Writing narratives about a socioscientific issue: Engaging students and learning science

By Louisa Tomas

International assessments of student science achievement, and growing evidence of students’ waning interest in school science, have ensured that the development of scientific literacy continues to remain an important educational priority (Tytler, 2007). Consequently, researchers and classroom teachers alike have called for innovative approaches to teaching and learning that engage students meaningfully in the learning of science. This paper explores the cognitive and affective outcomes of one such approach. Known as BioStories, this online science writing project requires students to write hybridised narratives that integrate information about an important socioscientific issue as a way of reengaging students and developing an understanding of the underlying science concepts. Studies conducted with students in Year 9 and 12 have shown that such writing can stimulate students’ interest and make science accessible, while developing their scientific literacy and a positive disposition towards science. This paper reviews the growing research evidence to support this approach and implications for classroom practice.

WRITING STORIES IN SCIENCE

The use of writing tasks to develop scientific literacy is well-reported within the literature (e.g., Hand & Prain, 2002; Hand et al., 2003; Wellington & Osborne, 2001), however, there is growing recognition that there is value in engaging students in writing to learn science activities that move beyond the traditional scientific genres taught in schools. An extensive review of the literature on writing for learning science conducted by Prain (2006) found that educational theorists “have emphasised the value of expanding the purposes, writing types, and readerships for writing in science” (p. 184) as a way of helping students to clarify networks of science concepts.

A number of studies have shown that diversified writing tasks, including more imaginative writing, can assist students’ learning processes; improve learning outcomes, and impact positively on students’ attitudes, motivation and engagement (e.g., Hanrahan, 1999; Prain & Hand, 1996, 1999). Narratives, in particular, can be a powerful tool in science instruction, as they enhance the relevance and accessibility of science by enabling students to connect personal experiences with science ideas (Avraamidou & Osborne, 2009; Fensham, 2001) and can be used to “initiate writing in science in a manner which is enjoyable” (Wellington & Osborne, 2001, p. 76).

While some researchers are apprehensive about the provision of creative writing opportunities in science (e.g., Keys, 1999), proponents of a diversified approach argue that sole emphasis on scientific genres can turn students off science as they often encounter difficulties writing in the third person style typical of scientific texts (Wellington & Osborne, 2001). There is also concern that teaching students the scientific method (i.e., the principles of scientific experimentation and research, and writing laboratory reports) can mislead students about the ways in which science is conducted or reported and “conveys an unrealistic and unappealing view of science” (Bereiter & Scardamalia, 2009). While a diversified approach to writing does not diminish the value of canonically accurate scientific discourse, it can “promote students’ scientific literacy by developing their interest in and capacity to apply scientific thinking to social issues for the purposes of informed action” (Hand & Prain, 2002, p. 742).

THE BIOSTORIES PROJECT

The research outcomes summarised in this paper arose from a series of ‘BioStories’ studies that engaged students in the writing of hybridised scientific narratives – that is, short stories that merge scientific information with narrative storylines. Hybridised writing offers students an opportunity to “cross borders between specialist and more popular genres and readerships” (Prain, 2006, p. 190) by employing their vernacular language to communicate science understandings through dialogue between characters; a process that emulates the conversations that students might have about important socioscientific issues with their parents or peers. Situating students’ writing in the context of a socioscientific issue enhances the relevance of the learning activities and offers students an opportunity to explore societal issues and problems with conceptual links to science and technology (Sadler, Barab, & Scott, 2007). The following excerpt illustrates how technical information about a biological incursion can be integrated into a conversation between characters:

“Well,” Steve continued energetically, “tilapia have invaded and taken over our local waterways. They prey on native fish eggs and have a very effective reproductive strategy which allows them to lay 1200 eggs at a time!”

“Wow, that’s a really big number!” Jennifer replied in amazement, “but how did they get here?”

“They were brought into Australia for the aquarium trade, but someone released some into our waterways”.

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"So how have they become such a problem?" Jennifer asked.

"Well, tilapia aren't very fussy eaters, and will eat insects and weed. They also take over native fish's habitat and eat the food they need to survive," Steve explained.

