Student and Teacher Perceptions of the Use of Multimedia Supported Predict-Observe-Explain Tasks to Probe Understanding

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Abstract

This paper discusses student and teacher perceptions of a new development in the use of the predict–observe–explain (POE) strategy. This development involves the incorporation of POE tasks into a multimedia computer program that uses real-life, digital video clips of difficult, expensive, time consuming or dangerous scenarios as stimuli for these tasks. The program was created by the first author to be used by pairs of secondary physics students to elicit their conceptions of force and motion and encourage discussion about these views. In this computer learning environment, students were required to type full sentence responses that were recorded by the computer for later analysis by the researcher. Other data sources for this study included audio and video recordings of student discussions, interviews with selected students and their teachers, classroom observations, and student questionnaires. This paper will report on some findings from the study, focussing on student and teacher perceptions of the computer-mediated POE tasks. The findings have implications for the effective use of multimedia to enhance meaningful learning in science classrooms.

Key words: Physics learning, constructivist software, peer learning, predict-observe-explain strategy, computer-mediated learning, interactive multimedia and digital video.

The constructivist view of learning suggests that learners build their own framework of ideas by fitting their new sensory experiences with their pre-existing mental structures. Learners construct their own knowledge, strongly influenced by what they already know, and facilitated by social interactions. In this way, learners build their own individual sense of reality (Tobin, Tippins, & Gallard, 1996). Constructivism encourages teachers to recognise the views and ideas which children bring to the classroom and provide experiences that will help them build on their current knowledge of the world (Duit & Confrey, 1996). Constructivist classrooms rely on students sharing and discussing their own personal interpretations of the world around them. Written and oral communications hence become very important in this process (Parker, 1992; Warner & Wallace, 1994).

Probing Students' Preconceptions

The elicitation of student ideas is central to any teaching approach informed by constructivism (Driver & Scott, 1996). If students are to experience meaningful learning they must review and if necessary reform their strongly held personal views of the world. Teachers need to be aware of their students' views in order to plan subsequent learning experiences which will help to facilitate this learning. Student interviews, concept maps, student journals and diagnostic multiple-choice tests are techniques which have been used as probes of student understanding for these purposes (Duit, Treagust, & Mansfield, 1996). However in the busy classroom often under the constraints of a curriculum overloaded with content, these techniques may be either too time consuming (e.g., individual student interviews) or restrict students' expression of their ideas (e.g., multiple-choice tests).

Using Predict–Observe–Explain (POE) Tasks to Elicit Students' Ideas

White and Gunstone (1992) have promoted the predict–observe–explain (POE) procedure as an efficient strategy for eliciting students' ideas and also promoting student discussion about their ideas. The POE procedure is based on the classic model of research where a hypothesis is stated and reasons are given for why this may be true, relevant data is gathered and results are discussed (White, 1988). It involves students predicting the result of a demonstration and discussing the reasons for their predictions; observing the demonstration and finally explaining any discrepancies between their predictions and observations. The procedure was developed at the University of Pittsburgh (Champagne, Klopfer, & Anderson, 1980) where it was initially labelled a DOE (demonstrate–observe –explain) strategy.

The use of POE tasks has been reported extensively in the literature. POE tasks have been used to investigate student ideas in studies by Baird and Mitchell (1986), Gunstone, Champagne, and Klopfer (1981), Gunstone and White (1981), Liew and Treagust (1995) and Palmer (1995). The POE technique has been discussed in Driver (1983), Driver, Guesne, and Tiberghien (1985), Gunstone (1990, 1995), Gunstone and Champagne (1990), Searle (1995), White (1988), and White and Gunstone (1992). POE tasks have also been used in studies of conceptual change (Searle & Gunstone, 1990; Tao & Gunstone, 1999).

Using POE Tasks within a Computer Environment

A computer environment can support the sequencing and presentation of POE tasks and has the potential to encourage the social interactions and personal reflections which are so important in the constructivist classroom. In contrast to the more common strategy of using whole-class, teacher-led POE tasks, the computer environment encourages small group interactions and permits a more intimate engagement with the tasks. This environment offers

students control of the tasks and allows the teacher more time to interact with students, exposing the teacher to students' views and beliefs. The computer environment can also support the use of the digital video medium.

Previous Studies of POE Tasks in a Computer Environment

Research relating to the use of POE tasks in a computer environment has been reported sparingly in the literature. Tao and Gunstone (1999) used computer-supported POE tasks to investigate the process of conceptual change. The POE tasks were presented as abstract computer simulations and students had to predict what would happen if certain changes were made in their *Force and Motion* microworld. Goldberg and Bendall (1996) reported on a program used for facilitating learning in geometrical optics. In this program, students were presented with a situation where they needed to make a prediction about certain optics problems. They then observed what happened on the computer simulation, evaluated their observation and compared it with their prediction. Russell, Lucas, and McRobbie (1999) looked at the use of microprocessor based laboratory (MBL) activities to facilitate student understanding of physics. In this study, the Grade 11 students worked in pairs on seven POE tasks relating to the subject of kinematics. In these tasks, the students had to predict the shape of relevant motion graphs before physically simulating the scenario themselves and observing the graphs produced by the MBL equipment (e.g., motion sensors).

