motivated in their learning of science. In his discussion of intrinsic motivation and multimedia use in science education, he discussed aspects of intrinsic motivation such as fantasy, challenge and curiosity (Malone, 1981) and related these to multimedia use. For example, he suggested that the rich visual images and sounds in multimedia can help to create and communicate real-world 'physics stories' as an alternative to the traditional physicists' fantasy world of boring and mundane point particles, fields and frictionless planes! Such uses of multimedia are motivating for students and help them to relate science to the real world (Fuller, 1992). These sentiments provide a fitting summary of the dominant themes in the literature surrounding the constructivist use of software in the science classroom. Such programs use rich world contexts for students to consider, are relevant to the learners' goals and experiences, are interactive and encourage consensual meaning-making in a peer learning environment. Examples from science education include the appropriate use of video-based laboratories, student-authored multimedia, microcomputer-based laboratories, simulations and microworlds.

Video-based laboratories. An important learning outcome in most science courses is for students to learn to observe their own world more carefully. The use of digital video gives teachers and students sophisticated tools to observe dynamic processes and physical phenomena in intricate detail. Our human 'window' into the natural and physical world is limited and much phenomena of interest to the science community exists as scales beyond our temporal, perceptual or experiential limits (Kozma, 2000). However, video can help to expose students to such phenomena and overcome these traditional barriers by showing dangerous, difficult, expensive or time consuming demonstrations not normally possible in the laboratory (Hardwood & McMahon, 1997). For example, video can create the illusion of slowing down or speeding up time either through filming techniques or by using the capabilities of the medium such as using slow motion or toggling whilst viewing the clips. These facilities are particularly useful when considering time-dependant phenomena prevalent in many science episodes. Digital video clips also allow students to observe accurate and reliable replications of demonstrations (Bosco, 1984) and enable students to enjoy a continuous, seamless experience, unlike the experience of live demonstrations that may be given days apart (Hoffer, Radke, & Lord, 1992). Hence, interactive digital video makes possible the detailed observation of interesting laboratory or real life events and is considered an important technology in the area of computer-based learning in science (Weller, 1996). Such real-life scenarios can make science more relevant to the students' lives (Duit & Confrey, 1996; Fuller, 1992; Jonassen & Reeves, 1996), and help students build links between their prior experiences and abstract models and principles (Escalada & Zollman, 1997). The study outlined later in this paper attempted to utilise some of these affordances.

In the case of video-based labs, interactive video presentations are indeed used to make observations, measurements and gather data about events. Computer digital video systems allow students and teachers to capture video of experiments they perform themselves by storing the video on their computer's hard drive. When connected to spreadsheets, students can then use the interactive video clips to efficiently gather data and make graphs and other representations to analyse and model their data. Many studies have shown these video-based laboratories to be motivating and authentic learning experiences for students (Beichner, 1996; Gross, 1998; Laws & Cooney, 1996; Rodrigues, Pearce, & Livett, 2001; Rubin, Bresnahan, & Ducas, 1996). Indeed, Squires (1999) described these video-based laboratories as facilitating a constructivist learning environment by promoting open-ended exploration in an authentic learning environment; this is particularly so when the learner chooses and captures his or her own film clips. Rubin et al. (1996) introduced this notion of learner-shot video in mathematical analysis when students used *CamMotion* to explore a dance sequence and analyse the motion of their own bodies.

Student multimedia authoring. Jonassen, Peck and Wilson (1999) advocated the use of multimedia as an authoring platform for students to represent their own meaning; possibly as part of inter-disciplinary, large scale projects. In making their own multimedia, students improve their self confidence by planning, producing and sharing productions in a cooperative learning environment. Zucchermaglio (1993) (cited in Winn and Snyder, 1996, p. 131) used the metaphor of *empty technologies* to describe this type of authoring software that is flexible, child-centred and acts like ‘shells’ waiting to be filled by anything the student or teacher wishes. Alternatively, traditional software such as tutorial and drill and practice software, were described as *full technologies*, where the program’s content and strategies are pre-determined. An example of a study in this area was made by Beichner (1994). He examined the cognitive and affective impact of multimedia editing tasks carried out by students near a zoo. The study demonstrated the importance of designing curricula that incorporate realistic, highly involving tasks that empower students to create meaningful multimedia products.

Constructivist use of microcomputer-based laboratories. Microcomputer-based laboratories (MBLs) use sensors and probes to make measurements and allow associated data to be displayed (usually as graphical representations) in real-time on a computer. MBLs enable large amounts of data to be collected and allow for too fast or too slow measurements. They can significantly reduce the time gap between measuring and evaluating the data and help gain more flexible opportunities to plan and realise investigations. For example, students can use their own bodies to make motion graphs (Schecker, 1998).

