

Learning to read with a critical eye: cultivating discerning readers of media reports with a science component

Billy McClune and Joy Alexander

ABSTRACT It is important for young people to be able to read science-related media reports with discernment. 'Getting Newswise' was a research project designed to enable science and English teachers, working collaboratively, to equip pupils through the curriculum with critical reading skills appropriate for science news. Phase 1 of the study found that science and English teachers respond differently to science news articles and eight categories of critical response were identified. These findings informed phase 2, in which classroom activities were devised whereby pupils examined, evaluated and responded to science-related news reports. Science–English collaboration had positive outcomes for pupil understanding.

'It is not acceptable to promote bad science.'

So said well-known physicist and science communicator Professor Brian Cox when accepting the Institute of Physics President's Medal in 2012. In that address, he welcomed the prominence of science in the news media but was critical of some media reporting. In particular, he highlighted the then-imminent switch-on of the Large Hadron Collider that was accompanied by alarming headlines and speculative 'doomsday' scenarios. It is important to state that this is not a charge that could be made against all science reporting, much of which is acknowledged to be of a high standard (Science Media Centre, 2002). However, his point was to emphasise the importance of STEM education for the wellbeing of society by equipping individuals to participate in discussion and decision-making on issues with a science component. In a world where cutting-edge science issues are aired in the media, the spotlight should be directed towards the capability to handle a media-driven science experience, since citizens with a good understanding of science methods would be better equipped to cope with the *'misrepresentations of what scientists do and the mis-selling of the wonder of science exploration'* (Cox, 2012).

In their report, *Principles and Big Ideas of Science Education*, a group of international science educators set out ten principles of science

education (Harlen, 2010). These included enabling individuals *'to take an informed part in decisions, and to take appropriate actions, that affect their own wellbeing and the wellbeing of society and the environment'*. These values fit well with the aim of advancing scientific literacy and in particular the objective of improving pupils' capability to cope confidently and competently with big ideas in science that they meet in the world beyond the classroom. Hence science in the media has emerged as one focus of scientific literacy (Millar and Osborne, 1998; National Research Council, 2012).

Scientific literacy is not synonymous with providing opportunities for reading, writing, talking and listening in science lessons, though it cannot be detached from these basic elements of literacy. Fundamental literacy is a prominent theme in scientific literacy research where the importance of learning science through language is highlighted. In their influential text, Wellington and Osborne (2001) explored this relationship in the context of classroom teaching. The relationship is one of interdependence and mutual benefit and, while the elements of reading, writing, talking and listening provide the platform for science learning, learning in science can also advance literacy in a fundamental sense. This is particularly the case where the focus is on science reported in the media.

When the US science education standards suggest that students should be able to ‘*read media reports of science or technology in a critical manner so as to identify their strengths and weaknesses*’ (National Research Council, 2012: 73), they are encouraging pupils to be discerning consumers of as-yet-unimagined science and technology. Science educators recognise that, while few people study science beyond the years of compulsory secondary education, most will gain ongoing science information from news media outlets or other informal sources such as the abridged article in Box 1. Their grasp of media-reported science will influence personal decision-making and their role as contributors to community and society policy and practice. Their sources will often be reporting newsworthy current research and cutting-edge technology. This diet of science in the making is very different from the textbook material that is the chief ingredient

BOX 1 Extract from the newspaper article ‘The five-second rule is real, say scientists’

The ‘five-second rule’ that many of us secretly adhere to is an actual scientific measure of how long your food is safe to eat for, according to a group of biologists.

Final-year students at Birmingham’s Aston University found there is a ‘significant time factor’ on the transfer of bacteria from the floor to food – basically, you have a five second window to pick it up before it stops being safe to eat.

The students placed toast, pasta, biscuits and a sweet on the floor to determine that food picked up straight after being dropped is less likely to contain common bacteria such as *E. coli*.

They also determined that bacteria are least likely to transfer from carpeted surfaces, and most likely to transfer from laminate or tiled surfaces, to moist foods that made contact with the floor for more than five seconds.

‘Consuming food dropped on the floor still carries an infection risk as it very much depends on which bacteria are present on the floor at the time...’, Professor Anthony, who led the study, said.

‘We have found evidence that transfer from indoor flooring surfaces is incredibly poor with carpet actually posing the lowest risk of bacterial transfer onto dropped food.’