However, the classroom use of digital video to present real-life demonstrations within a POE framework has not been reported in the science education literature.

Affordances of the Digital Video Medium for Computer-mediated Learning in Science

Over the past decade, the digital video medium has developed from an expensive, rather clunky medium involving external laserdisc players, to a cheaper, user-friendly medium with many capabilities that facilitate learner control. These 'media attributes' (Salomon, Perkins, & Globerson, 1991) include random access, allowing users to select or play a segment or individual frame (picture) with minimal search time; still frame or pausing, allowing any frame of the video clip to be clearly displayed (or 'frozen') for as long as the user wishes to view it; step-frame or toggling, enabling users to display the next or previous frame, and slow-play, enabling the user to play the video at any speed up to real time in a forward or backward direction. Although most of these features were possible in the older VHS videotapes, computer-mediated digital video makes these capabilities far more efficient and accurate. "This ease of access to any part of the video changes its function from a linear element used to introduce or enhance instruction to an integral resource that can be explored and analysed in detail" (The Cognition and Technology Group at Vanderbilt, 1991, p. 38). Although not included in the program used in this study, recent developments with this medium include the use of 360-degree cylindrical panoramic images. For example, Apple Computer's QuickTime VR clips can handle simple panning, tilting, and zooming about given viewpoints (Chen, 1995).

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 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 slow-motion or step-frame. These facilities are particularly useful when considering time-dependant phenomena prevalent in many science episodes, particularly in the mechanics domain. 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 which may be given days apart (Hoffer, Radke, & Lord, 1992). Hence interactive digital video makes possible the detailed observation of both interesting laboratory or real-life events and is considered an important technology in the area of computer-based learning in science (Weller, 1996).

Finally, the digital video medium can be used to include realistic, non-laboratory contexts for the students to consider. For example, one clip used in this study shows footage of an astronaut on the moon. Such real-life scenarios can make science more relevant to the students' lives (Duit & Confrey, 1996; Jonassen & Reeves, 1996), and help students build links between their prior experiences and abstract models and principles of physics (Escalada & Zollman, 1997).

A New Development in the Use of the POE Strategy: Incorporation of Digital Video Clips

The incorporation of the digital video medium as part of computer-mediated POE tasks offers a new development in the use of the POE strategy. This development has not been reported in the science education literature. The use of this medium can potentially expose student to a huge range of out-of-classroom contexts not normally possible in live, laboratory-based POE tasks. Digital video clips should also give students control over the actual viewing of demonstrations in the important observation phase of the POE strategy.

This observation phase is crucial as it provides feedback to students after committing themselves to a prediction. From a constructivist perspective, students can articulate, discuss and record their observations during this phase, providing an important insight into their strongly held ideas and beliefs (Driver, 1983). The capabilities of the digital video medium should offer a more sophisticated way of observing events during this important observation phase of the POE strategy.

The Study

The findings discussed here are from an interpretive study of a Year 11 physics class and a Year 10 science class using sixteen POE computer tasks incorporating digital video clips of real-life events. Students used the program in collaborative pairs at the beginning of their study of motion for the purpose of eliciting their preconceptions and encouraging discussion of their ideas. The study did not attempt to address conceptual change issues but rather focussed on the use of the program to promote discussion, reflection and probing of students' science views. The section of the study reported here sets out to understand the students' and their teacher's individual interpretations of their experiences with the computer program. An interpretive methodology incorporating a constructivist perspective was used in the study (Guba & Lincoln, 1989).

Research Questions Relevant to this Paper

The main research question relevant to this paper is given below, along with three subsidiary research questions:

How do the students and teachers perceive the use of the POE tasks within a computer environment?

i)   What were their perceptions of the level of student control of the POE tasks?

ii)   What were their perceptions relating to the use of the digital video clips to observe the events in the POE tasks?

iii)   What were their perceptions relating to the use of the digital video clips to enhance relevant contexts in the POE tasks?

Participants

The two classes which participated in this research were primarily chosen because of the interest expressed by the teachers associated with them. Both teachers were well respected by their peers and were considered to be highly skilled teachers. They were both familiar and comfortable with constructivist teaching strategies and appreciated the value of students discussing and reflecting on their science conceptions in collaborative settings. Each teacher had over 15 years experience teaching science.

Each class was familiar with cooperative group work and POE tasks in a normal, non-computer environment. The first class was a Year 11 physics class following the New South Wales Higher School Certificate (HSC) physics course. The class consisted of 18 girls and their female teacher. The second class was a Year 10 advanced level science class from a different school and consisted of 26 boys and their male teacher.

