Investigating the Use of Digital Video Recording To Improve Literacy in Science

Abstract

Pupils with poor reading literacy levels struggle to achieve good levels of scientific literacy. This study investigated the use of digital video production as a method of improving literacy levels among low achieving Year 7 science pupils. Based on an existing theoretical scale of literacy in science, an assessment was developed, which assessed pupils' nominal, functional, conceptual and multidimensional aspects of literacy. It was found that the use of digital video recording in the lessons prior to the assessment significantly improved pupils' levels of nominal and functional literacy in science, and in most cases also enhanced their conceptual and multidimensional literacy. The implications for teaching and learning described in this study are extensive and cross-curricular.

Introduction

Research has shown that paying more attention to the learning of language in science is 'one of the most important acts that can be done to improve the quality of science education' (Wellington and Osborne, 2002, p.1).
Science teachers often consider the language of science to be 'of marginal relevance to the learning of science (op. cit.), despite an overwhelming body of research that suggests otherwise (Cromley, 2009, Norris and Phillips, 2003,

Wellington and Osborne, 2002, p.6). Vgotsky (1962, cited in Wellington and Osborne, 2002, p.6) described the inextricable link between language development and conceptual development, which is echoed by Wellington and Osborne (2001, p.6) who state that 'thought requires language, language requires thought'.

It is not surprising therefore, that difficulty with language causes difficulty with the learning of new concepts. Research has shown that there is a positive correlation between reading literacy and literacy in science (Cromley, 2009), which has been identified as essential for pupils to 'participate fully as citizens, community members, and in the globalised economy' (op. cit.). Poor readers lack the skills that 'drive higher science achievement' (op. cit.). This highlights the barriers that pupils with poor reading literacy face when they come to learning the language of science. Through the use of digital video recording this study aims to improve pupils' literacy in science at a school where 'attainment on entry is well below average, with particularly low levels of literacy' (Ofsted, 2007).

Literature Review

The body of research of the past 30 years showing that 'one of the major difficulties in learning science is learning the language of science', has tragically gone largely unrecognised by the science teaching profession (Wellington and Osborne, 2001, p.1). The Bullock Report (1975) advocated that all teachers should see themselves as teachers of language, however, despite this interminably resonating message highlighting the importance of language in the learning process, the focus of secondary science has largely been as a practical subject (Wellington and Osborne, 2001, p. 3). The value of practical work should not be underestimated here; it helps students to develop an understanding of science, and to appreciate the nature of science (House of Lords Select Committee, 2007). However, the language of science is fundamental to conveying meaning, not just through verbal language but also through a combination and interaction of words, pictures, diagrams, images, animations, graphs, equations, tables and charts (Jones, 2000 cited in Wellington and Osborne, 2001, p.6).

Recently, there has been a central drive for an increased emphasis on language in science teaching. A recent National Curriculum contained 'less prescribed subject content in the new programmes of study' (QCA, 2008), and highlighted the importance of literacy in science. For example, at Key Stage 3, pupils were expected to 'explain phenomena using scientific ideas and models', 'communicate scientific information and contribute to presentations and discussions about scientific issues' (QCA, 2008). The mandatory framework for teaching provided by the National Curriculum is a reflection of the knowledge, skills and understanding that our society believes are crucial for its citizens to acquire. If secondary science education is to act as a major contributor to citizenship and the public understanding of science, then we believe that literacy should be at the heart of what we teach. This view is echoed by Cromley (2009), who states that students need to develop literacy in science 'in order to participate fully as citizens'. The positive correlation between reading literacy and scientific literacy (op. cit.) creates a literacy gap in society, which can only be reduced by developing teaching methods and materials that improve scientific literacy for pupils with poor reading literacy.

It is important to recognise that individuals are not simply scientifically literate or scientifically illiterate. There have been many attempts at defining various levels of scientific literacy (Shwartz et al, 2006), ranging from recitation of information to analysis and evaluation of a scientific text, requiring extensive knowledge of the scientific field (Wellington and Osborne, 2001, p. 139). Various research tools have been developed that try to assess a distinct aspect of scientific literacy (Shwartz, 2006). The Program for International Student Assessment (PISA) and Trends in Mathematics and Science Studies (TIMSS) are two of the most ‘comprehensive survey programs aimed at assessing scientific literacy’ (op. cit.). PISA focuses on the scientific processes such as critically evaluating conclusions and communicating scientific ideas, whereas TIMSS focuses on the recall of knowledge (op. cit.).