Russell, Lucas, and McRobbie (1999) looked at the use of constructivist microprocessor-based laboratory activities to facilitate student understanding of physics. In this study, the Grade 11 students worked in pairs on seven tasks relating to the subject of Kinematics. In these tasks, the students had to predict the shape of relevant motion graphs before simulating the scenario using the MBL equipment (e.g., motion sensors) and making second-hand observations as they monitored the graphs produced by the MBL equipment. If there was any discrepancy between their predicted graphs and the computer generated graphs, they were required to explain these differences. Analysis of students’ discourse and actions revealed many instances where students negotiated new understandings mediated by the computer activities.

Constructivist use of simulations and microworlds. Simulations make a representation of a part of reality, emulating physical systems and processes and allowing experiments that are normally impossible, dangerous, inaccessible, too slow or too fast. As in video-based laboratories, simulations can be reviewed at any time (Rodrigues, 1997) and aid in visualising abstract concepts: “New technologies, such as computer simulations, can help to make the reasoning of children explicit and help them to visualise the consequences of their thinking as they work individually or in small groups” (Plomp & Voogt, 1995, p. 173). Learners can adjust variables and observe effects as they use the simulations to enhance the inquiry process

(Windschitl, 2000). Indeed, White (1998) advocates the use of this software for student exploration, allowing them to use the same simulation tools that real scientists encounter.

Microworlds could be described as highly complex simulations where users can explore problems, experiment, test, revise and hypothesise (Weller, 1996). They often use images that represent a concept (semantic icons) which can be directly manipulated by the learner on the screen (e.g., by a mouse click or point etc.) They do not aim to represent reality but are imaginary worlds where students can investigate science problems, hypothesise, design, test their ideas and use feedback to reflect on ideas (Plomp & Voogt, 1995).

INTRODUCTION TO STUDY

This study outlined in this paper aimed to build on the literature base of constructivist software use in the science classroom. It involved the investigation of two secondary science classes using an interactive multimedia program that was designed for use in small groups to elicit and promote discussion of students' pre-instructional conceptions on motion. The software was designed and constructed by the author and incorporated sixteen digital video clips, primarily focussing on projectile motion, showing difficult, expensive, time-consuming or dangerous demonstrations of mostly real-life, out–of–classroom scenarios. The program used the predict–observe–explain (POE) strategy to structure the students' engagement with each scenario—the clips acting as stimuli for the sixteen POE tasks. This strategy involves students predicting the outcome of a demonstration and discussing the reasons for their prediction, observing the video-based demonstration and finally explaining any discrepancies between their prediction and observation (White & Gunstone, 1992). The choice and sequence of the video clips, as well as the multiple-choice options available to students in the prediction phase of each task, were informed by alternative conception research and the history of science literature. Kearney and Treagust (2001) make a more extensive report on the design and development of the program.

This interpretive study used constructivism as a theoretical perspective to focus on the personal and social dimensions of students' learning and their perceptions of the learning tool. The study explored three main questions relating to the classroom use of the multimedia-supported POE tasks:

1. To what extent did the computer-mediated POE tasks promote meaningful discussion about students' science ideas?
2. Did the students' engagement with the program effectively elicit their personal science views?
3. What were the perceived affordances and constraints of the computer-mediated environment for the predict–observe–explain strategy?

Students worked in pairs and were required to type full sentence responses that were recorded by the computer for later analysis by the researcher. In addition, the students were required to make pencil and paper drawings during some tasks. Other data sources for this mainly qualitative study included audio and video recordings of student discussions, interviews with selected students and their teachers, classroom observations, and student questionnaires.

FINDINGS AND DISCUSSION

Students participated in meaningful small group discussions at the computer and the program acted as an efficient and convenient teaching instrument to elicit and record their conceptions of motion. The multimedia nature of the program offered fresh and exciting opportunities that mark a new development in the use of the predict–observe–explain strategy in science education.

The Students' Learning Conversations at the Computer

This section of the study addressed research question one and focussed on the students' small group discussions at the computer during their engagement with the POE tasks. A social constructivist perspective was adopted to analyse and synthesise these findings. Claims here were supported by quoted conversations between students that represented critical incidents occurring during the computer sessions. Claims also were supported by data from interviews, survey responses and class observations (refer to Kearney and Treagust (2000) for further details).