Computer Program Used in this Study

Sixteen POE tasks were used in this study (see Table 1 for a brief description of the tasks). The POE tasks were created within a computer environment using the multimedia authoring software, Macromedia Authorware. Demonstrations within the POE tasks were presented using digital video clips. About half of the video clips were filmed by the researcher and the other half were obtained from commercial VHS tapes after copyright permission was granted. The demonstrations consisted mostly of events which presented real-world contexts to the students, although a few featured laboratory equipment which would be difficult or time consuming to set up (e.g., task thirteen: Two Falling Balls). Where the outcomes of the demonstrations were limited (e.g., task one: The Falling Ball), students made their predictions using a multiple-choice format. When pathway predictions were needed (i.e., tasks three to eight), student made drawings for both predictions and observations. Reasons for predictions, observations and explanations were always required to be typed in full sentence, written response format. All multiple-choice selections and written responses were recorded on the computer. A more detailed account of the program's development is reported in Kearney and Treagust (2001).

Domain of Study

The topic of motion (mainly projectile motion) was chosen as the domain for the study for three reasons. Firstly, there was ample literature on alternative conceptions in mechanics to aid construction of the POE tasks and for use in later analyses of students' elicited views. Secondly, motion is an essential part of all introductory physics courses. Finally, there were sufficient numbers of relevant digital video clips available for the program.

INSERT TABLE 1 ABOUT HERE

Alternative conception research on mechanics (Caramazza, McCloskey, & Green, 1981; Clement, 1982; Eckstein, 1997; Fischbein, Stavy, & MaNaim, 1989; Halloun & Hestenes, 1985a, b; McCloskey, 1983a,b; McDermott, 1984; Millar & Kragh, 1994; Twigger et al., 1994; Whitaker, 1983) informed the selection and creation of the video clips. Common alternative conceptions emerging from this literature also informed the design of the multiple-choice options offered in the prediction stage of the POE tasks. Most video clips were designed to elicit different variations of pre-Newtonian alternative viewpoints. Where possible, abstract situations discussed in the literature were adapted to an everyday context for the video clips used in this study. For example, the pendulums discussed in Caramazza et al. (1981) and McDermott (1984) were adapted to a child on a swing (task eight). In some cases, similar contexts could be created. For example, the scenario of a running person dropping a ball as discussed in McCloskey (1983a) was adapted to the video clip of a walking child trying to drop a small ball into a cup on the ground (tasks ten and eleven). Speed variations (tasks four and five) and mass variations (tasks five and six) were incorporated into some of the tasks to help elicit student views relating to Impetus theory.

Three tasks (one, two and nine) used video clips relating to vertical motion only. They were designed to elicit alternative viewpoints relating to one-dimensional motion. The remaining videos covered both half flight and full flight projectiles. Projectiles used in these video clips covered both active and passive launches (Millar & Kragh, 1994).

Data Collection and Brief Description of Lessons

The following data sources were used in the study: participant observation, collected documents, audio and video recordings, semi-structured interviews and questionnaires. The students and the teacher initially completed two background questionnaires that provided

some quantitative data for the project. The first was devised for the purpose of becoming familiar with the students' background and previous experience using computers. The second, a revised version of the Constructivist Learning Environment Survey (Taylor, Fraser, & White, 1994), was used to gain an insight into the students' and teacher's perceptions of their normal classroom learning environment.

The study mainly employed qualitative research techniques for collecting data. Classes were observed both before and after the computer sessions. There were frequent informal interviews with the teachers and documents were collected during visits to the classes. For example, the Year 11 students did some teacher directed POE tasks using ticker tape during a lesson leading up to the computer sessions. Their responses during these tasks were collected. Students were given instructions on how to manipulate the digital video clips using the slow-motion, step-frame and rewind facilities during the lesson before the computer sessions.

The students worked in pairs with the program for two lessons at the beginning of their unit of study on motion. During this time they completed the sixteen POE computer tasks. The typed responses were automatically stored in a text file on the computer as a source of data for the study. Student drawings completed during the computer sessions were also used as a data source. Student discourse and teacher discussions with groups were recorded on audiotape. Sample group interactions of students using the program were filmed using a video camera.

Immediately after completing the computer sessions, all students and their teacher completed a questionnaire about their experiences during the computer lessons. Several days later, some students and their teachers were formally interviewed. Students were selected for these interviews by means of purposeful sampling (Bogdan & Biklen, 1982) based on their questionnaire responses, observations of group dynamics and teacher recommendations. They

were interviewed in pairs, using the same groups that worked together during the computer sessions.

Findings

All names used in the following findings are pseudonyms. Judy is the teacher of the Year 11 girls' class and Wayne is the teacher of the Year 10 boys' class.

Perceptions of Student Control over the POE Computer Tasks

Teacher perceptions

Student control of the POE tasks was a main issue emphasised by both teachers. Judy emphasised that her students enjoyed being in control of the POE sequence as opposed to a teacher led POE task. This had positive implications for students of varying abilities in her classroom:

> I think they really enjoyed being able to work at the pace of just their small group. If I were trying to demonstrate these things in class, everyone would have to work together. Like I couldn't go on to the next one until everyone was ready. I think they really enjoyed that because there's a reasonable range of abilities within the class.

Judy believed that her girls felt very comfortable because they were in control of the pacing and sequencing of the POE demonstrations. They could interact with the POE tasks at their own rate. This had a helpful effect on the girls' confidence and encouraged discussion:

> Kids can go over and over as many times as they like as slowly as they like. I think that's really important with girls to take the pressure off them that they have to have the right answer instantly because they do like to think about it and discuss it and feel confident that they have seen the right thing.