Several suggestions have already been made to improve literacy in science. The Secondary National Strategy (DfES, 2002) describes the four main aspects of literacy in science as words, reading, writing and talk, and suggests activities to cover each of these aspects, including the use of word roots, DARTs (directed activities related to text), writing frames and whole class discussion. However, many of these suggestions are teacher-led, and do not give students ownership of their learning. Bartholomew et al. (2002) highlight the value of moving pupils’ thinking beyond the factual input provided by the teacher. Discussions allow pupils to ‘identify and articulate their own views, exchange ideas and reflect on other students’ views, reflect critically on their own views and when necessary, reorganise their own views and negotiate shared meanings’ (McRobbie and Tobin, 1997, cited in Kearney and Treagust, 2001). This process is essential to the constructivist view of learning, in which learners construct their own knowledge, influenced by their existing knowledge. Therefore, by allowing pupils more autonomy in directing their learning, such as through the production of video clips, constructivist learning may be enhanced.

Whilst the use of video in science education is not new, studies have recognised the major limitations of the passive watching of video clips (Kearney, 2001). However, Kearney and Treagust (2001) take the simplistic view that the control exercised by the teacher or student is limited to turning the video on or off, whereas we feel that the learning can be made more active by giving pupils an activity to do whilst watching the clip, or even by muting the clip and asking pupils to do the voiceover. Authoring With Video (AWV) is a promising approach to motivating students to engage in reading and writing (Strassman and O’Connell, 2007). AWV removes the narration from a video clip and requires students to write the script. The final results look professional and can be shown to a variety of audiences (op. cit). Despite these possibilities, pupils’ learning is still prescribed by the teacher’s choice of video clip, and in this respect AWV is not an ideal approach to constructivist learning.

Despite these limitations, the number of schools streaming digital video to enhance their lessons increased from 30 to 45 percent between 2004 and 2006 (Techlearning, 2008), indicating the popularity of this modern technology in helping students to retain what they have learned. Abisdris and Phaneuf (2007) describe an example of the application of digital video cameras. They used a digital video recorder to analyse the motion of a basketball, and then used freely available computer software to measure the ‘acceleration due to gravity of a basketball in free fall’. This simple activity makes use of abundant video recorders on pupils’ mobile phones, and exemplifies an innovative application of digital video production.

His (2007) recognises the ‘intensified engagement’ that young people are experiencing with digital technologies, including video games, social networking websites, mp3 players and mobile phones. Whilst teachers search for strategies that will motivate pupils to engage in literacy activities (Strassman and O’Connell, 2007), it makes sense to channel pupils’ enthusiasm for mp3 players and mobile phones, rather than facing the tireless battle to eliminate them from the classroom. This view is similar to that of Siegle (2009, p.14), who states:

> ‘Young people are naturally drawn to viewing and creating videos… educators should seize on this significant communication and learning tool’.

This highlights the potential of mobile phones and mp3 players as learning tools. Siegle (2009) even suggests that the production of video clips may soon be the ‘fourth ‘R’ (reading, writing, arithmetic and recording), indicating that the skills learnt in planning for and producing digital video clips are transferable across subject areas. For example, creating a documentary on a current issue rather than writing a persuasive essay not only allows students to communicate their ‘ideas, thoughts and feelings’ (op. cit), but also provides pupils with the opportunity to direct their own learning, building their own framework of ideas by sharing their experiences and ideas with each other, and modifying their pre-existing conceptions; a process that is central to the constructivist view of learning (Kearney, 2001). Although research directly linking the use of digital video to improved literacy is limited, the wide range of applications of digital video and the potential for students to direct their learning are very promising.

Methodology

Research Sample

The study was carried out at a mixed inner-city comprehensive for students aged 11-19 years. Attainment on entry to the school is well below average, with particular low levels of literacy (Ofsted, 2007). The study involved 46 Year 7 pupils. The school divides pupils into two equal bands (named X and Y), and pupils in each band are then set according to ability. 25 of the pupils involved in this study were in the lowest set of one band (referred to as 7X3), and the remaining 21 pupils were in the lowest set of the second band (referred to as 7Y3). The pupils were therefore deemed to have comparable literacy levels, which are well below average on entry to the school (Ofsted, 2007). Both groups were taught a sequence of six lessons covering the concept of the particle model. The sequence of lessons for 7X3, as detailed in the scheme of work, included the planning for and production of a two-minute clip using digital video cameras. On the other hand, 7Y3 were taught by more conventional methods, following the school's 'Framework science' lesson plans. None of these lessons involved the use of digital video recording. Following the sequence of six lessons, all pupils were given a literacy assessment to complete, which assessed different aspects of scientific literacy, as described below. It is also important to note that all pupils signed a consent form on entry to the school, giving permission for photographs and video to be taken and used as teaching resources within the curriculum.

