Children participating in science through digital-media literacies

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ABSTRACT
This article outlines the findings of a research project in which primary school students in Queensland, Australia, undertook science learning through media arts pedagogy. The project was a component of the URLearning Project. We found that students’ development of digital media literacies allowed participation and communication in science in ways that were otherwise unavailable to them.

Introduction
Encouraging primary students to actively participate in school science can be challenging. Instilling science knowledge and process skills required for practical application to everyday situations can be facilitated by classroom tools which connect to students’ real-life competencies, experiences and sources of satisfaction. In this article, we suggest that digital media literacies can enable an alternative to print-centric approaches to science education, and that engaging students through multimodal texts may be a way to connect middle years students to science learning. By facilitating ways of learning science through multimodal means such as filming, photography, editing and creation of Web-based science profiles, digital media production has the potential to make science more accessible to students than working in more traditional print modalities may be able to achieve. We argue that digital media production can create opportunities for repeated reflection on science content and processes.

We introduced a digital media production component to a Year 4 science project with the hypothesis that learning through media arts and the introduction of digital literacies could make science teaching and learning more manageable for students. We intended that the digital media production process would draw on the genre of science infotainment, popular within television science programs. Working in a school within a culturally diverse community, where many students were considered to be financially disadvantaged, our research was directed by the following questions:

1. What impact does media arts pedagogy have on students’ ability to participate in science processes and learning?
2. What impact does media arts pedagogy have on students’ ability to communicate science processes and knowledge?

Tytler (2007) has raised the issue of a ‘crisis in science education’ (p. 7) both within Australia and internationally. Researchers have argued that science pedagogical practices need to change in order to re-engage disinterested students (e.g., Osborne, 2007). Our approach in this paper is to investigate students’ ability to participate in the science learning process, and the consequences of introducing multimodal texts for both learning about science and communicating this new learning. We believe participation is a more useful concept than engagement because it draws attention to the specific practices undertaken by individuals as they take part in an activity. Our focus is on the aspects of digital media production that provide opportunities for participation in science that might not be provided by more traditional print literacy practices. The aim here is to investigate the possibilities for science learning created by moving between pedagogies of science and media arts to produce multimodal representations of science procedures.
Reardon (2004) has argued that participation in digital media practices encourages science students to question content and trial alternative ideas as they take part in the processes of science and report on science investigations. She described links between readers, writers and scientists as she observed the science processes of explanation, reasoning, argument, editing and revising when students participated in science explorations through film-making, photography and website construction. Digital media offer a way of representing science phenomena that is similar to the vernacular communication practices of contemporary students. Digital media can support students making sense of scientific phenomena as they interpret and represent science (Prain, 2009). As an example, filming science investigations requires students to work with tools that encourage thinking and communication about science in order to generate representations of science via integrated visual, audio and text modes. These modes can be re-presented as movie or internet profiles of science investigations (see also Waldrip, Prain, & Carolan, 2010). Working with new technologies can require digital literacies, and thus students can be developing new skills with media while forming science representations. For some time, researchers have recognised the impact of literacy in its multiple forms, including digital literacies, on thinking about and communicating science (e.g., Hubber, Tytler, & Haslam, 2010; Schaal, Bogner, & Girwidz, 2010). It is from this perspective that we investigate how media arts pedagogy may complement science pedagogy to encourage the participation of middle years students in science learning.

**Theoretical perspectives**

The study was framed by two overriding theoretical perspectives: a framework for digital media literacy building blocks; and Bernstein’s (1975) visible and invisible pedagogies. A conceptualisation of digital media literacy building blocks was called upon to provide a heuristic framework consisting of four categories of digital building blocks: These four building blocks are: digital materials, media production, media analysis, and conceptual understandings and to this way of thinking the four are linked and operated simultaneously (Dezuanni & Woods, 2014). Digital materials include things such as digital text, still images, moving images, recorded sound and generated media. Media production describes the process of using media equipment to create digital materials and combine them into recognisable media products. Media analysis denotes the process of investigating how others have used digital materials and production to communicate in specific contexts and for specific purposes. Finally, conceptual understandings are the assemblages of knowledge developed as individuals use digital materials and undertake media production and media analysis. In the URLearning project, media arts pedagogy was planned and implemented to combine these building blocks through both material and conceptual participation, including experimentation and play with digital technologies.