The BioStories project requires students to write a series of short stories about the socioscientific issue of biosecurity with the support of a dedicated BioStories website. The website presents scenarios that require agricultural industries. The scenarios call for the construction of fictional stories that incorporate scientific information and include dialogue between key characters. The stories introduce students to exotic species (e.g., fire ants, chytrid fungus, silverleaf whitefly, tilapia and avian influenza) that threaten native Australian ecosystems or agricultural industries.

Part A: Crikey!

Since Steve Irwin's fatal encounter with a stingray in 2006, September 4 is usually a sad day for Jennifer. On this particular spring day, strolling between biology lectures at uni, Jennifer fondly remembered her first meeting with the legendary environmentalist, affectionately known around the world as the Crocodile Hunter...

Suddenly, there was a commotion at one of the checkpoints. A customs officer was trying to persuade a reluctant passenger to part with some prohibited plants he had brought with him from the US.

'You know,' Steve started as he watched the passenger try to argue his way out of trouble, 'biosecurity and quarantine are so important to our country. We know how devastating it has been for our vulnerable ecosystems when [Species X, e.g., tilapia] got into the country somehow; it ruined our native ecosystem or agricultural industry, e.g., local waterways,' he explained.

'How on Earth could something like that have such a terrible impact?' Jennifer asked.

'Well,' Steve continued energetically...

Your task: Write 200-250 words in order to complete the story. Your teacher will allocate you one of the following scenarios, from which to insert into the storyline above. Be sure to research your biological incursion by exploring the associated websites and reading the scientific information, before completing Part A. Your story must be informative and include scientific information. Remember, using the biological incursion allocated to you, Steve is trying to help Jennifer understand the importance of quarantine. In the conversation that you complete between the characters, aim to address the following information:

- What the biological incursion is.
- Its country of origin.
- How it entered Australia.
- The problems it caused or continues to cause for native ecosystems or agricultural industries (i.e., its impacts).
- The difficulties scientists and farmers face controlling the pest, or how the pest was brought under control.

Figure 1: An extract from the Part A writing task.

Students are provided with links to government websites to assist them in locating accurate and relevant scientific information for inclusion in their stories, and to minimise search time. They work collaboratively with a partner to compose their stories and upload their work to the website where it can be read and reviewed by other students. As well as building a community of learners, this feature of the project exposes students to a broad range of narrative styles and enables them to read about a range of biological incursions.

The learning potential of writing BioStories has been investigated in four studies conducted with students in Year 6 (Ritchie, Tomas, & Tones, 2010), Year 9 (Tomas, 2010; Tomas, Ritchie & Tones, 2011) and Year 12 (Tomas & Ritchie, 2012). While story-writing might be more typically associated with primary-aged children, this paper summarises the major findings of the Year 9 and 12 studies. Year 9 is a critical juncture as students select subjects that will inform their choices for their senior years of schooling. Similarly, for students in Year 12, their school science achievements can play an important role in shaping their future career choices. Collectively, these studies have focused on a range of cognitive and affective outcomes arising from students' participation in the BioStories project:

- Students' developing conceptual understandings (Tomas, 2010);
- Students' attitudes toward science and science learning (Tomas et al., 2011); and
- Positive emotions elicited by the BioStories project (Tomas & Ritchie, 2012).

In the following sections, a summary of these outcomes is presented as evidence to support the inclusion of writing activities that feature hybridised scientific narratives in science curricula as a way of engaging students and learning science. This is followed by a discussion of implications of these outcomes for classroom practice.

OVERVIEW OF YEAR NINE STUDIES: DEVELOPING STUDENTS' CONCEPTUAL UNDERSTANDING AND ATTITUDES TOWARD SCIENCE

The Year 9 studies were conducted with eight science classes and their teachers in a co-educational urban school. The first study (Tomas, 2010) investigated the conceptual science understandings of students in a single case study class. As well as examining the texts qualitatively for instances in which conceptual understandings related to biosecurity were communicated, the stories were analysed quantitatively using a series of specifically-designed matrices to produce numerical scientific content scores. These scores served to reflect the extent to which the stories communicated accurate information about biosecurity.