The Development of the Assessment

The assessment was based on a theoretical scale of literacy in science, identified by Bybee (1997, cited in Shwartz et al., 2006) and used successfully by Schwartz et al. (2006) to assess literacy in chemistry in high school students. The scale describes the following levels of scientific literacy:

Illiteracy in science: Students are unable to recognise questions as scientific, and do not have the 'vocabulary, concepts, contexts, or cognitive capacity' (op. cit.) to respond.

Nominal literacy in science: Students recognise a concept as scientific, but have a limited level of understanding.

Functional literacy in science: Students can describe a concept, but have limited understanding of it.

Conceptual literacy in science: Students can relate their understanding of specific concepts to more general aspects of their scientific knowledge. Pupils also understand the processes of scientific inquiry.

Multidimensional literacy in science: This level of scientific literacy includes 'philosophical, historical and social dimensions of science and technology' (op. cit.). Pupils make connections between scientific concepts and their relevance to their daily lives, and also make connections between scientific disciplines. Pupils are able to apply their understanding to the 'larger issues challenging society' (op. cit.).

Due to the multi-faceted nature of literacy in science, it is difficult to address all its aspects using one form of assessment. The assessment was therefore split into three parts, each of which was designed to assess a particular level on the scale of scientific literacy.

Part 1

The first part of the assessment was used to assess nominal and functional aspects of literacy in science. Pupils were asked to rate their understanding of the particle model concept, and then to describe in their own words the arrangement of particles in a solid, liquid and gas. The results of the pupils' own judgements of their understanding were compared qualitatively, whereas the pupils' descriptions of the particle arrangements were marked according to pre-defined criteria. The marks were then compared quantitatively by calculating the mean score and standard deviation for each group.

Pupils were also asked to rate their enjoyment of the topic in comparison to other topics studied in science. Research has shown that if pupils enjoy learning, they are 'more likely to engage and achieve high standards' (QCA, 2008). I therefore felt that it was important to ascertain how much pupils enjoyed the lessons, as this may be a confounding factor in raising achievement.

Part 2

The second part of the questionnaire assessed pupils' ability to use their scientific understanding to explain phenomena, and therefore assessed the conceptual aspect of literacy in science. The questions in this section were based on a framework used by Shwartz et al. (2006) to successfully assess literacy in science. For each question pupils were asked to state whether the suggested explanation for each phenomenon was correct or wrong. Pupils could also choose 'I do not know', to encourage less guesswork, which could inadvertently affect the results. I decided to eliminate the 'partially correct' option used by Shwartz et al. (2006), since pupils consistently choosing this option rather than 'correct' was identified as a limitation of the assessment tool (op. cit.). One mark was given for the correct response to each question, and no marks were awarded for pupils who selected the incorrect response, the ‘I do not know’ option, or those who selected two or more boxes for each questions. The pupils were not informed of this mark scheme, which therefore did not deter them from selecting ‘I do not know’ if they were unsure. Following the marking of this section the mean scores and standard deviation were calculated for both sets of pupils.

Part 3

The aim of this section was to assess the multidimensional aspect of literacy in science. Pupils were presented with an unseen paragraph on the history of the development of the particle model, and were asked to answer the associated questions. These questions involved a reading comprehension, as well as inferences regarding the size and number of particles in a grain of salt given the data in the text. These questions were marked according to the mark scheme and the mean score and standard deviation for each set of pupils was calculated for comparison. Lastly, pupils were asked whether or not they had any questions relating to the paragraph or the particle model in general, which gave them an opportunity to link the concept to their daily lives and the wider issues affecting society.

Discussion of the Outcomes

The results of the study have been split into two sections: the results of the formal assessment of literacy in science (parts 1, 2 and 3) and the pupils' enjoyment of the lessons.