Bernstein (1977) emphasised aspects of play as beneficial to classroom practices enabling teachers to observe students as they practise skills in learning contexts which the students themselves have had more control in creating. Visible and invisible teaching practices (Bernstein, 1975) are identified as explicit and implicit classroom teaching practices. Explicit teaching practices are characterised by teacher control with little room for variation within curriculum choices or pedagogical practice and little control by students in their learning environment. In science education, explicit pedagogies are often considered the norm because of the specialised knowledge and discipline encompassed by the nature of science. Our approach in this project contrasts to more traditional science pedagogical practices which, as we have stated, are characterised by more overt or visible teaching instruction. Here the media arts pedagogical practices encouraged experimentation and play, and we propose in this way that they facilitated what Bernstein would call covert or invisible teaching instruction. The creative nature of the media arts pedagogy in the science classrooms permitted students to become decision makers in their own and their colleagues’ learning. We take this to represent a more implicit pedagogical practice.
Methodology

The research discussed in this article was undertaken as part of a five year URLearning project undertaken in a school servicing a lower socio-economic community on the outskirts of a major Australian city. The larger project aimed to investigate, among other issues, the potential for digital learning to improve students’ literacy through a design experiment approach. According to Cobb, Confrey, diSessa, Lehrer and Schauble (2003) design experiments provide a research tool to engineer ‘particular forms of learning and systematically [study] those forms of learning within the context defined by the means of supporting them’ (p. 9). In the design experiment reported here, we engineered science learning through media arts and systematically studied the forms of learning which took place in the Year 4 context.

The science program took place in the school’s two Year 4 classes in the second half of the school year. This meant that the students had been involved in media arts learning for more than six months and their teachers had been engaged in a collegial reform process of how they taught literacy within the classrooms for a similar period. This science program marked our interest in how the new media arts and literacy learning could be capitalised upon in other disciplinary areas. Weekly interviews with teachers and more in-depth interviews following the science unit provided the teachers and researchers with valuable time to discuss students’ progress and insights into the advantages or disadvantages of the science/media arts pedagogical approach. This approach generated explanations about how and why science/media arts pedagogy impacts on science learning (Cobb et al., 2003).

Data were collected via audio recordings of planning meetings between class teachers, learning support teachers and the research team, teacher interviews, observations of teaching practices and students’ participation in activities, student artefacts, and students’ science videos which were the final products of this program. Teaching practices were analysed using observational data where pedagogies were plotted on a continuum representing the two extremes of Bernstein’s visible and invisible pedagogies.

The observational data of students’ participation in science was analysed according to the digital building blocks students used to facilitate their representations of science processes and their learning of science. For example, we analysed the students’ ability to interpret the science experimental detail and re-create the investigation using digital text, still images, moving images, and audio devices to conduct the science procedure and express phenomenon via the process of media production. Their conceptual understandings about science were interpreted using the media codes, conventions and story structures they created to represent science. The analyses of these rich data sources inform our discussion here and indicate positive outcomes for linking media arts pedagogies and students’ acquisition of digital and science literacies. The following sections address each of the two research questions to describe these links and then outline further considerations for the integration of media arts and science education in terms of students learning digital and science literacies.