In the second study (Tomas et al., 2011) attitudinal data were generated using a Likert-style questionnaire, the BioQuiz, completed by all students at the beginning and end of the project. The BioQuiz examined students' interest in learning about science; science self-efficacy; perceived general and personal value of science; familiarity with biosecurity issues; and attitudes toward biosecurity.

Both studies were followed by semi-structured student interviews that probed students' conceptual understandings and their perceptions of the project, including aspects that they did or did not enjoy. Qualitative analysis of the interview transcripts complemented the quantitative data sources in each case.
Conceptual Understanding

An analysis of the scientific content scores generated by the BioStories written by students in the Year 9 case study class revealed a significant improvement in scores from Part A to Part B, which indicates that students included more accurate scientific information in their Part B BioStories, compared to Part A (Tomas, 2010). While this finding suggests that students successfully communicated science through their stories, analysis of the interview data revealed that students did learn science through their participation in the BioStories project, and they were able to verbalise their understandings in conversations about their stories. Importantly, this learning had more than a short-term effect: as students could recall or explain concepts two to six weeks after completing the final writing task, when the interviews were conducted. For example, students could accurately recall the scientific concepts about which they wrote, such as the environmental impacts of the biological incursions that featured in their Part A BioStories. Most significantly, students elaborated on the concepts identified in their BioStories, or explained new concepts that they didn’t write about, including the ecological, social and economic impacts of the biological incursions.

Collectively, these findings suggest that students’ participation in the BioStories helped them to develop an understanding of the underlying science concepts (as well as the broader social and economic implications of breaching biosecurity) as evidenced by their conceptual understandings articulated at interview, and the improvement in students’ scientific content scores.

Attitudes toward Science and Science Learning

The results of the previous study found significant gains in students’ conceptual understanding arising from their participation in the BioStories project. Could writing hybridised narrative science engage students affectively and enhance their attitudes toward science and science learning? An analysis of the BioQuiz scores revealed significant improvements in students’ interest in learning science, science self-efficacy, and their personal and general value of science (Tomas et al., 2011). The greatest improvement was observed for interest in learning science.

Qualitative analysis of student interview data reinforced these findings and provided deeper insights into the ways in which their participation in the BioStories project enhanced their attitudes toward science and science learning. In particular, four themes were drawn from the aspects of the project most frequently identified by students as being positive or enjoyable, as exemplified by the following student comments:

- **Writing differently in science** – both in terms of the genre (i.e., hybridised scientific narratives) and topic of their writing (i.e., biosecurity) – enhanced students’ engagement in science learning: “I thought it was fun how you could put [scientific information] into stories. You didn’t have to sit in class and just get all the information thrown at you, and you put it in your book. It was fun to get on the computer and type up your stories”.

- **The student-centred nature of the BioStories writing tasks enabled students to play an active role in their learning:** “I thought it was fun how you could put [scientific information] into stories. You didn’t have to sit in class and just get all the information thrown at you, and you put it in your book. It was fun to get on the computer and type up your stories”.

- **Writing BioStories engaged learners with diverse interests and abilities by enhancing the accessibility of science for those who didn’t normally enjoy science, or found regular science activities more difficult.** This enabled diverse students to experience success in completing the tasks: “I found it really interesting because the term before I had to do a story in English, and so this way was kind of like an English assignment in a science way, because it was more about science than English. So it was really fun”.

While the results of the Year 9 studies suggest that writing hybridised scientific narratives can develop students’ conceptual understanding and enhance their attitudes toward science, it raised further questions about the role and affect, and, more specifically, positive emotions, in engaging students in hybridised writing about a socioscientific issue. This is significant given that improving students’ “emotional relation to the subject matter” (Rosiek & Beghetto, 2009, p. 183) can also enhance learning.