(from Saul, 2014)

of much science in school. Media reports are presented in ways that are intended to entertain and they may be speculative and sometimes report science that is contested. Some reporting will dazzle the audience and important elements of the science story may be obscured. Hence the need for science education that engenders a critical response to science experience that is media driven.

At a time when we are becoming used to the blurring of boundaries between traditional science subject disciplines, science and English may nevertheless seem unlikely allies. However, terms such as ‘critical reading’ are becoming part of a shared vocabulary in the professional conversations of both groups of teachers. Science news has emerged as an authentic context for an interdisciplinary approach to scientific literacy (Alexander *et al.*, 2008) and an exemplar for education practice that promotes cross-curricular learning (CIDREE, 2005), but proposals for theoretical constructs that underpin critical reading of science-related news present new challenges both for teacher education and interdisciplinary learning (Jarman and McClune, 2010; McClune and Jarman, 2011; Savage, 2011).

Research study

This article reports on a curriculum and professional development initiative, ‘Getting Newswise’, that was intended to embed media-based scientific literacy within the existing junior school (ages 12–14) science curriculum. This involved articulating learning intentions, identifying appropriate teaching strategies and designing activities that enabled pupils to adopt a critical approach to science-based media reports. In its development, it took account of the different approaches to critical reading of science-related news adopted by science and English teachers (Jarman and McClune, 2011).

This project was conducted in two phases and addressed the personal capabilities and professional skills that teachers use when engaging with media-reported science individually and in an instructional context. Firstly, a study of teachers’ approaches to critical reading of science-related news reports addressed a number of research questions, in particular:

- To what extent does subject discipline influence a teacher’s capacity for critical reading of science-related news?

Secondly, a study of curriculum enhancement initiatives developed by teachers and intended to increase young people’s capacity as discerning consumers of media-reported science was undertaken. The research questions underpinning this element of the study focused on the knowledge, skills and attitudes engendered by interdisciplinary approaches to critical reading, in particular:

- What are the characteristics of strategies and resources that teachers use to support literacy development in this context?
- What is the impact on teachers and pupils of interdisciplinary working in relation to the development of critical reading skills?

A theoretical framework for critical reading of science-related news (McClune and Jarman, 2011) provided a basis for data analysis in both phases of the study.

Phase 1: Teachers’ critical reading practice

Phase 1 was a qualitative observational study involving 90 trainee and experienced teachers of science and of English. Participants in this study were all university graduates with either science or English-based subject expertise.

News articles with a substantial science component were identified in prominent national print media sources. Articles on health-related issues and space science topics were selected and participants each completed two critical reading tasks at the start of the project. Two additional critical reading tasks were completed following a period of interdisciplinary working.

For each critical reading task, participants were provided with a news article and were asked to identify all the elements in the report that stimulated a response as they read the article with a critical eye. In addition to annotating text as fully as possible, participants were asked to indicate the nature of their critical response by adding a comment, a question or a request for clarification or additional information, or by drawing attention with explanatory notes to elements of the text that they believed might influence their interpretation and response to the story. Data in the form of participants’ annotations provided an insight into their spontaneous and individual critical reading practice. These responses were coded, collated and subsequently analysed. Table 1 shows the categories (elements) of the news reports that stimulated a critical response.

Table 1 Categories (elements) of news report that stimulated a critical response

Categories of news reports that stimulated a critical response (news report elements)	→ Exemplar queries →	→ Characteristics of a critical reader
1. Source of report (publisher and author)	Who wrote the article?	Aware of influences of media production
2. Sources of information (informants)	Where is it published? Are the sources credible?	
3. Headlines and language	Is the language emotive or persuasive?	Demonstrates literacy skills
4. Text elements	What facts are reported? Whose opinion is reported?	
5. Technical vocabulary	Questioning scientific or technical words or ideas.	Uses science knowledge
6. Evidence and conclusion	Is there evidence about what others in the scientific community think?	
7. Consensus or disagreement	What conclusions are made? Does the evidence support the conclusion?	
8. Significance	Is this important? How will this affect me? What impact will this have on others?	Displays critical habits of mind Is perceptive and shows sensitivity

Phase 2: Curriculum development and classroom practice

The second phase of the study was intended to identify strategies and teaching approaches to help pupils make meaningful cross-curricular connections to support their learning. Findings from phase 1 of the study informed this development. Lesson planning, classroom practice and professional discourse were all scrutinised in order to identify the influence of interdisciplinary working on pedagogy. In particular, the objectives of the study were to observe and report the effect of encouraging teachers to work beyond their traditional disciplinary practices and to:

- apply interdisciplinary knowledge in their planning for teaching, drawing on skills from other subject areas in support of their classroom practice;
- adopt a collaborative attitude to professional interactions that support pupils' learning.