Background to the science/media arts project

The intention of our approach to media arts across the school year was to integrate participation with digital texts with other aspects of the Year 4 curriculum. The point was to make links to the students’ development of print literacies. The focus of media arts programming was to begin developing the building blocks of students’ digital media literacy. Table 1 illustrates the media arts program implemented with the students during each of four terms. The teachers were supported by a media arts teacher, who worked on gradually releasing control for the program back to the teachers as the year progressed. In this way the teachers were learning new skills with new technologies in the context of their everyday pedagogy and curriculum work.
Table 1. The Year 4 media arts program

<table>
<thead>
<tr>
<th>Term</th>
<th>Year 4 media arts focus</th>
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<tbody>
<tr>
<td>Term 1 (10 weeks)</td>
<td><strong>Operational knowledge and skills</strong>: operating the laptops; logging in; highlighting,</td>
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<tr>
<td></td>
<td>dragging and dropping text and images; using software to create text, still images,</td>
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<td></td>
<td>audio files and video files; using web design templates. These skills were developed in</td>
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<td></td>
<td>a contextualised manner through the completion of media arts projects.</td>
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<tr>
<td>Term 2 (10 weeks)</td>
<td><strong>Operational knowledge and skills</strong>: operating digital still and video cameras;</td>
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<td></td>
<td>conducting interviews with video cameras; recording sound; capturing footage; editing</td>
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<tr>
<td></td>
<td>footage using video editing software. These skills were developed in a contextualised</td>
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<td></td>
<td>manner through the completion of media arts projects.</td>
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<tr>
<td>Term 3 (10 weeks)</td>
<td><strong>Representing science procedures</strong>: recording a science procedure with a video camera;</td>
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<td></td>
<td>using video editing software to edit footage; recording voice-over commentary; adding</td>
</tr>
<tr>
<td></td>
<td>titles and captions to video footage.</td>
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<tr>
<td>Term 4 (10 weeks)</td>
<td><strong>Representing self</strong>: using video cameras and video editing software to construct a</td>
</tr>
<tr>
<td></td>
<td>micro-documentary about things important in the students’ lives; using video editing</td>
</tr>
<tr>
<td></td>
<td>software; recording voice-over commentary; adding titles and captions; using music</td>
</tr>
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<td></td>
<td>creation software.</td>
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During the second semester of the school year, media arts (Table 1, Term 3) was taught concurrently with a science teaching block in preparation for a Queensland State Government assessment item completed by Year 4 students throughout the state, namely, the Queensland Comparative Assessment Task (QCATs) investigation, which in this particular year was called ‘Ink Spots’ (Queensland Studies Authority (QSA), 2011). In this task, students were required to identify properties of materials and investigate the best ink for labelling a hat. Table 2 summarises the class programming for integrating the QCATs assessment with media arts. The purpose of this was to allow students to represent science concepts through a film-making project.

Table 2. Science/media arts planning

<table>
<thead>
<tr>
<th>Science</th>
<th>Media arts</th>
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<tbody>
<tr>
<td>Lead up to QCATs investigation</td>
<td>Analysing example children’s science programs</td>
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<td></td>
<td>Identifying shot types and editing techniques</td>
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<td></td>
<td>Story board</td>
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<td></td>
<td>Interview Techniques</td>
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<tr>
<td></td>
<td>Filming [mock-up practice]</td>
</tr>
<tr>
<td>Phases of QCATs investigation</td>
<td>Filming the prediction during the Fair Test.</td>
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<tr>
<td></td>
<td>Discussion: The ‘prediction’ phase of the experiment.</td>
</tr>
<tr>
<td></td>
<td>Student groups film/discuss/write their predictions.</td>
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<tr>
<td></td>
<td>Students conduct Fair Tests.</td>
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<tr>
<td></td>
<td>Discussion: The filming of the predictions with a reminder of</td>
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<td></td>
<td>the importance of shot types.</td>
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<tr>
<td></td>
<td>Students filming/editing/presenting their videos.</td>
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<tr>
<td></td>
<td>Students complete the ‘Explain’ phase of the Fair Test.</td>
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<td></td>
<td>Students complete the QCAT’s booklet.</td>
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</table>
For the media arts component of the science procedure, it was decided that students would individually create a brief procedural video, based on their study of examples from children’s television science shows. The video was to consist of:

- an opening shot in which the student would introduce the experiment;
- three or four shots of the experiment during which the audience would hear a voice-over explanation; and
- a closing shot in which the student would explain the outcome.