Formal Assessment of Literacy in Science

The analysis of the contribution of digital video recording to the improvement of scientific literacy is presented in Table 1 below.

Table 1: Differences between mean scores and standard deviation for 7X3 and 7Y3.

	7X3 Mean	7Y3 Mean	7X3 Standard Deviation	7Y3 Standard Deviation
Part 1	96.0%	61.9%	11.1%	33.8%
Part 2	81.3%	61.9%	19.4%	20.4%
Part 3	72.7%	44.4%	14.3%	27.0%
Overall	80.9%	56.1%	12.2%	17.6%

Part 1

The mean score is significantly higher for 7X3 than 7Y3, indicating that the use of digital video recording was extremely effective in improving pupils' literacy in science. The low standard deviation (11.1%) for 7X3 also indicates that the results are consistently high, whereas for 7Y3 the standard deviation (33.8%) suggests that some pupils' literacy levels are significantly worse than others. The greatest difference in mean scores between 7X3 and 7Y3 was for part 1 of the assessment, suggesting that the use of digital video recording particularly improved pupils' levels of nominal and functional literacy. Pupils rarely get an opportunity to talk and discuss science in the classroom (Dillon, 1994, cited in Wellington and Osborne, 2001, p.82), despite evidence favouring 'learner-centred' teaching over 'teacher-oriented' teaching (Rodriguez-Maimon et al., 1990). Much of the dialogue that does take place between teachers and pupils is characterised by the 'initiation, response, feedback (IRF)' sequence (Jones, 2007), which fails to give responsibility to the learners, thereby inhibiting their autonomy (Rodriguez-Maimon, 1990). The group work encouraged by the use of digital video recording gave pupils the opportunity to discuss science in the classroom. Learning the language of science has been deemed essential to learning science itself (Wellington and Osborne, 2001, p. 82). I therefore believe that this opportunity to discuss science with peers in preparation for the digital video recording has significantly enhanced the learning of science for 7X3. The pupils were consequently able to articulate their descriptions of the particle arrangement in solids, liquids and gases, exhibiting high levels of nominal and functional literacy.

Part 2

The mean score of the literacy assessment for 7X3 is 19.4% higher than that for 7Y3, and the standard deviations are similar for both groups. These results are consistent with the conclusion that the digital video recording significantly improved literacy levels in science. However, the gap between attainment for 7X3 and 7Y3 is narrowest for this part of the assessment, indicating that the digital video recording was not as successful at improving levels of conceptual literacy as it was at improving other aspects of the literacy scale. It is also important to note that the standard deviation for 7X3 is greater for this part of the assessment than for any other, indicating that the results are more spread out. This suggests that whilst some pupils' conceptual literacy was not significantly improved, other pupils' levels were greatly enhanced. This may have been due to the nature of the activity set. Pupils worked in groups to plan their digital video recording and different groups were set different phenomena to explain. The higher ability groups related the arrangement of particles in solids, liquids and gases to the properties of materials, such as a solid being unable to diffuse. On the other hand the lower ability groups were less likely to relate their knowledge of the particle model to the properties of solids, liquids and gases. Whilst there was less consistency overall in the results of pupils' literacy assessments, the range of activities acted as effective differentiation by task, which has been shown to 'foster autonomous learners' (Betts, 2004). Giving pupils a more rigid framework to use whilst planning their video clips may have encouraged more pupils to relate their understanding of the particle model to more general aspects of science, including the properties of materials. However, this would have compromised the valuable degree of autonomy that pupils had, which allowed them to direct their own learning (Rodriguez-Maimon, 1990).

Part 3

In the assessment of multidimensional literacy, 7X3 achieved a mean score that was 28.3% higher than that of 7Y3, indicating significantly higher levels of literacy. However, whilst marking the assessments I noticed that a number of pupils in 7Y3 had not read the question prior to completing the diagram, 'Ideas about the world'. Subsequently, they described their own ideas about the world with no reference to the historical development of the particle model, as described in the paragraph provided. This lack of attention to the question may have been a negative reaction to the length of the assessment, however since this only occurred in one of the groups, it is more likely to be linked to a feature of that set of pupils. Research has shown that scientific text is 'often less engaging and less motivating than other types of reading matter' (Wellington and Osborne, 2001, p. 43). Since pupils in 7X3 enjoyed the particle model lessons more than those in 7Y3 (as described below), the pupils' interest in the topic may have inspired their motivation for reading. It may also be that pupils in 7X3 felt more familiar with some of the terms in the paragraph due to their higher levels of nominal and functional literacy, and therefore felt more confident in reading and interpreting the scientific language.