Judy perceived this student control over the POE tasks as ultimately allowing her to probe students' views further. The small student-centred groups allowed most students to voice their opinions and be heard by the teacher through their written responses.

> I would never have been able to do those demonstrations in two lessons and get feedback from each individual student about what they thought was going on. You can't listen to twenty girls at the same time when they're saying things to you in class—or remember it!

Wayne also believed that the boys in his class enjoyed being in control of the POE tasks. In his interview he stated: "I think that they particularly enjoyed being in control of the process…."

Student perceptions

Students very much enjoyed being in control of the whole program, progressing through each POE sequence and actually manipulating the video clips to enhance their observations. This was evident in the classroom observations, questionnaire responses and comments made during interviews.

Anne strongly believed that she had more input into the demonstrations because she was working with one other person rather than a whole class:

You feel like it's your input. Where as if you're doing the whole class and the teacher's dropping the ball [for example] your say isn't necessarily what comes across because everyone's throwing their own thing in. You don't miss out on having a say [working in pairs].

Anne's partner Jane also enjoyed controlling the pace of the POE tasks: "You don't have to ask the teacher to do it again, or have to wait for other people or whatever else." The student control of the tasks was also important for Mike and Steve. They both enjoyed manipulating the demonstrations according to their own needs, stating: "You can repeat [the video]…what you need it for," and "You can control it. You can do what you want; you don't have to just watch them." The student control of the tasks enhanced the interactivity with the demonstrations for Joanna and was motivating for her too: "I thought it was good because it was interactive so it made educational things interesting."

Perceptions Relating to the Use of the Digital Video Medium to Observe Events in the POE Tasks

Observing the outcome of the demonstration is a crucial stage of the POE sequence. As well as forming a link between the prediction and explanation phases, the demonstrations provide feedback to students after committing themselves to a prediction. In the context of probing student understanding, this observation stage becomes more significant. The process of making an observation requires interpretation arising from one's prior experiences of the world (Roth, McRobbie, Lucas, & Boutonne, 1997). Hence students' observations alone can provide a window into their own personal views and ideas. Both students and teachers perceived the digital video medium as an important tool facilitating their observations.

Teacher perceptions

Judy perceived the digital video facilities in the program as being most useful for students. She commented on the number of options that the digital video clips offered the students to facilitate their observations of the demonstrations in the POE tasks. She believed that students in her class found it easy to use the digital video clips to closely observe the scenarios presented. She witnessed many groups of students using the sophisticated video tools available to them, including: playing in slow-motion, rewinding and playing frame by frame. This was in agreement with classroom observations and also comments made during student interviews. During her interview, she compared the video medium with live demonstrations:

> I thought it was really good on the computer how easy it is to play and replay and control them [the video clips] frame by frame. I've never found that very easy on a normal video recorder and you certainly can't do that in a live demonstration.

Judy also contrasted the use of digital video clips with a live demonstration she did in class during a previous POE activity. In that lesson, she carried out teacher-directed, live POE tasks with students using ticker timer tapes showing constant speed, decreasing speed and increasing speed. She discussed the time-consuming preparation involved in attempting to produce identical tapes for groups to discuss and observe. She compared these ticker tape demonstrations with the ease and accuracy of reproducing identical, visible results for all students using digital video clips.

Judy gave an interesting insight into girls' education. In her considerable teaching experience with girls, she had come to the conclusion that girls often neglected careful observation of everyday science phenomena, especially physics phenomena. She believed that

for various reasons associated with gender stereotyping, girls were not encouraged to observe such phenomena as young children. Hence they may struggle to recognise everyday phenomena in the video clips:

…sometimes when they tried to relate them [the tasks] to their past experiences they still got it wrong. The one thing that I think girls often suffer from is that they haven't been keen observers of dynamical situations in their lives because from small children they often haven't been given toys to play with that encourage those sorts of skills; and so even though all of these situations should be familiar to everyone…they may not have ever observed carefully what actually happens.

This was an important comment in the context of this research as one of the objectives of using the digital video clips was to initiate links between the tasks and the students' everyday experiences. However, Judy was also implying that the digital video provided, perhaps for the first time, a lens for the girls to observe everyday phenomena.

Wayne emphasised how easily and frequently the students in his class replayed demonstrations. He was impressed with the option for students to see exact clones of demonstrations if they wished to review a clip. He commented that as a teacher, he could not possibly provide such an accurate replication of a live demonstration:

I suppose the advantage is that they [the demonstrations] are clean—bang—you get the potted view of what's going on and there it is there! And you can replay the same thing so it's like doing the experiment again, having set it up precisely. So you see the same thing again and again and again. You can talk about that at various levels. So I think it's pretty useful. It saves time, it allows complete reproducibility and therefore it's something that you can discuss from that level of saying that we're going to get the same result if we do it again.

Student perceptions

Jenny and Joanna found the video medium was easy to manipulate and rich in detail. They appreciated the option of using slow-motion to help them observe the outcome of the video demonstrations. The outcome of each event became more convincing for them through the use of the video facilities:

Jenny: I think having video clips was good, it was easier.

