http://dx.doi.org/10.1002/tea.20431

Tomas, L., Ritchie, S.M. and Tones, M. (2011) Attitudinal impact of hybridized writing about a socioscientific issue. Journal of Research in Science Teaching, 48 (8). pp. 878-900.

Attitudinal Impact of Hybridized Writing about a Socioscientific Issue

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Abstract: The development of scientifically literate citizens remains an important priority of science education; however, growing evidence of students' disenchantment with school science continues to challenge the realisation of this aim. This triangulation mixed methods study investigated the learning experiences of 152 9th grade students as they participated in an online science-writing project on the socioscientific issue of biosecurity. Students wrote a series of hybridized scientific narratives, or BioStories, that integrate scientific information about biosecurity with narrative storylines. The students completed an online Likert-style questionnaire, the BioQuiz, which examined selected aspects of their attitudes toward science and science learning, prior to their participation in the project, and upon completion of the writing tasks. Statistical analyses of these results and interview data obtained from participating students suggest that hybridized writing about a socioscientific issue developed more positive attitudes toward science and science learning, particularly in terms of the students' interest and enjoyment. Implications for research and teaching are also discussed.

Keywords: attitudes, scientific literacy, hybridized writing, socioscientific issues, ecology education, writing-for-learning

The development of scientifically literate citizens who are willing to engage in science-related issues, capable of understanding and applying scientific ideas, and drawing evidence-based conclusions about scientific issues, remains a key priority of science education (OECD, 2006; Sadler, 2004; Tytler, 2007). At the same time, it is well known that disengagement is a common and widespread problem in secondary science classrooms, which is reflected in students' disenchantment with the science curriculum, and declining enrolments in science classes beyond compulsory schooling (Lyons, 2006; Tytler, 2007). This issue is particularly problematic in the middle years of schooling (i.e., Grades 6-9), where students demonstrate lower levels of interest in science as they become less engaged in school science activities (Goodrum, Hackling, & Rennie, 2001; Logan & Skamp, 2008; Osborne & Collins, 2001). For example, an analysis of attitudinal data from the TIMSS 2007 survey found that the proportion of Australian students who held positive attitudes toward science dropped from 78% in 4th grade to only 47% in 9th grade (Martin, Mullis, & Foy, 2008). This deterioration in students' attitudes toward science is a concerning issue for science educators, as it threatens the development of a scientifically literate future citizenship who uses natural, scientific and technological resources responsibly for a sustainable future (Linder, Östman, & Wickman, 2007; Tytler, 2007). As well as the need for teaching and learning strategies that promote the development of scientific literacy, and engage middle school students in the learning of science (Fensham, 2007; Prain, 2006), there are calls to understand better the "effect of affect" in science learning and teaching (Alsop, 2005, p. 3).

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A previous study by Ritchie, Tomas and Tones (2011) investigated the effects of a science-writing project on the development of 6th grade students' scientific literacy. The students wrote a series of short stories that merge scientific and narrative genres (i.e., hybridized scientific narratives) about the socioscientific issue of biosecurity. The results from this study support the argument that writing the sequence of stories enhanced students' familiarity with biosecurity issues, helped them to develop a deeper understanding of related biological concepts, and improved their interest in science. While this and other studies (e.g., Morrow, Pressley, Smith, & Smith, 1997; Ritchie, Rigano, & Duane, 2008) into the learning potential of hybridized scientific narratives have been conducted with elementary and lower middle school students, few have focussed on the upper end of middle schooling—a time when students begin to make subject choices that determine their career paths. More worrying is that students' interest in science declines in the middle years, particularly at the primary-secondary school interface (Logan & Skamp, 2008). For this reason, this study investigates the learning experiences of 9th grade science students as they engage in the writing of hybridized scientific narratives about biosecurity, as a means of developing more positive attitudes toward science and science learning.

In order to understand better the extent to which writing hybridized scientific narratives about a socioscientific issue enhances students' attitudes, we first explore the ways in which such writing can engage students in science learning. We then define the affective characteristics investigated by the study before identifying the role that writing hybridized scientific narratives can play in the development of scientific literacy in the context of socioscientific issues (SSI) education.