This second phase of the study involved 14 teachers from seven secondary schools. The science and English departments in each school jointly sponsored the project, with one science and one English teacher from each school taking a lead role. Schools selected topics taught in the early years of secondary school, working with pupils aged between 12 and 14 years. They identified topics that could be incorporated into the existing programmes of study for both science and English. Data were collected from teachers and pupils by interview and by observation, and from analysis of resources, critical reading tasks, classwork and curricular and planning documentation.

Findings and observations

Phase 1

In the study of teachers' critical responses to news reports, researchers identified eight different categories of information or text elements that stimulated a 'critical response'.

Table 1 shows these categories (elements) of the news report and maps them via exemplar queries to characteristics of a critical reader based on a theoretical framework for critical reading of science-related news (McClune and Jarman, 2011).

This phase 1 study uncovered differences in the way science and English specialists respond to media reports with a science component. Initially (before any collaborative work), participants were

given two news articles. One described a scientific study that involved a treatment of some forms of inoperable cancer and the other was a scientific study claiming to provide insights into the origin of the solar system. Analysis of the critical responses showed that:

- participants limited their critical response to just a few categories of news reports but often gave several examples in any one category;
- some categories have a higher prominence than others in teachers' critical response;
- there is variation between individuals in the type and pattern of critical response to a science-related news report.

These findings suggest that, while core themes are recurrent in critical responses, there is no commonly understood checklist in use that is informing teachers' critical reading practice.

In addition, analysis of critical responses showed that:

- science and English specialists have different perspectives on critical reading of science-related news reports that are characteristic of the subject group and these differ from one another in important ways.

Science and English teachers as discrete groups are likely to approach critical reading differently. Where they target the same news elements, they emphasise different aspects of these. An individual's response to a news report is unique, reflecting the respondent's experience, interests and priorities. It could additionally be argued that individual critical responses were partial and lacked the rigour present in the critical response of a multidisciplinary group. Figure 1 shows the percentage of teachers in the study (by subject background) responding to each category in one news report. While there are different patterns of response for each news report, the response profiles for different news reports are comparable. There are no firm boundaries between the responses of science and English teachers; however, the evidence would support the following generalisations:

- Science teachers focus on the accuracy of the headline language; English teachers focus on the use of language in the text to influence the reader.
- Science teachers take note of the scientific context and make links to established

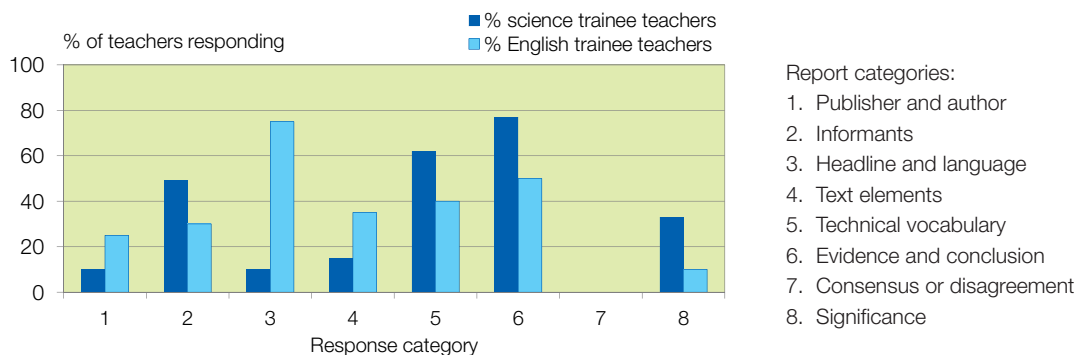


Figure 1 Critical response profile for a science news report (in this example, a health article entitled 'Gold shells kill inoperable tumours')

knowledge; English teachers find meanings of technical words and phrases to be an obstacle.