The footage was recorded by the students working in groups using inexpensive flipcam video cameras. The students directed their peers who acted as camera operators for each other. The footage was then captured to laptop computers, edited and sound-dubbed using video editing software.

Prior to filming, the students practised the science procedure with partners in their media production groups. The class teacher instructed the students on the process of plan, predict, explore and explain which the students incorporated into their filming practice time. As well, the students viewed and analysed examples of popular after-school television science programs to identify the types of shots used. They drew their own storyboards to plan the video recording of the science procedure. The media arts teacher explicitly modelled the filming procedure for the students; however, the students were free to make their own choices about how they organised their filming, interviews and investigation by utilising their planning as recorded on their storyboards.

**Integrating science with media arts**

To demonstrate the impact of combining media arts with science pedagogy on students’ participation in science processes and learning, the pedagogies for both media arts and science are discussed in relation to Bernstein’s visible and invisible pedagogical practices. For media arts, explicit demonstrations were required so that the media production procedures could be modelled. Figure 1 shows the teacher explaining and demonstrating the types of digital building blocks the students would require to represent the science investigation via video production. It is important to note that the successful completion of the project required the teacher to shift across a full suite of visible and invisible pedagogies.

![Figure 1. Media arts visible pedagogy](image_url)

Implicit teaching/learning opportunities were required for children to participate in digital literacy skill practice. These episodes provided students with opportunities to work with peers and teachers in a way that recognised their individual learning styles and requirements to enhance their learning (e.g., Figure 2). So there were many occasions throughout the unit when the students were working outside of the boundaries of the classrooms and their desks.
The series of media arts lessons focusing on aspects of recording with the flipcams provided students with opportunities to learn about the codes of moving images, or shot types, specifically required for procedural video. As an aspect of the digital building blocks, this is fundamental knowledge. Shot types are central to all moving image production and need to be taught explicitly. The connection to conceptual knowledge is important because different shots are appropriate to different genres. In the case of science, procedural videos use mostly close up and medium close up shots.

Figure 3 depicts students’ knowledge of when and how to use different shot types while planning the science video. The work sample on the left is an example of students’ drawings as they learnt about procedural video shots during visible learning experiences. The sample on the right shows an example of a storyboard typical of students’ planning for their science video. The story board indicates the shot number, the type of shot and the subject of the shot.

The impact of media arts on students’ participation in science processes and learning
During the filming of the science QCAT, students were required to undertake the investigation as well as describe, explain and reason about phenomena which they had observed. The student QCAT booklet (QSA, 2011) provided guidelines for the students’ investigations; however, because the students were creating a media production of their investigation, they planned their filming process in conjunction with the science process. Therefore, they made individual and group decisions about their science media production. In the actual experiment, the students were required to test the solubility of three black inks using a paper strip test. The paper strips were compared and results discussed with peers to decide which pen was insoluble, and therefore which would be the best pen with which to label a hat. The QCAT focus for students was to ‘use evidence to draw conclusions about the properties and purpose of inks’ (QSA, 2011, p. 1). The photographs in Figure 4 show aspects of student videos: materials, students’ film of the test, and the outcome.
In the series of photographs displayed in Figure 5, students can be seen working from their story boards as they make decisions about the construction of their video text. Students used their story boards as a procedural account for each step of the filming process as they filmed the science investigation. Students explained science and filming processes and knowledge to researchers during the process. Researcher discussions and observations of students demonstrated their eagerness to participate in the science process via media production.