When asked whether or not the pupils had any further questions on the particle model concept, only 3 pupils wrote down questions, and these pupils were all in 7X3. Two pupils asked, 'Can we do practicals more often?' and one pupil asked, 'What was the theory of the scientists?' Neither of these questions connected scientific disciplines with larger issues challenging society, and thus neither illustrated high levels of multidimensional literacy.

Bybee (1997, cited in Shwartz et al., 2006) recognises that achieving multidimensional scientific literacy ‘in all scientific domains’ is probably impossible, and it was therefore expected that the lowest average marks would be in this section of the assessment. Despite this, the evidence still suggests that the use of digital video recording in 7X3 helped to enhance multidimensional literacy.

Pupils’ Enjoyment of Lessons

The comparison of pupils’ enjoyment of lessons is presented in table 2 below.

Table 2: A comparison of the proportion of pupils at different levels of enjoyment.

Level of Enjoyment	7X3	7Y3
Enjoyed the particle lessons more than other topics	76%	33%
No difference in enjoyment between this topic and others	24%	48%
Enjoyed other topics more than the particle model lessons	0%	19%

The table shows that a large majority of pupils in 7X3 enjoyed the particle model lessons more than other topics, compared to 7Y3 where the results are more diverse. Research has shown that if pupils enjoy learning, they are ‘more likely to engage and achieve high standards’ (QCA, 2008). This indicates that the higher literacy levels of 7X3 may be linked to their high degree of enjoyment of digital video recording. Research has also found that pupils' learning styles affect the degree of enjoyment in mini science projects (Mehmet, 2009). This, combined with pupils' high degree of enjoyment, suggests that the digital video recording suited a range of pupils' learning styles. Wellington and Osborne (2001, p.82) write:

> 'Ideas in science are communicated through words, charts, diagrams, symbols, pictures and mathematics…'

This emphasises the multidimensional nature of the language of science, which we expect pupils to learn. By allowing pupils to direct the planning and production of their video clips, pupils could use a range of these methods, as well as practical equipment, in accordance with their preferred learning style. This degree of choice is likely to have increased their degree of enjoyment of the lessons (Betts, 2009), and thus ultimately contributed to their engagement in the topic and high standards of achievement (QCA, 2008) in terms of increased levels of literacy in science.

Implications for learning and teaching

The use of digital video recording has opened up an innovative way of enhancing literacy in science. By using simple cameras and ensuring that a classroom PC and projector is set up in advance, footage can be recorded, transferred to the computer and presented in one lesson. This provides an exciting and highly effective way of providing feedback to pupils. Peer and self-assessment can also be used to evaluate the quality of the footage, which, when compared with teacher feedback, provides pupils with a greater volume of feedback in a shorter period of time (Topping, 2009). The use of the digital video cameras also had a motivational effect, since pupils knew that their work would be shown to the class. The applications of digital video recording are vast. For example, pupils could use the cameras to record explanations of a particular misconception. Pupils could also record a movement, which they then represent in a distance-time graph. Video clips could also be transferred to pupils' ipods or mp3 players using free downloadable software, for use as revision tools. Although this study has focussed specifically on improving literacy in science, the digital video recording can be used across the curriculum to encourage pupils to develop higher level thinking skills and to direct their own learning as part of the constructivist learning process.

Conclusion

Shwartz (2006) writes:

> 'The challenge for developers of learning materials is to recognise and enhance all levels of literacy…'

The results of this study indicate that the use of digital video recording can enhance nominal, functional, conceptual and multidimensional aspects of literacy. The teaching method seizes the enthusiasm that pupils have for technology and allows pupils to take control of their learning. The planning and recording stages of digital video production can involve many ways of communicating (visual, verbal, practical), which can be exploited to engage with different learning styles.

The importance of this study goes beyond assessing the effect of digital video recording on literacy in science. Evidence suggests that digital video recording has a wide range of applications across the curriculum (His, 2007; Siegle, 2009). It is important for teachers to recognise the benefits of digital video recording, and for future research to establish the role that digital video recording can play in enhancing learning in other areas. An important area for future study would be to investigate the impact that digital video recording can have on the literacy levels in science of pupils who already have average, or above average levels of literacy.

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