- Science teachers challenge the credibility of the sources and seek reassurance; English teachers appreciate the voice of a first-hand witness and appear less concerned than science teachers about their status.
- English teachers are more likely than science teachers to distinguish between fact and opinion.
- Science teachers are more likely than English teachers to look for links between the conclusion of the article and the evidence presented in the text.

Elements of language (3), science knowledge (5) and the role of informants (2) in the report all feature prominently in the critical response profiles of news articles by all teachers. However, while science teachers tend to limit themselves to the language of the headline, English teachers address aspects of language more fully, drawing attention to examples of limiting clauses, emotive and neutral language, and the devices journalists use to engage and influence their readers.

Furthermore, while all teachers note the impact of technical vocabulary, science teachers regularly engage in a more extensive enquiry by drawing attention to the science knowledge that underpins the news report. This is often in an attempt to place the report in its science context or to expand on, or question, what they consider to be a superficial level of explanation. In addition, science teachers often comment on or seek clarification about aspects of the study, for example the nature of the data collected, the sample size or the sources of funding.

English teachers often draw attention to the role of informants in the news report. Their interest is often in the perceived credibility of the individual and the impact of a personal witness to the reported research. By contrast, science teachers are more likely to draw attention to the source of information or the informant in order to question the credibility. For example, when news articles report conference presentations, journal publications or the university location of research groups, science teachers seek reassurance of peer review or enquire about the reputation and status of individuals and research groups who carried out the work.

As well as distinct responses in these areas of overlap, there are also observable differences between the categories of response used by science and English teachers. Most notably, English teachers distinguish between fact and opinion in the text, whereas science teachers are more likely to look for links between the conclusion of the article and the supporting evidence.

Observations

Teachers displayed traits in critical reading that were characteristic of their subject background. This may have implications for how critical reading skills might be taught. If teachers are unaware of alternative perspectives on critical reading, pupils may have difficulty connecting learning experiences from different curricular areas. However, there may also be opportunities for pedagogical synergies that could be beneficial and enhance the learning experience if differences are acknowledged.

This suggests that if pupils experience critical reading tasks in both science and English

lessons initiated and moderated by both science and English teachers, they are likely to have a more comprehensive critical reading experience than would be the case if the task were left to one subject area or the other. If those critical reading experiences are coordinated in some way, greater potential benefits may be realised. These findings provided impetus for the development of strategies and resources in a framework grounded in the interdisciplinary nature of critical reading (McClune, Alexander and Jarman, 2012)

Phase 2

The phase 2 study focused on the impact of a scientific literacy curriculum initiative, ‘Getting Newswise’, on teachers’ curriculum planning

and classroom practice, in particular learning outcomes and lesson content.

The study identified a range of resources and strategies that teachers believed to be effective. These have been categorised and the resulting structure forms the basis of a framework to promote critical reading. Teachers devised learning intentions and planned activities that were intended firstly to help pupils check the overall credibility of the text (Examination), secondly to consider the purpose of the text and the potential influence of media presentation and language (Evaluation), and finally to personally react to the text (Response). Figure 2 illustrates the links between a framework to promote critical reading