Most students participated freely in meaningful discussions about the science related phenomena in each task. They freely articulated their own conceptions as they engaged in the activities and there were many disputes caused by conflicting views between students. Most students listened carefully to their partner's viewpoint and there were many occasions where students showed strong reflection on the viability of these and their own conceptions. For example, there were many reflective pauses during group discussions and students often asked each other thoughtful and relevant questions. A feature of this section of the study was the widespread incidence of non-verbal communicative acts such as student gestures and off-computer 'mini-experiments' instigated by the POE tasks. Another feature was the high frequency of students editing their (written and drawn) responses sometimes up to three or four times! These collaborative activities often augmented the learning discussions and enhanced reflection processes. Indeed, 'inscriptions' (Kozma, 2000) such as photographs, video clips and student drawings served as an appropriate backdrop to these learning conversations. Although there were some cases of genuine shared meaning-making and co-construction of ideas, such in-depth discussions were less frequent probably due to time and science vocabulary constraints.

It must be noted that the positive results reported in this section were relevant to the prediction, reasoning and observation stages only. For various reasons discussed elsewhere (e.g., Kearney & Treagust, 2000), students generally did not conduct rich conversations during the challenging explanation stage of the POE tasks in this study.

The Elicitation of Students' Conceptions

This section of the study addressed research question two and explored the effectiveness of the POE computer tasks as a tool to elicit a variety of student preconceptions. Claims in this section of the study were mainly supported by data from students' written responses and drawings. Responses to teacher surveys and interviews also were used as data.

The two teachers perceived the POE computer-based tasks as providing an efficient and effective way of eliciting students' science views. A large variety of pre-instructional conceptions were revealed through the students' engagement with the program. From both classes, approximately 300 instances were identified where students' views were considered contrary to the established science view. A speculative reason for this success was the visual and social nature of the students' experience with the program. In many cases, these interactions possibly activated real situation-based prior knowledge—although this would need to be verified by further research.

Many of these conceptions emerged from the reasoning and observation stages as well as the prediction stage. Drawings in particular provided a rich source of data, probably because of their open-ended nature. Most views revealed a variety of pre-Newtonian conceptions that were consistent with the literature—medieval impetus and Aristotelian beliefs are 'alive and well' in modern Australian students! For example, the tasks involving projectiles passively released from moving carriers were a major problem and revealed strong impetus beliefs in both classes. The large mass and speed of the car in task 6 provided a particularly 'inviting' task for impetus theorists! The students' frequent use of the terms *momentum*, *energy* and *force* to imply impetus properties also was in agreement with relevant literature.

It must be noted that the students' written responses recorded by the computer (as well as their drawings) represented group responses. Although this could be seen as a limitation in this section of the study, it also represents a benefit when compared with other individual probes that produce a massive amount of data for teachers to process. The computer printouts of students' responses were perceived as useful and manageable by both teachers. Hence, findings from this section revealed the successful use of a collaborative, computer-mediated probe of understanding to effectively and conveniently capture students' pre-instructional conceptions.

Teacher and Student Perceptions of the Multimedia-supported POE Tasks

This final section of the study addressed research question three and explored the perceived affordances and constraints of the computer environment for the POE strategy. These findings have implications for the technology-mediated implementation of the POE strategy in science classes. Indeed, the strong educational technology focus in this section is an attempt to provide some answers to Kozma’s (1994) important question: “In what ways can we use the capabilities of media to influence learning for particular students, tasks and situations?” (p. 16). Three main issues emerged from this section: the learner control of the POE tasks, the use of the digital video medium during the observation phase, and the rich physical settings depicted in the video clips.

Firstly, the computer environment afforded student control of the pacing of the POE tasks and also permitted students to control the presentation of the video-based demonstrations. This extra autonomy facilitated opportunities for students to thoroughly discuss their predictions, reasons and observations and helped elicit conceptions. It also contributed to a high level of ownership of responses.

Secondly, the computer-based digital video clips afforded new opportunities for students in the crucial observation phase of the POE process by providing a refined tool for students to make detailed observations of events, enhancing the quality of feedback on their predictions. Student dyads made clinical and comprehensive observations using the digital video facilities, helping them make mature interpretations of the real world events presented to them and more elaborate articulations of their conceptions. The step-frame, slow-motion and replay facilities were particularly helpful in convincing students of outcomes.