Filming participation in science provided students with flexible opportunities to participate in science processes and apply prior knowledge to new learning. The print texts (story boards) outlined science procedures and provided the steps for filming investigations. In order to follow their procedural outlines, students needed to discuss science and media knowledge and processes as well as exchange ideas within their working groups (Figure 6).
Moreover, these discussions provided opportunities for students to explain and reason about their ideas, thus participating in science talk within their science group and whole class communities. Increased science talk, facilitated by the media arts/science project, in comparison to earlier opportunities for science learning in these classes, is supported by comments made during interviews with the class teachers. For instance, Justine (pseudonyms have been used throughout) said:

Justine: [The filming process] brought out a lot more discussion and made them more inquisitive. Media arts helped them refine ideas about science.

The teacher also reported her opinion that the project helped to bridge the gap between classroom and home science learning and led to discussions about this between teachers and students:

Justine: We both have had incidents of kids going away and trying out different versions of the test at home and bringing in their findings.

A further outcome resulting from the media arts/science integration was increased participation of those students considered to be dealing with learning difficulties. These students were encouraged not only by the motivational factor provided by using digital media but also by their classmates. Classroom observations noted how these students happily joined in and appeared confident during the filming and editing of the science procedures. Their peers seemed keen to help them when required and the help was willingly accepted. Teacher comments supported this finding, for example:

Rosemary: They were a lot more engaged than what I thought they would be. It was a really good way to accommodate our less-skilled students … The better kids actually helped [the other kids]. The kids reached them. It was very encouraging. They would guide them through the process [of editing and so on].

Video data show students with learning difficulties participating in the investigation and being filmed demonstrating the investigation. Other students can be seen working with, and were heard prompting, these students encouraging them to participate in the learning experience:

Rosemary: I found the same with explanations. [As well with problem solving], kids will look at a problem and say ‘Nope, too hard’ and give up but this experience has improved the confidence of some of them. They will attempt something.

Furthermore, students’ confidence in science participation was strengthened by the opportunity to use alternate ways of working with science via digital media. One teacher stated:

Justine: I think it’s improved their [all students’] confidence. I think because they’ve done something hands-on that was achievable they now have had that success and probably will have more confidence the next time they try something such as, they know what a fair test is now so next time we say we’ll do a fair test, they will say – ‘oh yeah! We know what that is’ – So it’s a confidence building thing.

We believe the media arts pedagogical approach used in the project enhanced student participation and learning. It provided an appealing way for students to revisit science concepts via a cyclical method. The media arts approach required students to plan how they would create their shots (storyboarding); record and sometimes re-record their shots; and then capture, edit and sound-dub their production. In doing so, they repeated the science process thus revisiting science concepts with description, explanation and reasoning several times. Rather than being a repetitive exercise of learning concepts, the students found the media arts/science process motivating. According to the teachers, the reason children enjoyed the media arts/science integration was partly because it seemed to make the process more ‘real’. In answer to the question ‘What benefits do you see media arts having in the learning of science?’, the teachers stated:
Justine: It made them slow down and stop and think about the process they were going through. It reinforces the scientific process.

Rosemary: The kids can reflect back on (the science) so when they’re editing their film, it goes back to science concepts that they’ve seen – that they actually did – it reinforces it. It gives them a visual [representation].

Justine: Yeah – so they can actually go back and say: ‘well, what did we actually see there or let’s go back and see what actually happens when we’re filming the process or even the final product’ – [It’s] slowing the steps but then when they see it [the film] put together, they say oh yeah – ‘ok, we’re showing our materials, we made our predictions – we did this – we did that—and then we did this at the end’. It’s reinforcing that whole process again.

Rosemary’s comment above refers to the connection between bringing prior science knowledge and the digital media process. Students recalled learning the science concepts and related that prior learning to what they saw as they edited their films. In subsequent interviews, both teachers discussed what they perceived to be the positive effect of merging media arts and science pedagogies:

Rosemary: I think it helped them comprehend the meaning of the science … because I noticed … they used scientific language a lot more in their reflections … and I think that helped them consolidate science learning.

Justine: It slowed them down and actually made them think about what they were doing each step of the way rather than rush in … I think they were thinking more about the processes and at the end looking at what the actual outcome of what they were doing was.