Writing Hybridized Scientific Narratives

Writing, talking and reading about science are desirable *goals* of scientific literacy; however, they also hold great potential as ways of *achieving* scientific literacy (Hand, Prain, & Yore, 2001). A number of researchers have advocated the use of writing tasks to develop scientific literacy, and call for science educators to take heed of the relevant research on language and science learning to improve students' chances of achieving scientific literacy (Hand & Prain, 2002; Hand et al., 2003; Wellington & Osborne, 2001).

Over the past 20 years, there has been growing recognition among educators that there is value in writing to learn science, beyond the traditional scientific genres taught in schools. This research is guided by a pedagogical perspective of the development of the literacies of science that draws on cognitive theories of knowledge production (Prain, 2008). It seeks to identify cognitive and communicative conditions that support science knowledge construction through a diversified range of writing types. Written language can be a valuable resource for developing scientific literacy and learning science; therefore, students should be exposed to a more diverse range of formal and informal writing in the classroom (Prain, 2006). Proponents of a diversified approach argue that sole emphasis on scientific genres can mislead students about the ways in which science is conducted or reported, and discourage their participation in the discourse of science (Hildebrand, 2002; Prain, 2008).

Wellington and Osborne (2001) argued that students often encounter difficulties writing in the passive or third person style typical of scientific genres, which can deter students from writing in science. Hand et al. (2003) noted that students' vernacular language, along with their culture and lived experiences, are foundational resources that need to be respected and mobilised to support learning science, and that “there is no problem with starting with vernacular language … no problem with returning to it time and time again to anchor our sense of self to our scientific activities” (p. 612). A pedagogical perspective of knowledge production assumes that employing students’ vernacular language is essential for engaging effectively with and learning the literacies of science (Prain, 2008). However, a diversified approach to writing does not diminish the value of canonically accurate scientific discourse; rather, such an approach 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).

Narrative writing is not traditionally associated with learning science, as science is generally portrayed as a source of objective knowledge. Conversely, narratives are subjective accounts of human experience, and, unlike writing in science, the genre with which most students are familiar (Avraamidou & Osborne, 2009; Wellington & Osborne, 2001). Narratives can therefore be used to “initiate writing in science in a manner which is enjoyable. Using a familiar genre [such as narrative] at least begins the process of helping children express their thoughts in written language through being personally engaged” (Wellington & Osborne, 2001, p. 76).

In spite of support for creative writing opportunities in science, some researchers are sceptical. Keys (1999), for example, asserted that employing creative writing techniques suggests to students that science is not intrinsically interesting, and must be infused with “artificial excitement” (p. 124). At the same time, it detracts the learner’s focus from science understandings, and fails to develop the skills necessary to engage with the reading or writing of scientific texts that students will encounter in higher education. While this could possibly be the case if creative writing is taught at the expense of scientific writing, the utilization of contrasting genres and different kinds of writing tasks in science can lead to different kinds of learning outcomes, and achieve very different agendas (see Prain & Hand, 1996; Schumacher & Nash, 1991). Furthermore, concerns have been raised regarding the teaching of the traditional school science genre, at the expense of alternative writing-to-learn strategies. This approach does not support expanded notions of scientific literacy whereby students are required to communicate to diverse audiences for diverse purposes (Hand, Prain, Lawrence, & Yore, 1999). Although hybridized scientific narratives introduce an element of creativity and imagination in the construction of narrative storylines, they should not be characterized as creative writing, as they require students to transform and communicate scientific knowledge in such a way that more closely aligns with their everyday language. Diversified science writing tasks that engage students with an alternative genre such as this might 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.

Developing Positive Attitudes toward Science: An Aspect of Scientific Literacy

Measurements of students’ attitudes toward science have been considered important in understanding the decline in school science enrolments and the number of young people pursuing science-related careers, by evaluating students’ engagement (or disengagement) with science (Osborne, 2003). The development of positive attitudinal outcomes in science education is seen as one way of alleviating these problems.

In addition to engaging students in school science, there is now widespread awareness of the need for schools to attend to the affective domain in the identification of learning goals and objectives (Rennie & Punch, 1991; Schibeci, 2009; Tyler, 1973). For example, the majority of interpretations of scientific literacy include reference to one's attitudes toward science. This is evident in the definition of scientific literacy adopted by the Programme for International Student Assessment (PISA): "Awareness of how science and technology shape our material, intellectual, and cultural environments; and willingness to engage in science-related issues and with the ideas of science, as a reflective citizen" (OECD, 2006, p. 23).