Joanna: It [the video clips] demonstrates how it happens, not just like a textbook where you read this happens and you don't see it.

Jenny: Also you can have it in slow-motion.

Joanna: You can actually see what's happening. Also you can work out why it's happening from just seeing it. It's just easier to imagine; it's easier than just seeing a picture because you actually see that it does actually happen.

Joanna in particular appeared to enjoy and value the rich detail of the video clips. For her, the clips provided a source of meaning that was lacking in her physics textbook. She found the video medium more convincing than static graphics and text. Anne expressed similar sentiments in her interview. She made an interesting comparison between the video clips and the stroboscopic photographs found in many physics textbooks:

It helps a lot because you can replay it slowly backwards and forwards. It helps instead of watching someone throwing a ball up in the air and wondering what happens. Say if you have photos of a movement – you miss out parts. With a video it's like a continuous movement, you don't miss any section of it.

Anne obviously valued the realistic element of the video clips and like Joanna, enjoyed a greater level of conviction from the clips. Patrick and Brent also enjoyed using the

digital video facilities to observe the outcomes of the POE demonstrations. They were able to control the video demonstration by themselves and observe the clips at their own pace, claiming that: "You can replay as many times as you like. Play in slow-motion; frame by frame. Where as with the teacher, you blink and it's gone. You do it in your own time."

In his interview, Patrick recalled how he observed the outcome of POE task one: The Falling Ball. The video clip in this task shows a little girl dropping a ball from shoulder height. Patrick's account illustrated how he used the step-frame feature to make clinical observations of the ball increasing its speed as it was falling:

Patrick:	You can sort of pinpoint times and freeze it right there…with the frame by frame. For example when the balls are falling down, you can actually see how they progressively pick up speed. Where as if you drop it, it's just milliseconds and it's gone.
Interviewer:	How did you know the ball was speeding up?
Patrick:	Frame by frame. Just click, click, click. Each frame the ball was further and further down the page. The first frame it had only fallen just a little bit; the second frame a little bit more.

Like her teacher, Rosie appreciated the opportunity to observe an exact replica of the demonstration as many times as she wanted. She mentioned: "If you want to play it again it will be exactly the same. For example, if you drop a ball live your hand could be higher the second time." Anne also appreciated the value of using digital video to create exact clones of prior demonstrations; unlike live demonstrations. She explained: "You see someone throwing a ball and you miss it and they have to throw it again, it may not be the same."

A small number of students criticised the film quality of some video clips and said that it impeded their observation of the outcome. Amanda and Rosie found the film clip of

the astronaut on the moon (POE task nine) difficult to see because of the age and quality of the film clip. At one stage they were unable to differentiate between a ball and a screen pixel!

POE task fifteen (The Cart and Ball) became an interesting exercise in observation. In this task, the cart is travelling down an incline and fires a ball into the air at an angle of 90 degrees to the incline. The cart continues to fall down the incline. Students had to predict whether the ball would land back in the cup. The video of this demonstration was taken using stroboscopic techniques. When viewing the video in slow-motion, the ball appears to land back in the cart. However, when viewed frame by frame, a few students realised that in fact the last snapshot of the ball in the film clip occurs just before it reaches the cart. There was no evidence in the video clip that the ball actually lands back in the cart! Although this was totally unknown to the researcher during the design of the program, the task became an interesting exercise in who was observant enough to notice this dilemma. It was also a source of great debate within groups. For example, Lisa and Elle were very surprised when they viewed the film clip of this task and after replaying the clip many times, they disagreed on the outcome:

Elle: Did it go back in the cart?

Lisa: Yes it did.

Elle: Did it? Play it again. Didn't it [the ball] go over the top of it [the cart]?

Lisa: No. It runs in. See! That's it, you can see it go in.

Elle: No it doesn't! The cart's just there.

Lisa: No – see. Go back one frame. See it goes in!

Elle: Going in where? There's nothing there. It [the cart] is over there and the ball's there.

Lisa: That's not the ball.

Elle: Yes it is. See, look when we go back a frame – and now go forward [a frame].

Lisa: See it's going in.

Elle: We need a second opinion!

Lisa and Elle continued to debate the outcome of the video clip until calling the teacher for help. The teacher complimented them on their close analysis of the scenario and asked them to make up their own minds. They recorded an undecided response.

The credibility of the digital video clips was important for students. This issue has strong implications for whether students actually believe what they observe in digital video clips and hence is crucial for the effective use of this medium in the POE strategy. For example, how do students know if a video clip has been edited? A few students touched on this topic in their interviews. Jenny, for example, trusted her teachers. In response to the interviewer's question about the possibility of the video clips being edited before viewing and whether she believed what she saw in the clips, she replied: "Yes. It doesn't seemed to be rigged you know. It's a teaching thing – I don't think they'd do that." Amanda did a 'reality check' with her own experiences to assess the credibility of the clips (indeed this was one of the intentions of using video clips of real-life events): "You can usually link most of the things that happened to everyday life. You kick a soccer ball and [you know] it goes up and comes down."