However, despite great care in the development phase of the program, the filming techniques used in some video clips were perceived as constraining factors for the observation of a few demonstrations. Camera angles, panning, zooming and stroboscopic filming techniques were all raised as important issues in a these tasks. For example, the panning and zooming techniques used in Task 7 (Soccer Ball) were perceived as inappropriate as the camera at one stage ‘lost sight’ of the ground – an important frame of reference for the viewer observing the shape of the ball’s trajectory. Also, the stroboscopic technique used in Task 15 (Cart & Ball) led to an observation dilemma when it was discovered that there was no actual evidence of the ball landing back in the cart. When viewed in step-frame mode, it was apparent that the last ‘snapshot’ of the ball was actually just before it reached the cart. Consideration of these filming issues is obviously crucial to the future use of the digital video medium in multimedia-supported POE tasks.

Thirdly, the real-life physical settings depicted in the video clips were interesting and relevant for the students and helped them to feel comfortable and confident in voicing their opinions, particularly in the important prediction phase of the POE process. Both teachers acknowledged the ability of the digital video medium to present (and accurately replicate) unusual or time-consuming demonstrations that would be difficult to set up in a classroom. However, a few task settings created a degree of confusion for some students, providing them with excuses after incorrect predictions. These problems highlighted the importance of teacher facilitation to help students acquaint themselves with these rich task settings before making predictions.

From a constructivist perspective, many of the affordances emerging from this part of the study were a major factor in helping students articulate their views with confidence and initiating some of the rich discussions. The extra learner control and the affordances of the digital video medium gave students unique opportunities to discuss and reflect on rich scenarios and their related personal science conceptions. These affordances also are related to the probe function of the tasks, providing a greater insight into learners' strongly held beliefs. Kearney, Treagust, Yeo and Zadnik (2001) provide a more extensive insight into this section of the study.

FUTURE DIRECTIONS EMERGING FROM STUDY

Further investigations relating to this study should focus on the affordances and constraints of the computer environment for the POE strategy, particularly the use of the digital video medium to present scenarios. Further exploration of learner outcomes associated with these tasks is also needed.

Further Affordances of the Computer Environment for the POE Strategy

Although the computer environment was shown to be most suitable for the POE strategy in this study, there were some technologies that were not considered and could be further investigated. These include the use of a supplementary 'page' in the software to allow students to indicate their level of commitment to their predictions; the use of a drawing or paint program to allow students to create and save their digital drawings and the further innovative use of appropriate multimedia resources.

Dawson and Rowell (1995) discuss a supplementary step in electronic multiple choice items that can give some indication of the level of uncertainty in participants' responses. This effectively involves students going to a separate screen after making their multiple choice prediction and clicking on one of a number of options that indicate a student's level of commitment to their chosen prediction. In the case of POE tasks used in pairs, students could complete this individually to give extra feedback to the teacher by giving some indication of the mutuality of a response. Investigations into the use of this supplementary technology as part of computer-based POE tasks could be most fruitful.

The ability of students to easily edit their predictions and reasons was a crucial part of the program used in this study. Indeed, the student control over the pacing of the POE tasks gave students greater time to make these editions and many critical incidents occurred as students edited their (written and drawn) responses. The open-ended nature of the drawing responses in particular seemed to promote meaningful discussion and a great variety of elicited ideas amongst students in this study. Further affordances of the computer-mediated environment for these purposes need to be explored. For example, the use of ‘e-drawings’ using a paint program may well benefit students’ drawings. Would these electronic drawings still act as meaningful focus for the students’ learning conversation? Would they allow for improved flexibility in the editing of drawings, thereby facilitating quality reflections? Indeed, groupware technologies may be beneficial for these e-drawings. For example, students could use multiple input devices such as electronic pens and ‘telepointers’ (Cockburn & Greenberg, 1995) to edit and talk about a shared drawing (depicted and updated dynamically—possibly on separate screens). In this way, students collaborate *through* their networked computers. These and other appropriate groupware technologies need to be fully investigated to find their suitability for POE tasks.

Affordances relating to new developments in the field of multimedia also need to be investigated. For example, digital scent (or ‘digiscent’) technology is emerging as a legitimate media in computer environments. How can this media be used in POE tasks to enhance learning? What topics would be suitable and what particular new strategies would need to be considered? Indeed, how can the sound medium be used innovatively in these multimedia-supported POE tasks?

Further Use of the Interactive Digital Video Medium

There are numerous unexplored issues relating to the use of the digital video medium to present demonstrations as stimuli for the POE tasks. Technical developments with this medium need to be fully explored for different domains of science and the level of credibility of the medium needs further investigation. Learner-shot video provides an interesting extension of this area of research.