**Overview of Year Twelve Study: Positive Emotions Elicited by the BioStories Project**

The Year 12 study was conducted with three Multi-Strand Science classes (in which students engage in multidisciplinary topics) at a co-educational suburban high school. This study adopted the same hybridised writing tasks as the preceding Year 9 studies, however, given this new focus, additional data sources were included. Students completed an online, Likert-style questionnaire at the end of each BioStories lesson that examined ten positive emotions drawn from the Positive Affect Negative Affect Schedule (PANAS): attentive, strong, inspired, alert, active, excited, proud, enthusiastic, determined and interested (Watson, Clark, & Tellegen, 1988). In order for particular emotions to be attributed to particular BioStories activities, the questionnaire also included items that required students to identify which activities they had engaged in during the lesson. The students’ responses were analysed quantitatively in order to determine which positive emotions where elicited most strongly by particular BioStories activities.

Analysis of the survey data was complemented with qualitative analysis of video recordings of four students (Sarah, Damien, Angus and Mark) as they participated in the writing tasks. Video clips that corresponded to critical shifts in survey responses were analysed using the Facial Action Coding System (FACS) (Ekman & Friesen, 1978). Unlike the survey, this analysis facilitated the identification of in-the-moment emotional responses to their experiences of the project.

Like the Year 9 studies, the project was followed by semi-structured student interviews that explored their perceptions of the project and the emotions most strongly elicited during their participation.

**Students’ Emotional Arousal**

An analysis of the emotions survey completed at the end of each BioStories lesson revealed that strength, pride, determination and interest were the most...
sali ent positive emotions identified by students (Tomas & Ritchie, 2012). Like the Year 9 study (Tomas et al., 2011), analysis of student interview data revealed that learning about the socioscientific issue of biosecurity and writing hybridised scientific narratives in science stimulated students' interest, while enhanced feelings of pride and self-efficacy arose from successfully writing stories about science. Positive teacher-student interactions recorded on video in which students' work was praised by their teacher also elicited outward expressions of positive emotion, which is likely to have contributed to the feelings of pride described at interview. In addition, writing hybridised scientific narratives offers students the opportunity to employ their everyday language and culture to draw on their vernacular language, culture and lived experiences as a way of learning science, and understand science as a "serious subject" devoid of narrative and aesthetic discourses and emotions (Roth, Ritchie, Hudson, & Mergard, 2011; Tyler, 2007), as the following comment from Sarah exemplifies:

"I think it’s good because you kind of get sick of writing in third person. You learn how to, basically, if someone asks you about something, you learn how to have a conversation with them in a way they understand how science works. It’s good because it gives you a break from science and how you have to be really 100 per cent serious!"

An analysis of the activities in which students engaged over the course of the project revealed that transitioning into a new BioStories activity corresponded to a marked increase in selected positive emotions, while participating in the same activity for an extended period of time corresponded to a sharp decline in students' positive emotions (Tomas & Ritchie, 2012). For example, the first lesson in which students engaged in peer evaluation of their BioStories saw a distinct increase in the mean level of delight expressed elicited during the project. As Sarah commented, the peer review process alerted her to, 'what other students think of my work': Learning about biosecurity also alerted students to a range of environmental, social and economic impacts. While some students reflected on this at interview (e.g., Angus: "It shows you how something small [i.e., cane toads] can affect a whole ecosystem'"), the video recordings revealed a moment in time when learning about the potential cost of a bird flu outbreak in Australia elicited an expression of surprise and disbelief from Sarah (Erman & Friesen, 1975): "Holy moley! Look! Look at what would happen to our economy... 4.4 million, no trillion dollars would be lost. That is ridiculous!"

**Implications for Classroom Practice**

It has been suggested that learning can, and is likely to, occur when teachers encourage different forms of expression, and require students to create original and public products that enable them to be 'experts' (Perrone, 1994). Writing narratives in science requires students to draw on their vernacular language, culture and lived experiences as a way of learning science, with an emphasis on interpreting and constructing scientific texts for a public audience.