Students approach learning tasks with both cognitive entry behaviors and affective entry characteristics (e.g., attitudes, self-efficacy, values, self-concept and interest), and it is the dynamic interaction between these domains during the learning process that results in both cognitive and affective learning outcomes (Bloom, 1976). In addition to developing self-esteem, self-efficacy and personal values, an affective focus in the curriculum shapes students' attitudes toward subject matter, and their interest or motivation to become involved in learning activities (Bloom, 1976).

The importance of the affective domain in the context of science education was recognised by Klopfer (1971), who presented a classification scheme for science education aims. It includes six affective categories that are concerned with the expression of positive attitudes toward science and scientists; acceptance of the notion of scientific inquiry; espousal of "scientific attitudes"; enjoyment of learning science and science experiences; and interest in science and science-related activities, and pursuing a science-based career.

An important distinction was made a short time after by Gardner (1975) between 'scientific attitudes' and 'attitudes toward science'. The former is of the cognitive domain, and is characteristic of scientific thinking; the latter (which encompasses the majority of Klopfer's characteristics) involves feelings, beliefs and values held in relation to the scientific enterprise, school science, science and society, or scientists, and is of the affective domain (Osborne, 2003).

While there are many definitions of the term 'attitude', there is general agreement in the social sciences that an attitude is a state of mind (i.e., evaluated beliefs, feelings and values) that predispose the individual to respond preferentially to some given object (i.e., things, people, places, ideas, actions or situations) (Oskamp & Schultz, 2005). There are several important theoretical views about the nature of attitudes. The tri-componential viewpoint is an early model that presents attitudes as a single entity composed of affective, cognitive and behavioral components (i.e., feelings and emotions, ideas and beliefs, and action tendencies, respectively) (Oskamp & Schultz, 2005). Other models view these components as separate entities (Fishbein & Ajzen, 1975), or as latent processes occurring within the individual that result in observable responses (DeFleur & Westie, 1963). While these models present different views concerning the relationship between affective, cognitive and behavioral components of attitudes, the present study is primarily concerned with engaging students in writing differently about science, as a way of developing more positive attitudes toward science and science learning. In doing so, it attends to the affective component of attitudes (i.e., students' interest and enjoyment in learning science), and the cognitive component (i.e., their beliefs in relation to their science-specific self-efficacy, and personal and general relevance of science; see *Quantitative Data Source and Analysis*).

As this study is concerned with students' attitudes toward science and science learning in a writing-to-learn context, the affective characteristic of interest is also relevant. Interest is a positive affective state characterized by engagement or a desire to reengage with particular content (Hidi & Renninger, 2006). Like attitudes, interest has been identified as a resource for learning, particularly as it is a key component of motivation and engagement with academic tasks (Ainley, 2007; Hidi, 1990; Schiefele, 1999). These constructs may be viewed as being similar because attitudes are targeted toward objects, while interest reflects one's attitude toward tasks or activities (Gable & Wolf, 1994). In this study, the term *attitude* will encompass both students' attitudes toward and interest in science and science learning.

Two main perspectives have guided educational research into interest: individual interest and situational interest. Individual interest is often associated with intrinsic motivation, and arises from knowledge about and value for an object or idea, which motivates a desire to be involved in activities related to that topic (Boekaerts & Boscolo, 2002). Situational interest is an immediate reaction to certain environmental stimuli, which may or may not endure over time, generated through interaction with a text, topic or idea (Ainley, Corrigan, & Richardson, 2005; Boekaerts & Boscolo, 2002; Hidi & Renninger, 2006).

The majority of research into interest to date has investigated aspects of situational interest (see Schraw & Lehman, 2001), perhaps because it is somewhat more acquiescent to change than individual interest, particularly over the short-term. Such research has explored the relationship between interest, engagement and text comprehension through the identification of three general subcategories that have been shown to relate positively to situational interest (Schraw & Lehman, 2001): *text-based interest* is evoked by the properties of a text, such as the nature of the information presented and the text's structural features (Hidi, 1990); t*ask-based interest* encompasses *encoding-task manipulations* that modify readers' approach to texts (e.g., allocating different perspectives to readers) (Schraw & Dennison, 1994), and *change-of-text manipulations* that enable readers to change the texts themselves (Hidi & Anderson, 1992); and *knowledge-based interest* is that which is influenced by prior knowledge and familiarity with a topic, and is related to both situational and individual interest (Schraw & Lehman, 2001).