The digital video medium provided a wider lens for students to make observations of events presented in the POE tasks; helping them to make more profound interpretations of their world and more elaborate descriptions of their ideas and views. The sophisticated tools inherent in the medium allowed the students to make detailed observations of events and hence receive valuable feedback on their predictions.

Perceptions of the Contexts Used in the Multimedia Supported POE Tasks

Judy believed the rich contexts presented in the video clips were another factor contributing to her students' enhanced confidence. The everyday contexts of most of the clips

helped her students feel comfortable, especially in the initial prediction phase of the POE sequence.

> I think that's the good thing about them – it didn't make them feel inadequate or nervous – because they were all fairly comfortable contexts. They felt comfortable in trying to make a prediction about the contexts. Where as if they were all laboratory equipment situations, I think by the end of 16 tasks they would have started to feel 'this is too hard for me.'

The students generally appreciated the everyday context provided in most of the video clips. When asked about the purpose of the program, Rosie reflected that "It is great to let us know that this stuff can actually be good physics. [Stuff] that you wouldn't normally do." Amanda also appreciated the everyday context of many of the video clips, stating: "I think that basically this program shows us physics in our daily life that we didn't really pay attention to." Her comment also reiterated Judy's notion that girls in her class could improve their observation of everyday phenomena. For Mike, the program was an opportunity to observe new and unusual science events: "[The program was] an introduction I suppose. It showed us practical work – motion. Things you can't do like the sailing boat and the astronaut; [things] you can't really show us."

However, it was found that the rich context provided in the film clips needed careful description before students could engage in the POE tasks. Some students found that the initial description of the physical setting of each task was not sufficient for them to make a valid prediction. This is despite great care taken during the development of the program to avoid ambiguous language and contexts. Some students said they needed more information in order to make valid predictions.

Anne and Jane needed more information to make sense of some contexts. Anne's experience with sailing actually made their prediction for task twelve (The Sailing Boat) more

complicated: "At home we've got sailing boats and normally you have other factors such as wind and it would push the ball back…you think you should consider it but you're not quite sure…." Anne and Jane thought that outside factors, such as wind, could also affect the results of tasks fourteen and fifteen (the Cart and Ball tasks). They were also not sure of the setting for task thirteen (Two Falling Balls). They mentioned that the background in this video clip was dark and hence could have been set in space. Hence they wanted to predict that the balls would not fall at all! (Indeed, the setting for a previous task (The Astronaut) was on the moon with a similar background!) Brent and Angus also commented on the Two Falling Balls task in their interview. They thought that the balls may be on a string! They were also not sure exactly how fast the balls were rolling off the tables in tasks four and five. They felt that this uncertainty and lack of explanation affected the accuracy of their predictions.

Wind effects were also a problem in task twelve (The Sailing Boat) for Joanna and Jenny and were used as a reason for their incorrect prediction. They made the following comments as they observed the outcome of the video demonstration during the computer lessons: "Oh my God. It fell straight down. That's so weird!" and "It's the wind!" Jenny strongly believed that the ball in task ten (The Heavy Ball and Cup) would fall into the cup. After observing the outcome from the video clip, she acknowledged that she was wrong in this instance, but was convinced that if the object was heavy enough, it would fall in the cup. Hence, detail on the composition of the ball was lacking for her in this task. She mentioned: "We could have underestimated the weight of the ball. If it was lead, it would have gone straight down [into the cup]."

Teachers and students appreciated the opportunity to use out of school contexts in the video clips. Judy in particular thought that these contexts helped her students to feel comfortable and confident about making predictions. However, the rich context in most of the videos provided students with possible excuses for incorrect predictions.

Conclusions

Multimedia supported POE tasks represent a new development in the use of the POE strategy in science education. These computer-mediated tasks afford new opportunities for students in the crucial observation stage, enhancing the quality and detail of feedback to students after making a prediction. They promote learner control of the POE strategy, granting students time to discuss and reflect on their views. They also allow interesting, real-world contexts that can help students feel confident and comfortable, particularly in the initial prediction phase. Data from this study suggests these affordances are a positive development in the use of the POE strategy in science classrooms.

Use of the computer environment to present the POE tasks had a noticeable impact on the whole classroom environment. Students manipulated the demonstrations in small groups instead of in a whole class situation giving them more control of the POE tasks on two levels. Firstly, students could control the pace of each POE task, giving students the time and confidence to thoroughly discuss predictions, reasons, observations and explanations. In Judy's opinion, this created a more comfortable atmosphere for her female students to confidently discuss their opinions and views. She perceived this level of student control led to quality feedback about the students' views, which ultimately allowed her to probe students' views further. Secondly, students could control and manipulate the actual demonstration because it was presented through the digital video medium. Again, this control gave students the time and confidence to articulate their observations of the events presented.

The data findings suggest that the digital clips were a suitable medium for presenting the demonstrations in the POE tasks, providing a sophisticated tool for students to observe

phenomena. Students and teachers perceived the slow-motion, rewind and step-frame facilities inherent in the video medium as most useful in making clinical observations of events. They also valued the ability of the digital video medium to replay exact replications of demonstrations. Judy was particularly impressed with the way the video medium helped her students to closely observe everyday phenomena.