The BioStories studies have shown that writing hybridised narratives in science can be equally interesting for both middle- and senior-school students. While one Year 9 student commented, "It was good that we didn’t just have to write a report", another explained, "The writing we normally do in science, you can’t say ‘I’ or ‘we’, they and in this you could just use whatever you want to say". Similarly, Sarah explained, "I think it’s good because you kind of get sick of writing in third person". These comments support concerns that over-emphasising the rules of formal scientific language can serve to disengage students and discourage them from writing in science (Wellington & Osbourne, 2001). At the same time, hybridised writing in science offers teachers a way of engaging students in the investigation of socioscientific issues that aren’t particularly suited to more traditional forms of scientific inquiry that might otherwise be taught in less engaging ways.

Notwithstanding the importance of reproducing traditional scientific texts (such as expository and argumentative texts), different combinations of writing tasks and genres will eventuate in different kinds of learning (Prain & Hand, 1996). For example, the construction of traditional scientific texts fosters the development of language and knowledge of discipline-specific language, while other hybridised writing in science (Wellingfon & Osbourne, 2001). Alternatively, hybridised scientific narratives can promote students' scientific literacy by developing their interest in and capacity to apply scientific thinking to social issues for the purposes of informed action. Where the students can learn to cross borders between specialist and more popular genres and readerships" (Hand & Prain, 2002, p. 742). Hybridised narratives can therefore be used to complement scientific writing for particular learning outcomes, in order to enhance student engagement and the accessibility of science for a broader audience.

While students' comments at interview indicated that they enjoyed learning about biosecurity, it is reasonable to predict that writing about other socioscientific issues perceived to be important to students and their communities would be equally engaging. The introduction of the Foundation to Year 10 Australian Curriculum: Science (Australian Curriculum, Assessment and Reporting Authority [ACARA], n.d.) affords exciting opportunities to develop hybridised writing tasks about socioscientific issues that support the Science Understanding strand of the new curriculum. For example, a writing task that engages with the issue of tissue and organ transplantation could be used in Year 8 to develop the concept of cells (Biological Sciences substrand), while the context of coal seam gas mining could support learning about the concepts of energy and change (Physical Sciences substrand). If teachers are interested in implementing writing tasks about biosecurity, like the studies reported here, they can explore how the introduction of new species via human activities can affect local environments and ecological interactions in Year 7 (Biological Sciences substrand).

As well as developing students' conceptual science understandings, writing stories about socioscientific issues also offers an opportunity to engage with the Science as a Human Endeavour strand of the Australian Curriculum, as students explore the nature and development, and use and influence of science. This aspect of the curriculum aims to develop students' "ability to solve problems and make informed, evidence-based decisions about current and future applications of science while taking into account ethical and social implications of decisions" (ACARA, n.d., p. 3). Writing BioStories requires students to negotiate the complex moral and ethical considerations that inherently implicate socioscientific issues. For example, writing hybridised stories about biosecurity, organ and tissue transplantation or coal seam gas mining presents opportunities to explore the ways in which science and technology contribute to finding solutions to important socioscientific issues, and the social and ethical considerations implicated by these applications of science.
The BioStories project was delivered via a dedicated website that housed short story templates and links to online resources, and provided a medium through which students could publish their writing. Teachers could just as easily implement their own online hybridised writing projects by using Web 2.0 technologies that emphasise online learning and collaboration. For example, wikis, blogs, and collaborative and social networking software (such as Mixedink™, Whiteboard™ and Google Docs™) support the creation of secure online learning spaces that allow students to create and edit written artefacts collaboratively, while enabling teachers to see who contributed what (Beldarrain, 2006). Just as students in the BioStories projects uploaded their stories for sharing and peer review, online technologies can also support contribution-oriented learning and peer assessment by allowing students to develop, share and evaluate collections of work that help them to learn from each other and build a community of practice (Collis & Moonen, 2006; Tsai, 2009).

**CONCLUSION**

The cognitive and affective outcomes of the projects summarised in this paper serve to illustrate the value of engaging students in the writing of hybridised scientific narratives as a way of developing their conceptual understanding, enhancing their attitudes toward science and science learning, and eliciting positive emotional responses. In addition, the implications for practice outlined herein highlight some ways in which teachers can develop and implement their own hybridised writing tasks that align with the new Australian Curriculum and complement the types of genres with which students engage in the science classroom as a way of engaging students and leading science.

**REFERENCES**


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