In order to support educational approaches that may enhance students' academic motivation, Hidi and Renninger (2006) offer a four-phase model of interest development that integrates two-phase conceptualizations of the development of individual and situational interest. The first phase, Triggered Situational Interest, can be prompted by environmental or textual features that temporarily alter students' affective and cognitive processing. This phase is often externally supported, for example, by learning environments and pedagogical strategies that stimulate situational interest, such as group and computer work. Phase two, Maintained Situational Interest, is characterized by persistent and/or recurring situational interest that is sustained through meaningful and active learning experiences, such as project-based learning and cooperative group work. Phases three and four, Emerging Individual Interest and Well-developed Individual Interest, respectively, refer to the development of an ultimately enduring predisposition to actively seek reengagement with specific content over time. Each phase may be considered sequentially as a deepening of interest, and as mediators of subsequent interest development (Hidi & Renninger, 2006).

In order to engage and motivate students in the classroom, it is important to recognize that:

> [I]nterest is not a characteristic of the person or of the object, but is relation between person and object … [F]rom the perspective of the interested student, critical attributes of [the] relation between person and object include having a sense of connection with the object, having positive feelings of activation, wanting to explore, investigate, or engage with the object, and making decisions that promote and maintain the connection over time. (Ainley, 2007, p. 152)

For students who are not motivated by individual interest for a particular topic, it is important to elicit situational interest by establishing favorable classroom conditions. In a classroom setting, research into situational interest is therefore concerned with the characteristics of learning environments that are likely to encourage such interest (e.g., Kuhl & Goschke, 1994; Wigfield & Eccles, 1992). This is of particular importance as research has consistently shown that being interested is fundamental to students' motivation, learning and achievement (Ainley, 2007; Rennie & Punch, 1991; Schiefele, 1999; Shernoff, Csikszentmihalyi, Schneider, & Shernoff, 2003).

Writing about Socioscientific Issues

The ability to negotiate socioscientific issues (i.e., significant social issues and problems with conceptual or technological links to science) may be considered an important component of scientific literacy (Kolstø, 2001; Sadler, Barab, & Scott, 2007; Zeidler, Sadler, Applebaum, & Callahan, 2009). According to Prain (2006), if socioscientific issues form the subject of students' diversified writing tasks, their scientific literacy can be enhanced by "developing their interest in and capacity to apply scientific thinking to social issues for the purposes of informed action and critique … students learn to cross borders between specialist and more popular genres and readerships" (p. 190).

SSI education is based upon a theoretical framework that focuses the development of students' moral, ethical and epistemological orientations, with an emphasis on discourse and argumentation (Zeidler et al., 2009). SSI education "seeks to engage students in decision-making regarding current social issues with moral implication embedded in scientific contexts" (Zeidler, et al., 2009, p. 74), as a means of empowering them to deal with these issues.

Zeidler, Sadler, Simmons and Howes (2005) present a conceptual SSI framework that consists of four pedagogical issues that serve as "entry points in the science curriculum" (p. 361): nature of science issues, case-based issues, classroom discourse issues, and cultural issues. *Classroom discourse issues* emphasize the critical role that discourse about socioscientific issues plays in the development of students' reasoning skills and their views about science (Zeidler et al., 2005). In the present study, the socioscientific issue of biosecurity served as a classroom discourse issue, as the writing of hybridized scientific narratives prioritizes the crucial role that discourse about a socioscientific issue plays in the development of 9th grade science students' attitudes toward science and science learning.

Although argumentation and inquiry have featured strongly in the SSI literature, particularly in relation to classroom discourse issues, engaging students in the writing of hybridized scientific narratives about a socioscientific issue, and development of positive attitudes toward science and science learning, has only a recent history (see Ritchie et al., 2011).

Given the innovative nature of this program, rigorous investigation, especially in 9th grade classes, is warranted.

Research Problem

This study sought to determine whether writing differently about a socioscientific issue would improve middle school students' attitudes toward science and science learning. The 9th grade students in this study authored a series of hybridized scientific narratives, or short stories that integrate scientific information about the socioscientific issue, biosecurity (i.e., *BioStories*). In doing so, the following research question was investigated: To what extent does students' participation in the BioStories writing tasks enhance their attitudes toward science and science learning?