Both teachers acknowledged the ability of the digital video clips to present time consuming demonstrations that would be difficult to set up in a classroom. Students in particular appreciated the ability of the video clips to present real-life, unusual or perhaps dangerous demonstrations; creating realistic contexts for them to think about science. However the rich contexts sometimes created confusion about task settings, hindering accurate predictions.

The credibility of the film clips was an important issue to be confronted in this study. Students unanimously agreed that the clips were authentic. As many of the clips focussed on everyday phenomena, students could usually consider their own experiences of reality to check the clips' authenticity. Students also agreed that their teachers would only allow unedited footage of real-life events to be the focus of such POE computer tasks. However, future research in this topic should focus on the effect of students filming their own video footage of events. For example, task one (The Falling Ball) could easily be filmed by students as a subject for further analysis in a POE task. The quality of the video clips also emerged as an important issue for students. For example, the unexpected dilemma faced when observing the stroboscopic video clip in task fifteen highlighted the importance of choosing appropriate film techniques when making video clips for these purposes.

A separate part of this study has endeavoured to analyse students' conversations and written responses, investigating the use of the computer-mediated POE tasks to elicit student conceptions and encourage reflection on these ideas. Although not the subject of this paper,

findings reported elsewhere (Kearney & Treagust, 2000) indicate that meaningful discussions about students' ideas were mediated by the program and common alternative conceptions about force and motion were elicited from the students.

There has been strong criticism of passive multimedia use in science classrooms (Madian, 1995; Yeo, Loss, Zadnik, Harrison, & Treagust, 1998). However, the data from this study would indicate that students were cognitively engaged and on task whilst using the multimedia enhanced POE tasks. Hence this study also provides an example of effective use of multimedia in the science classroom.

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Table 1

Description of the 16 Predict–Observe–Explain (POE) Computer Tasks and their Relationship with the Physics Education Literature

Task Number & Name	Motion Type (Type of Launch)	Description (from Introduction Screen)	Prediction Question and Given Options (from Second Screen)	Sample Related Literature
1. Falling Ball	Vertical (Passive)	The child in the photo is holding a ball. She is about to release the ball so it will fall.	What happens to the motion of the ball as it falls? a) It will get faster. b) It will slow down. c) It will fall at a constant speed. d) Other.	Champagne et al., 1980; Driver et al., 1994, pp. 163–165; Halloun & Hestenes, 1985a, p. 1049; Hestenes, Wells, & Swackhamer, 1992, p. 156.
2. Rising Ball	Vertical (Active)	The child in the photo is holding a ball. She is about to throw the ball upwards.	What happens to the motion of the ball as it rises upwards? a) It will get faster as it rises. b) It will slow down as it rises. c) It will rise at a constant speed. d) Other.	Clement, 1982, p. 67; Driver et al., 1994 pp. 163–165; Enderstein et al., 1996, p. 490; Halloun & Hestenes, 1985a, p. 1049; McDermott, 1984, p. 30.
3. Ball Throw	Half Flight Projectile (Active)	A tennis ball is about to be thrown by a person from left to right. The ball will initially be thrown horizontally as shown by the green arrow in the photo.	What is the shape of the pathway that the ball follows while it is in the air? Paper drawing required.	Eckstein et al., 1997, p. 1065; Halloun & Hestenes, 1985b, p. 1058, 1062; Hestenes et al., 1992, p. 156; McCloskey, 1983a, p. 116; McCloskey, 1983b, p. 305.
4. Slow Ball Jump	Half Flight Projectile (Active)	A tennis ball is about to roll off the table as shown in the photo. The ball is travelling SLOWLY from left to right. *Note*: The projectile is launched in a different way from Task 3.	What is the shape of the pathway that the SLOW ball follows while it is in the air? Paper drawing required.	Eckstein et al., 1997, p. 1065; Halloun & Hestenes, 1985a, p. 1051; Halloun & Hestenes, 1985b, p. 1058; Hestenes et al., 1992, p. 156; McCloskey, 1983a, p116; McCloskey, 1983b, p. 305.
5. Fast Ball Jump	Half Flight Projectile (Active)	A tennis ball is about to roll off the table as shown in the photo. The ball is travelling FAST from left to right. *Note*: The velocity of the projectile has increased from Task 4.	What is the shape of the pathway that the FAST ball follows while it is in the air? Paper drawing required.	Eckstein et al., 1997, p. 1065; Halloun & Hestenes, 1985a, p. 1051; Halloun & Hestenes, 1985b, p. 1058; Hestenes et al., 1992, p. 156; McCloskey, 1983a, p. 116; McCloskey, 1983b, p. 305.
6. Car Launch	Half Flight Projectile (Active)	The HEAVY car in the photo is about to be driven off the cliff while travelling quite fast. It is travelling from left to right. The cliff is approximately 20m high. *Note*: The mass of the projectile has increased from Tasks 4 and 5.	What is the shape of the pathway that the HEAVY car follows while it is in the air? Paper drawing required.	Eckstein et al., 1997, p. 1065; Halloun & Hestenes, 1985a, p. 1051; Halloun & Hestenes, 1985b, p. 1058; Hestenes et al., 1992, p. 156; McCloskey, 1983a, p. 116; McCloskey, 1983b, p. 305.
7. Soccer Ball	Full Flight Projectile (Active)	The soccer ball in the photo is about to be kicked downfield (from left to right on your screen) by a soccer player. The ball will travel through the air (not along the ground).	What is the shape of the pathway that the soccer ball follows while it is in the air? Paper drawing required.	Halloun & Hestenes, 1985b, p. 1063; McCloskey, 1983a, p114B; McCloskey, 1983b, p. 308.
8. Ball and Swing	Half-Full Flight Projectile (Passive)	The person is riding on a swing. He is holding a tennis ball in his outstretched hand. On the next swing forward, the boy will release the ball (while continuing to move forward on the swing) at the point marked 'X' on the screen, just BEFORE he reaches his maximum height.	What is the shape of the pathway that the ball follows while it is in the air (after the boy releases it)? Paper drawing required.	Caramazza et al., 1981, p. 117; McCloskey, 1983b, p. 311.