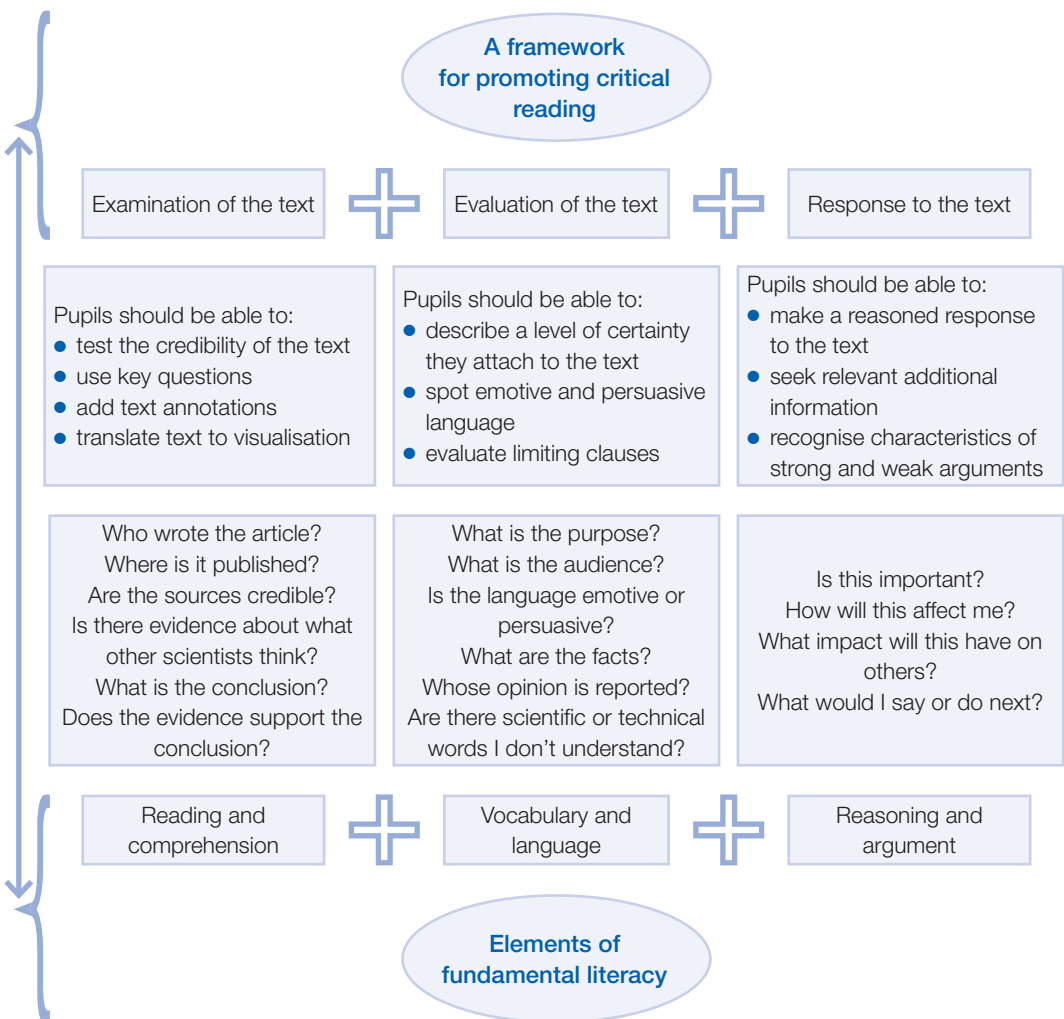


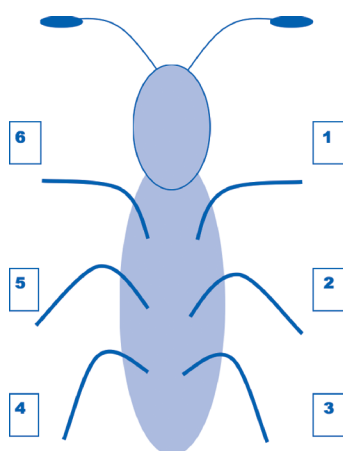
Figure 2 A literacy-based framework for promoting science-focused critical reading

and core elements of literacy. Teachers selected, adapted and created a range of activities for use in the classroom (Jarman and McClune, 2011). Many of these can be linked to the critical questions and news report elements illustrated in Box 1.

Examination

Tasks to help pupils judge the credibility of the text were often based around critical questions. Pupils were able to demonstrate their critical questioning skills in relation to science-based media reports as they assessed the content and context of the report, its scientific basis, and the adequacy of the conclusion (e.g. Who wrote the article? Where was the research conducted and by whom? Does the evidence support the conclusion?). A report may be considered inadequate if it is unable to satisfy the reader's critical questions. However, it is important to note that an inadequate news report does not imply that the science research that is reported is lacking in rigour. Media reports are often limited. A report that pupils consider interesting or important to them may stimulate additional questions and encourage further exploration. In this case, an appropriate critical response is to seek more reliable information.

Examination of the text involved a number of active learning strategies, including question sorting, text annotation and visualisation – translating text to labelled diagrams, flow charts or other forms of sequencing of any research method described or suggested by the text. One example of a questioning activity is illustrated in Figure 3.



Each leg of the 'news bug' represents a key question. Pupils build or disassemble the bug according to the number of questions they (as a group) agree have been satisfactorily answered from the text.

A news bug that is unable to stand or is particularly unsteady represents a media report story that lacks credibility in some key areas, i.e. the story does not stand up to scrutiny.