Research Design and Procedures

The study was conducted over a seven-week period in Semester 1, 2008 (i.e., May to July) in a co-educational urban school in Australia with 152 9th grade students and their teachers (*N*=7). The participants came from eight intact science classes (i.e., one of the teachers taught two classes), which represent the school's entire 9th grade cohort. The entire cohort undertook the BioStories project at the school's request to ensure that students in all classes participated in the same curriculum. The average age of the participants was 14 years.

This 10-lesson project was embedded in a Life and Living[1] unit (of 33 lessons) entitled *The Nature of Things*, which included elements of ecology (i.e., food chains, food webs, adaptations and evolution), human reproduction and genetics. The school's science department requested that this existing unit remained unchanged, and regular science lessons were assigned to the BioStories project. Four 50-minute lessons were allocated to the project in the first four-week period (i.e., 1 lesson per week). No class time was provided during the fifth week, as a science examination for the *Life and Living* unit was scheduled. All science class time in the sixth and seventh weeks were allocated to BioStories (i.e., six lessons), as the students had completed their assessment for the unit.

Through their participation in the project, students wrote a series of three BioStories – Parts A, B and C. The first two tasks required students to complete unfinished narratives about biosecurity through the provision of writing templates (refer to supplementary material accompanying the online article), while the third and culminating task asked the students to compose their own unique BioStory. An extract from the Part B writing task is available as supplementary material accompanying the online article. Through their participation in the writing tasks, it was hoped that students would learn about a number of different biological incursions that threaten natural and/or agricultural ecosystems in Australia (e.g., fire ants, tilapia, citrus canker, avian influenza). Biosecurity is a topical socioscientific issue that is not

[1] The Queensland Study Authority's Years 1-10 Science syllabus organises a number of key science concepts according to five strands: *Life and Living*, *Science and Society*, *Earth and Beyond*, *Energy and Change*, and *Natural and Processed Materials*. Through their engagement with the Life and Living strand, students will come to understand the characteristics, diversity and functioning of organisms, and the interactions between living and non-living components of the environment (QSA, 1999).

particularly suited to scientific inquiry approaches, thus it can be difficult to teach in such a way that engages students. In addition, it situates the students' learning within a real-world context, thereby enhancing its relevance and fostering engagement with the topic. For these reasons, biosecurity is an ideal theme for this type of instruction.

The students uploaded their stories to a dedicated BioStories website, where they could be viewed and evaluated by their peers. The students accessed this website throughout the project. It contained all necessary resources, including the *BioQuiz* (i.e., a student questionnaire), story templates that guided student use of digital resources in the composition of stories, digital resources (i.e., links to information about particular biological incursions supplied by Government Departments), student artefacts (i.e., completed stories that were uploaded), and peer reviews of the uploaded stories.

The participating science teachers were briefed on all aspects of the BioStories project by Tomas (i.e., first listed author), and were responsible for implementing the project in their own classrooms. In lesson 1, the teachers introduced the BioStories project to their students and administered the BioQuiz. In lessons 2 and 3, students completed the first writing task (i.e., Part A), which entailed researching their chosen biological incursion, composing a BioStory, uploading their work for peer review, and reading and commenting on other students' stories. Similarly, in lessons 4-6 and 7-10, students completed the Part B and C writing tasks, respectively, before completing the BioQuiz again at the end of the final lesson.

This study adopted a mixed methods design in which both qualitative and quantitative data were generated to develop a deeper understanding of the research problem (Creswell, 2010). In this complementarity model of triangulation, quantitative and qualitative research methods were applied to provide complementary viewpoints of the phenomenon under study (i.e., illuminate different aspects), and, in doing so, developed "a fuller and more complete picture" (Erzberger & Kelle, 2003, p. 461). This pragmatic approach recognises that together, both quantitative and qualitative techniques can provide a deeper understanding of social phenomena, than either approach would individually (Erzberger & Kelle, 2003). In this study, qualitative analysis of semi-structured student interviews was used to complement the quantitative analysis of the students' responses to the attitudinal items of a student questionnaire, the BioQuiz. These interviews probed the students' perceptions of learning science through the writing of hybridized scientific narratives. In doing so, students' comments at interview provided deeper, complementary insights into the ways in which their participation in the BioStories project enhanced their attitudes toward science and science learning.