Table 1 *continued*

Task Number & Name	Motion Type (Type of Launch)	Description (from Introduction Screen)	Prediction Question and Given Options (from Second Screen)	Sample Related Literature
9. The Astronaut	Vertical (Passive)	The astronaut in the photo is on the moon. He has a hammer in his right hand and a feather in his left hand and will release both objects at the same time. Both objects are held at the same height above the moon's surface.	Which object will hit the moon's surface first? a) The feather. b) The hammer. c) Both at the same time.	Clement, 1982, p. 67; Driver et al., 1994, pp. 163–165; Enderstein et al., 1996, p. 490; Halloun & Hestenes, 1985a, p. 1049; McDermott, 1984, p. 30.
10. Heavy Ball and Cup	Half Flight Projectile (Passive)	The student is walking at a constant pace from left to right. There is a cup placed on the ground ahead of her. She has a HEAVY ball in her hand and will release it (while walking) when her hand is directly above the cup.	Where will the HEAVY ball land? a) It will land behind the cup (at A). b) It will land in the cup (at B). c) It will land in front of the cup (at C).	Fischbein et al., 1989, p. 71; Halloun & Hestenes, 1985b, p. 1062; Hestenes et al., 1992, p. 157; McCloskey, 1983a, p. 114A & p. 122; McCloskey, 1983b, p. 303.
11. Light Ball and Cup	Half Flight Projectile (Passive)	The student is walking at a constant pace from left to right. There is a cup placed on the ground ahead of her. She has a LIGHT ball in her hand and will release it (while walking) when her hand is directly above the cup. *Note*: The mass has decreased from Task 10.	Where will the LIGHT ball land? a) It will land behind the cup (at A). b) It will land in the cup (at B). c) It will land in front of the cup (at C).	Fischbein et al., 1989, p. 71; Halloun & Hestenes, 1985b, p. 1062; Hestenes et al., 1992, p. 157; McCloskey, 1983a, p. 114A & p. 122; McCloskey, 1983b, p. 303.
12. Sailing Boat	Half Flight Projectile (Passive)	The boat in the photo is moving from left to right at a constant speed. There is a ball attached to the top of the mast. The ball will be released and fall while the boat continues to move with the same speed.	Where (on the moving boat) will the ball land after it falls? a) It will land to the left of the mast (at A). b) It will land directly below the mast (at B). c) It will land to the right of the mast (at C).	Hestenes et al., 1992, p. 156; McCloskey, 1983a, p114A, 122; Millar & Kragh, 1994, p. 29.
13. Falling Balls	Half Flight Projectile (Active)	The two balls in the photo are at the same height above the ground. They will be released at the same time. The ball on the left will be launched horizontally to the left. The ball on the right will be released from rest and fall vertically down.	Which ball will hit the ground first? a) The ball on the left. b) The ball on the right. c) Both will land at the same time.	Halloun & Hestenes, 1985a, p. 1052; McCloskey, 1983a, p. 116.
14. Cart and Ball I	Full Flight Projectile (Active)	The cart is moving horizontally from left to right at a constant speed. There is a small ball in the tube at the centre of the cart. The ball is about to be launched vertically upwards out of the tube (while the cart continues to move at the same speed to the right).	Where will the ball land? a) To the left of the cart. b) To the right of the cart. c) Back in the cart.	Millar & Kragh, 1994, p. 28.
15. Cart and Ball II	Half-Full Flight Projectile (Active)	The cart is 'falling' under gravity from left to right down the slope. There is a small ball in the tube at the centre of the cart. The ball is about to be launched out of the tube (while the cart continues to move down the slope).	Where will the ball land? a) To the left of the cart. b) To the right of the cart. c) Back in the cart.	

| 16. The Hose | Full Flight Projectile (Active) | The person in the photo is holding a hose. In photo A, the hose is held between 0 and 30 degrees to the horizontal. In photo B, 30 to 60 degrees. In photo C, 60 to 90 degrees. | What angle will produce the largest horizontal range of the water? a) 0 to 30 degrees. b) 30 to 60 degrees. c) 60 to 90 degrees. |