Different sets of questions may be needed for different types of media report.

Evaluation

A second group of tasks encouraged pupils to engage closely with the text. These critical evaluation tasks were intended to give pupils strategies that they can use to help them assess the degree of confidence the reader should have in the content and conclusions of the report. As pupils consider how and why the report was constructed, they examine the journalist's use of language to influence the reader, look closely at the text to assess the balance of fact and opinion, and identify and recognise the significance of limiting clauses in order to determine the level of certainty the reader can place on the report and its claims.

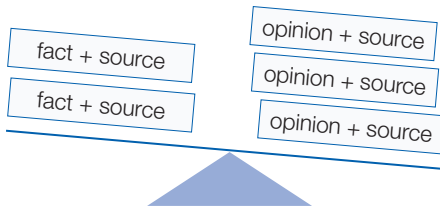
Evaluation of the text involved a number of active learning strategies that relied on and also supported language and vocabulary skills, as illustrated in Figure 4.

Response

Teachers also valued learning outcomes that encouraged critical and reflective thinking. These critical response tasks were intended to introduce pupils to strategies that they can use to help them make a personal reasoned response to a science news report.

Pupils were encouraged to read the text closely, listing additional questions that they (as a reporter) would ask or information they would seek from the science research team to enhance their report. Some activities imitated the practice common in web-based news outlets and social media platforms that provide their audience with almost instant involvement in the news construction by including the views and responses of the audience alongside the media report. By examining exemplar audience responses to the news report, pupils were able to identify the characteristics of a well-reasoned response. By making a personal response to a news report, pupils are able to demonstrate their

Figure 3 A news bug – a questioning instrument to represent critical evaluation (Jarman and McClune, 2011)



A good science report tells a story based on facts. Read the news report, highlight the facts, take a note of the source and list them on one side of the balance. Repeat the task looking for opinions. Sometimes these are the opinion of the author. Note the different voices in the report.

Figure 4 Fact finder – a tallying instrument to aid close reading

ability to include these characteristics in their own response or argument. Figure 5 illustrates some reader responses to a report about the scientific justification for not wasting food dropped on the floor (see Box 1).

Observations

Teachers noted that the source of the material (i.e. news media), the nature of the topics, and the balance of reading, writing, talking and listening activities helped some weaker or less engaged pupils find a voice. Increased involvement of boys was particularly noted. The outcomes of this study in the form of exemplar classroom activity and analysis of programmes for action represent a bridge between theory and practice.

Outcomes and discussion

Teachers reported that they used a variety of formal and informal mechanisms to conduct subject-related professional conversations. In addition to expected planning and progression issues, this professional discourse also addressed pupils’ learning and stimulated teachers’ shared thinking on teaching and learning. Teachers noted that this level of reflection on pupils’ progress was unanticipated but beneficial both for pupil learning and teacher professional development. They valued peer support and suggested that this level of interaction generated with colleagues across the curriculum was rare.

Efforts to coordinate work across the curriculum by accommodating different subject

Rate the comments below. A ‘5 star comment’ is one that you believe makes a good argument in response to the news item. Give fewer stars to arguments that you feel are weaker. Give a reason for your star rating. Remember that you do not have to agree with the argument.

Comment	Star rating	Reason for your rating
These findings confirm what I already knew – the five-second rule tells us that it is safe to eat food dropped on the floor if you know who dropped it.		
This article is irresponsible. Food safety is too important a topic to allow people to go on believing that food dropped on the floor is safe to eat. One study under laboratory conditions with selected bacteria is not sufficient to suggest that we drop our guard when it comes to food hygiene.		
I never get tummy upsets and I haven’t missed a day at work in 20 years. I live by the credo known as ‘when in doubt throw it out’. I think any sensible person would put this science where it belongs – in the bin!		
My parents lived through hard times and taught me that to waste anything especially food was wrong. Throwing away perfectly good food is a luxury only some people can afford.		
There are lots of bacteria on our hands; the second we touch anything it is contaminated. Food on the floor is more likely to be good after 5 hours.		