The BioQuiz, an online, Likert-style questionnaire that examined selected aspects of students' attitudes toward science and science learning, was administered on two occasions: once prior to commencement of the project, and once upon completion. The BioQuiz was adapted from the internationally validated student background questionnaire for PISA 2006 (OECD, 2005), administered to 15-year-old students, for use in an earlier study conducted with 6^{th} grade children (Ritchie et al., 2011); however, as significant modifications were made (e.g., a new subscale was created, *Attitudes toward biosecurity*), and the instrument was implemented with 9^{th} grade students, its reliability and validity were further scrutinised for this particular cohort of students.

The students' responses to the BioQuiz (*N*=152) were analyzed quantitatively in order to gauge any shift in their attitudes toward science and science learning that could be attributed to their participation in the writing activities. Seventy-two participants (47%) were boys, and 80 (53%) were girls.

Tomas observed the implementation of the project in one selected class. This selection was informed by conversations with all teachers and was based on the class demonstrating a broad range of responses to the items in the BioQuiz administered before the commencement of the project. Tomas also interviewed the students (N=24) at the conclusion of the project. Transcripts of these interviews were analyzed qualitatively for evidence of students' perceptions of the BioStories writing tasks, and the nature of their participation in the project, in order to provide further insight into their attitudes toward learning science.

Quantitative Data Source and Analysis

The BioQuiz used in this study consists of 29 items within six subscales that examine the students' interest in learning about science (Subscale 1); their science-specific self-efficacy (Subscale 2); their perceived general and personal value of science (Subscales 3 and 4, respectively); their familiarity with biosecurity issues (Subscale 5); and their attitudes toward biosecurity (Subscale 6) (Table 1). Subscales 1 and 6 concern the affective component of attitudes, as the items examine how interested students are in learning and writing about science, and more specifically, biosecurity issues. The items belonging to Subscale 1 refer to situational interest as they relate to the ways in which students interact with science (e.g., *I am happy writing about science*) (Table 1). The items belonging to Subscale 6 refer to individual interest in specific content related to the topic of biosecurity (e.g., *Knowing more about how introduced species can threaten eco-systems in Australia*) (Table 1). The items of Subscales 3, 4 and 5 examine the cognitive component of attitudes, and refer to students' domain-specific science self-efficacy (i.e., their perceived capacity to perform particular science-related tasks relevant to the context of biosecurity, such as explaining why food and other plant or animal products should not be brought into Australia), and their perceptions of the personal and general relevance of science. The items in Subscale 5 examine students' awareness of biosecurity issues, and are therefore not concerned with attitudes. Subsequently, while the results of this subscale are presented as part of the BioQuiz results, they are not discussed in this paper.

Modelled on the format used by PISA, the students responded to each item within the BioQuiz using a four-point scale specific to each subscale (Table 1). These responses were then scored on a scale of 1-4, so that higher scores represented more positive responses, as shown in Table 1.

Table 1 about here

Many of the test items were sourced directly from the PISA 2006 student questionnaire, which includes questions regarding students' views on scientific issues, the environment and science-related careers (OECD, 2005). Subscales 1-4 of the BioQuiz were adapted from Questions 16, 17 and 18 in Section 3 of the PISA test, *Your Views on Science*. Items belonging to Subscales 3 and 4 appeared as they do in PISA, as they examined students' general attitudes toward the relevance of science.

Subscale 6 was developed specifically for the current study, and examined students' attitudes towards biosecurity. The wording of these items was adapted from PISA attitudinal items relating to forensic science (OECD, 2006). This additional scale was included so that a comparison could be made between the students' general attitudes toward science, and those that specifically relate to biosecurity. As the BioStories project extended over a relatively short period (i.e., seven weeks), it was anticipated that the intervention would be more likely to impact students' attitudes specifically towards biosecurity, rather than general science attitudes.

The content validity of Subscale 6 was addressed during the item generation phase. Following its construction, the subscale was presented to a panel of five experts, in order to determine whether the items were representative of the area of interest, attitudes toward biosecurity. The panel consisted of three academics in science education (including a biology educator, and a key international figure in science education); a teacher who has a particular interest in science education and participated in the first BioStories study (Ritchie et al., 2011); and a biosecurity expert who specialises in entomology. Following this review process, the wording of a single item was changed so as to relate more clearly to the issue of biosecurity.