Justine: I think it helped the kids have more of a method to what they were doing because they had to produce a procedure and they had to have a sequence when they did their movie – they had to think about the order they were doing it in when they did the procedure itself.

Rosemary: So the actual process in the media helped the process of science.

The reiterative nature of the process of conducting the science investigation through the media arts production process meant that the students were revising the science concepts they had learnt and applied to their investigation. When asked about media arts and its contribution to the learning of the content of science, the teachers noted that it was evident to them that students were learning the science content and recalling it, as shown in the following statements:

Rosemary: It gave them a visual representation as well of their learning so when they looked back, when they were editing their film, they actually were looking at the science concept as well so it actually backed up the science because the visual went with the language, went with the context of the experiment.

Justine: The whole process helped them to connect the content and the application of what they were doing.

Rosemary: The visualisation helped them to recall certain aspects of the science like how the ink goes (reacted) – They saw how the ink goes. They recorded it. They edited it.

Justine: And they could go back and make their conclusions and say whether their statements were correct.

The teachers’ comments suggested that they believed that science learning was enhanced by media arts pedagogy and the reiterative and visual nature of media production – the chance to ‘play’
(Bernstein, 1977) with science processes. Partly, this is because the media arts production process required the students to take part, physically, in the scientific process, which the teachers suggested reinforced their learning of the science concepts. The teachers also suggested the students’ creations of a multimodal record of their science learning provided an opportunity to reinforce knowledge and understanding.

The building block of conceptual understandings suggests that digital literacies are developed when students engage with meaningful ideas when producing and using media. During this science/media arts unit, students did exactly this whilst planning and completing the science procedure and simultaneously planning, sharing and reflecting on the media production. The building block of media analysis was engaged with when students viewed science programs to identify available designs for televised science programs aimed at children and while they worked scientifically at planning activities and investigations and identifying and using elements of a fair test. Students worked with the building blocks of digital materials as they recorded digital still and moving images and recorded their voice over soundtracks to collect and organise data, information and evidence. Finally, students engaged with the building block of media production as they used editing software to combine their digital materials in an appropriate way to communicate scientific ideas, data and findings using scientific terminology and formats appropriate to context and purpose.

During post-program interviews, both class teachers expressed positive reactions to the incorporation of digital media practices with science pedagogy for positive student learning outcomes:

Rosemary: You can’t separate them [the science and the media arts]. I think it flowed pretty well.

Justine: And I think – like we did in the past – the science lesson and the media arts lesson separated – like I did find other times when we did it that way, we didn’t get as much benefit out of either. So having that whole session to build up the science and then build in the media when it needed to be built in … I think it made both of them more meaningful. In other words, the media arts worked hand-in-hand with the science adding a visual, representational dimension, providing concrete reinforcement of science concepts. Students could engage physically with the scientific process, thus reinforcing the science concepts.

The expression of science knowledge by students was one way in which students communicated about science; however, communication about science is also about participating in science communities. In the classroom context, the science community consists of the students and teachers but can extend to the wider community such as parents and other visitors. The following section investigates how the students communicated about the science knowledge and processes within and beyond the classroom.

The impact of media arts on students’ ability to communicate science processes and knowledge

The video production process provided a multimodal means of communication about a science process in which students conducted a fair test on solubility. The operational processes of using the media technology had become an increasingly everyday practice of communication for these students by the time they filmed the science process and, as a result, a less visible pedagogy and more playful pedagogy could be implemented for the science unit. Figure 7 shows photographs of students’ participation in the science process via implicit/invisible pedagogy. On show is the students’ ability to work independently on their science as they filmed the process as well as described and explained concepts about scientific phenomena. Students independently organised their investigations, asking for guidance when required. Often, when an adult joined their group, the students explained and demonstrated what they were doing.
Figure 7. Students independently engage in the science/media arts process