Figure 5 Reader response – a rating instrument to aid reflective thinking

priorities and incorporating unfamiliar ideas highlighted teachers' limited interdisciplinary knowledge, and thus the scope for subject integration at the level of individual lesson elements was restricted. Teachers attributed this to their lack of confidence but also to curricular inflexibility. However, they noted that collaborative working influenced the way continuity and subject links were emphasised, and the range of teaching strategies used increased as a result of borrowing or adapting strategies suggested by colleagues in other subject areas. Teachers also noted that the language and ideas were carried between lessons by pupils who talked about their related learning in other subjects. As one science teacher said, 'I know what happens in English – the lesson travels down the corridor with the pupils.'

Conclusion

Critical reading of science-related media is an authentic cross-curricular context for collaboration between teachers of science and of English who share a concern for developing pupils' critical reading skills. These subject specialists have

different but complementary perspectives on critical reading.

If science educators are to enable pupils to be critical readers who are media aware, they will need to occupy the ground where scientific literacy and media literacy intersect. In that area, teachers' appreciation of the cross-disciplinary subject knowledge and pedagogical knowledge needed for critical reading may be tentative and limiting. They will need support to develop appropriate teaching strategies and resources.

Initial teacher education providers and those responsible for their own or others' professional development could promote critical reading through proactive approaches to interdisciplinary collaboration. This would enable teachers to explore pedagogical synergies that could be beneficial to developing both scientific literacy and fundamental literacy and in addition further the goal of enabling pupils to become discerning readers of science presented in the media.

Acknowledgement

'Getting Newswise' was funded by the Primary Science Teaching Trust (formerly AZSTT).

References

- Alexander, J., Walsh, P., Jarman, R. and McClune, B. (2008) From rhetoric to reality: advancing literacy by cross-curricular means. *Curriculum Journal*, **19**(1), 23–35.
- CIDREE (Consortium of Institutions for Development and Research in Education in Europe) (2005) *Cross-Curricular Themes in Secondary Education: Report of a CIDREE Collaborative Project*. Belgium: CIDREE. Available at: www.cidree.be/uploads/documentenbank/4854365076a88c8ba93cbebe04fd9196.pdf.
- Cox, B. (2012) *It is not acceptable to promote bad science*. Acceptance speech for the Institute of Physics President's Medal. Available at: www.youtube.com/watch?v=r7BTqKeP6Ks.
- Harlen, W. ed. (2010) *Principles and Big Ideas of Science Education*. Hatfield: Association for Science Education. Available at: www.ase.org.uk/documents/principles-and-big-ideas-of-science-education.
- Jarman, R. and McClune, B. (2010) Developing students' ability to engage critically with science in the news: identifying elements of the 'media awareness' dimension. *Curriculum Journal*, **21**(1), 47–64.
- Jarman, R. and McClune, B. (2011) *Science Newswise 2*. Hatfield: Association for Science Education.
- McClune, B. and Jarman, R. (2011) From aspiration to action: a learning intentions model to promote critical engagement with science in the print-based media. *Research in Science Education*, **41**(5), 691–710.
- McClune, B., Alexander, J. and Jarman, R. (2012) Unexpected allies: advancing literacy in a 'Science-English' cross-curricular context. *International Journal of Educational Research*, **55**, 66–78.
- National Research Council (2012) *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Washington, DC: The National Academies Press. Available at: www.nap.edu/catalog/13165/a-framework-for-k-12-science-education-practices-crosscutting-concepts.
- Millar, R. and Osborne, J. (1998) *Beyond 2000: Science Education for the Future*. London: King's College London, School of Education. Available at: www.nuffieldfoundation.org/sites/default/files/Beyond%202000.pdf.
- Saul, H. (2014) The five-second rule is real, say scientists. *Independent*, 13 March. Available at: www.independent.co.uk/news/science/the-five-second-rule-is-real-say-scientists-9190069.html.
- Savage, J. (2011) *Cross-Curricular Teaching and Learning in the Secondary School*. London: Routledge.
- Science Media Centre (2002) *Consultation Report*. Available at: www.sciencecentre.org/wp-content/uploads/2012/09/Science-Media-Centre-consultation-report.pdf.
- Wellington, J. and Osborne, J. (2001) *Language and Literacy in Science Education*. Buckingham: Open University Press.

Billy McClune is Director of Education and **Joy Alexander** is an honorary lecturer in the School of Education at Queen's University Belfast. Emails: w.mcclune@qub.ac.uk and j.alexander@qub.ac.uk