A principle component analysis (PCA) conducted in SPSS (Pallant, 2005) and a confirmatory factor analysis (CFA) conducted using Amos (Arbuckle, 2006), were undertaken in order to identify and confirm the factor structure of the BioQuiz. The PCA identified a six-factor model on the basis of their corresponding items: *Interest in learning science* (ILS), *Science self-efficacy* (SSE), *Personal value of science* (PVS), *General value of science* (GVS), *Familiarity with biosecurity* (FB), and *Attitudes toward biosecurity* (AB). Each factor demonstrated excellent Cronbach's alpha reliability (or internal consistency) at pretest and posttest, which correspond favourably with international benchmarks established by PISA (Table 2). In addition, a range of fit indices produced by CFA were employed to assess the BioQuiz factor model: the Tucker-Lewis fit index (TLI), comparative fit index (CFI), root-mean square error of approximation (RMSEA), and the root mean square residual (RMR) (see Tabachnick & Fidell, 2007). These indices demonstrated a satisfactory fit between the six-factor model and the data, which confirms that ILS, SSE, PVS, GVS, FB and AB are reliable factors for directly describing students' attitudes toward science and science learning (Table 3).

Table 2 about here
Table 3 about here

Analysis of BioQuiz data generated from the entire cohort of 9th grade science students was conducted to determine the extent to which students' participation in the BioStories project influenced their responses. Changes in mean scores for each of the five subscales were analyzed using the related-samples *t* test, using SPSS. Two more specific research questions guided this analysis. These were:

1. Were there significant interaction effects for class and gender that influenced students' responses to the BioQuiz?
2. To what extent did the BioStories project enhance students' interest in learning science, attitudes toward biosecurity, and their perceived self-efficacy with science-related tasks, and personal and general value of science?

It was necessary to establish whether the data for the entire cohort could be treated the same by investigating possible interaction effects for class and gender (i.e., Research Question 1), prior to addressing Research Question 2. These findings would indicate whether the project had been implemented consistently across classes, and whether there were differences in the ways in which boys and girls responded to the BioQuiz.

Multivariate analyses of variance (MANOVA) were performed in order to identify any significant interaction effects between the six dependent variables in the BioQuiz (i.e., interest in learning science, familiarity with biosecurity issues, attitudes toward biosecurity, perceived self-efficacy with science-related tasks, and the students' perceived personal and general value of science), two independent variables (i.e., time, and BioQuiz[2]), and two co-variables (i.e., class and gender) that would warrant further statistical investigation. While all possible combinations of variables were explored, only the significant effects and interactions of direct relevance to the research questions articulated in the previous section are presented in this paper. Univariate analyses of variance (ANOVA) were conducted as follow-up tests on each dependent variable, and a number of *t* tests were performed in order to investigate further the significant interactions identified by the univariate tests, and their impact on BioQuiz scores.

Qualitative Data Source and Analysis

The student interviews were conducted two weeks following the completion of the project. Students were asked a number of questions at interview that explored their perceptions of their experiences in the project; specifically, what they enjoyed most and least about learning science through their participation in the BioStories project; their perceptions of the writing tasks; how they compared learning science through writing BioStories to the ways in which they normally learn science; and their perceptions of transforming scientific information and re-presenting it in their BioStories. Qualitative analysis of interview transcripts complemented the quantitative results to support the claim that students' interest in learning science, science self-efficacy, and their perceived personal and general value of science improved through their participation in the BioStories writing tasks (developed in *Research Findings*).

The combination of both qualitative and quantitative analyses employed in this study sought to strengthen the claims made from the BioQuiz results, in response to concerns that quantitative analyses in attitudinal studies provide limited information as they are restricted by a narrow range of responses based on the researcher's perspective of the problem (e.g., Osborne, Simon, & Collins, 2003). This study's complementarity model of triangulation sought to counteract this concern by developing a deeper understanding of the students' interest and enjoyment over the course of the project, by merging both qualitative and quantitative analyses.