There is a need to further explore the affordances of the digital video medium for different domains of science. For example, what video tools and film techniques are suitable for various science topics? (e.g., In what areas of chemistry and biology can time-lapse photography be used?) Are there any issues to be confronted when using such techniques as part of POE demonstrations? Another example is Apple© Computer’s QuickTime© (or cubic) VR technology that enables objects in a photo to be selected and rotated. Users also can zoom and pan around given viewpoints through the use of 360-degree cylindrical panoramic images. What are the affordances and constraints of such an exciting development for the POE strategy? Do they give learners extra control over the observation process?

The credibility of the digital video medium for these types of tasks is quite an urgent line of research in this field. Although this study touched on this subject, important questions need to be asked about the level of belief in these video clips. For example, Roth (1996) found that microworlds can be "ontologically ambiguous and subject to interpretive flexibility" (p. 185/6). Are the digital video clips used in this study also 'ontologically ambiguous'? As students become more computer literate and familiar with video editing software, how will this affect their perceptions of the video medium as representations of reality? Indeed, how do students perceive the credibility and authenticity of animation and simulations when used in POE computer tasks? Do they really link these representations with the real world?

An interesting development that confronts this issue of film credibility is the use of teacher and student-shot film clips. Learner-shot video laboratories (Squires, 1999) can potentially give students ownership of these video clips and perhaps enhance the authenticity of related learning experiences. For example, Tasks 1 and 2 from this study (Falling Ball & Rising Ball) could easily be filmed by students for consideration in a POE task. The effect of students (and indeed teachers) filming their own scenarios needs further investigation. For example, does it improve the level of credibility of the task demonstrations?

Further Exploration of Learning Outcomes Associated with the POE Computer Tasks

The constraints of this study restricted the full investigation of all learning outcomes associated with the program. Future research should further investigate issues associated with peer learning and affective outcomes.

This study used a social constructivist perspective to focus on important learning outcomes resulting from peer interactions. Future investigations could explore possible ways for students to communicate between groups and reflect on other groups' beliefs (as well as their partner's views). For example, if all groups posted their responses on a central database accessible through a network, they could establish a 'discourse community', comparing and reflecting on the multiple perspectives of others (e.g., see Lin, Hmelo, Kinzer, & Secules, 1999). Indeed, this process could help students to engage more meaningfully in the challenging explanation phase of the POE strategy.

The program used in this study provided students with an opportunity to engage in 'science talk' (Lemke, 1990) and a means of developing science discourse skills (exploration, justification, negotiation, challenge, etc.). There is a need for further analysis of students' conversations (and indeed their writing) to explore students' development of these skills and their ability to use the 'canon of science'. This research could explore the use of computer-based POE tasks to identify the "discursive changes such as to transform their everyday discourse into more canonical discourse" (Roth, Woszczyna, & Smith, 1996, p. 1013).

Affective learning outcomes of the program also could be explored further. The challenging, real-world contexts presented in the program were designed to stimulate students' intrinsic interest and curiosity in various physics events and related principles. The program also was designed to foster student awareness and appreciation of the integral relationship between physics and students' everyday lives. Further qualitative insights into these developments would be most valuable, especially for low ability or 'at risk' students.

CONCLUSION

According to Salomon and Almog (1998), we live in an age of "constructivist, socially shared, situative, technology-intensive learning environments" (p. 233). Indeed, a review of the science education literature informed by constructivism indicates that good learning is a process of socially-based, active co-construction of contextualised knowledge. There has been a demand for appropriate investigations of these types of environments. For example, Kozma (2000) called for more research on the impact of technology environments on the cognitive processes and social practices of science learning. Indeed, Harper and Hedberg (1997) challenged researchers to "demonstrate for developers how to capture these opportunities and support the intrinsic motivation of learners to explore their own world and the variety of viewpoints within it" (p. 15). They also identified a need to further investigate facilitative strategies that support learners in socio-cultural processes.

The study discussed in this paper attempts to add to the knowledge base of these types of technology-mediated science learning environments by investigating the collaborative use of computer-mediated POE tasks for the purpose of eliciting students' conceptions and promoting discussion and reflection on these views. The study provided an illustration of how technology can mediate this learning process. As well as acting as an efficient and convenient teaching instrument to elicit students' pre-instructional conceptions, the POE computer tasks facilitated reflective peer conversations and took advantage of new affordances offered by the multimedia nature of the program. In this way, the study explored significant developments in the use of the POE strategy in science education. The findings and future directions emerging from the study should have implications for the meaningful engagement of science learners as they strive to comprehend and fully appreciate their physical universe.

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