The video production process required students to participate and cooperate in small groups which formed classroom working science communities. Within these groups students worked co-operatively through the science process of conducting a fair test whilst predicting, formulating hypotheses, observing, discussing, making decisions, explaining, assessing and reassessing phenomena. The media production process therefore required the students to physically undertake a science procedure and to communicate to each other: verbally as they organised the experiment and visually as they used storyboards to plan and film the process; and then visually and aurally as they edited and sound-dubbed the production. Furthermore, the media production process provided the students with a meaningful purpose for communicating their science knowledge in that they aimed to inform their video production audience. Having an audience to communicate to made a positive difference to the purpose of learning in terms of making the learning more connected to students’ popular cultural experiences.

Digital media also provided the students with a different means of communicating about science that enabled all students to feel a part of the classroom science community. As many of these students struggled with traditional print literacies, digital video production provided opportunities for them to represent their science knowledge via an alternative medium. Justine stated that during the science/media arts project both class teachers ‘found they [the students] could verbally explain phenomena’. Both teachers reported that students were able to reflect back on their video production and recall the science concepts.

Justine: They were able to speak about what they had learnt and discovered and what they knew rather than having to answer questions and write a text as such.

Rosemary: It gave them a more even playing field because the people who aren’t that good at writing or articulating their scientific knowledge had an opportunity to have another avenue to show what they know.
Filming science investigations provided visual representations of the science process which formed a means to demonstrate science knowledge less reliant on written literacy. Therefore, participation in science was more accessible to those students who might have otherwise struggled to communicate with traditional print literacies. As students shared their video productions, they talked about and demonstrated science knowledge and processes to adults and peers. The media production process encouraged confidence in the students to share their achievements. When students were required to submit traditional print literacy evidence of their science knowledge, we found that their participation in the iterative media representations of science process facilitated more willing attitudes to writing about science knowledge. The media production process worked in conjunction with traditional print literacies to enable clear communication of science knowledge and processes.

Working across the digital materials (digital text, moving images, recorded voice over) required students to conceive of the science process and knowledge in multiple ways. From this perspective, the digital process was not just iterative, but a form of multimodal reinforcement. However, the video production method did not assist students who developed misconceptions. Like Eshach (2010) who noted that photography was not adequate to determine all student misconceptions about physics, video production did not highlight all misconceptions that students may form. In speaking to some students after the investigation, we found that while students could explain the process they had participated in, not all students could explain clearly the concepts of solubility and insolubility when not in context. In Bernsteinian terms, this insight would require us to think about whether, while the practice during video production remained at the invisible end of the continuum where students controlled their learning experience, it might be justified for the boundaries of the pedagogy to shift to include more explicit intervention by teachers where required.

Conclusions
This paper has highlighted the aspects of digital media production that provided opportunities for students’ participation in school science not provided by print literacy practices. We investigated the possibilities and barriers for science learning afforded to the students as they moved between pedagogies of science and media arts. The study highlighted the positive potential of linking media arts and science pedagogy. Media arts provided students with ways to participate more fully in science processes and learning. Overall, we found that media arts pedagogy afforded positive learning experiences in science. Teachers reported that students had ownership of their work. Reporting back on the investigation provided students with an opportunity to revisit the science concepts that they actually did. So, the video production process of planning, filming, editing and presenting their videos reinforced the science process and concepts as the students planned, predicted, observed, reasoned, inferred, questioned, explained and classified in their school science communities.

These results imply that media arts and engaging multimodal and digital texts can provide practical, accessible and versatile ways of learning and communicating about science and an alternative and complementary tool by which to explicitly teach science. Furthermore, media arts and science-integrated pedagogies also provide implicit pedagogical circumstances for science explorations in non-threatening environments. We see media arts as a feasible pedagogical process for science teaching, which will also enable literacy learning, especially in digital modes. An integrated science/media arts pedagogy has the potential to provide an accessible modality for learning science for all students. Notably, it may enhance the participation of those students who experience difficulty communicating and learning science through traditional print modes.

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References

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