Although the credibility of data generated from qualitative interviews may be questioned due its lack of 'objectivity' and inherent human interaction, this may be considered a strength, as interviews capture the subject's perspective of the phenomenon under study, and enables them to formulate their own conceptions of reality in a dialogue with the researcher (Kvale, 1996; Marshall & Rossman, 2006). In order to explore the factors students attributed to the improvements in their attitudes from the project, they were asked at interview a number of questions about their experiences and perceptions of the project. Open-ended questions that did not pre-empt student responses to particular themes were employed during the student interviews (e.g., What do you think about the writing tasks?). The interview protocol is available as supplementary material accompanying the online article.

[2] The independent variable "time", as it was used in the context of this analysis, refers to the difference in the means on the dependent variables from pretest to posttest, rather than the actual time that elapsed. The independent variable "BioQuiz" refers to the students' responses to the subscales of the BioQuiz.

Research Findings

In order to investigate the extent to which students' participation in the BioStories writing tasks enhance their attitudes toward science and science learning, quantitative analysis of the BioQuiz data generated pre- and post-intervention were performed to measure attitudinal shifts across all classes that participated in the study. Qualitative data arising from semi-structured interviews provided a more fine-grained perspective of the learning experiences of a single case study class in order to illuminate further these attitudinal shifts. In this section, we present evidence to support our thesis that writing BioStories enhanced students' attitudes toward science and science learning. Specifically, we make the claim that students' interest in learning science, science self-efficacy, and their perceived personal and general value of science improved through their participation in the BioStories writing tasks.

BioQuiz Interaction Effects

Repeated measures MANOVA revealed a significant main effect for time, Wilks's $\Lambda = .28$, $F(1, 152) = 4.21$, $p < .01$, partial $\eta^2 = .72$, which indicates that BioQuiz scores varied from pretest to posttest. A significant time*BioQuiz*gender interaction was also observed, Wilks's $\Lambda = .92$, $F(5, 152) = 2.68$, $p = .024$, partial $\eta^2 = .08$, which suggests that girls' and boys' BioQuiz scores changed from pretest to posttest. As indicated by partial η^2, a large proportion of the variance in students' BioQuiz scores (i.e., 72%) was attributable to the pretest to posttest condition. A medium effect was attributable to the time*BioQuiz*gender interaction, which accounted for 8% of the variance in BioQuiz scores. No significant effects were found for class teacher, which suggests that the ways in which the BioStories project was implemented across classes was comparable, and the presence of Tomas in the case study class did not influence the BioQuiz scores.

Univariate analyses of variance were conducted on each dependent variable as follow-up tests to the MANOVA. A significant within-subjects effect was observed for time, $F(1, 152) = 421.21$, $p < .001$, partial $\eta^2 = .72$, and a significant interaction was found between time, BioQuiz and gender, $F(4, 152) = 3.66$, $p = .005$, partial $\eta^2 = .02$. A number of *t* tests were conducted to investigate these observations further.

The significant time*BioQuiz*gender interaction was explored via an independent samples *t* test, which compared changes in BioQuiz scores pre- and posttest for girls and boys. This test was not significant, which suggests the boys and girls did not respond differently on the BioQuiz items. This result reinforces a similar result with 6^{th} grade students in a previous study (Ritchie et al., 2011). Collectively, it appears that writing BioStories is a strategy equally appropriate for boys and girls.

Paired-samples *t* tests were conducted to investigate the significant main effect of time revealed by the follow-up univariate tests. In doing so, we address the question, to what extent did BioQuiz scores change from pretest to postest? An overall improvement in BioQuiz scores was observed from pretest ($M = 13.2$, $SD = 2.49$) to posttest ($M = 14.10$, $SD = 2.36$), $t(176) = -6.38$, $p < .01$. Effect size, as measured by Cohen's *d*, was 0.48, which is indicative of a medium effect (Cohen, 1988). Effect size reflects the degree of association between two variables, or the strength of the relationship (Tabachnick & Fidell, 2007). Cohen's *d* is a measure of the standardised difference between two means, whereby the greater the value of d, the greater the difference between the means (Green & Salkind, 2005). According to Tabachnick and Fidell (2007), research in educational settings has a propensity to produce smaller effects.

In the following section, we present the findings of further paired-samples t tests that were conducted to evaluate whether students' BioQuiz scores for each subscale improved from pretest to posttest.

Attitudes toward science and science learning

As shown in Table 4, a statistically significant improvement was observed in the interest in learning science [$t(152) = -5.66$, $p < .01$, $d = .42$], science self-efficacy [$t(152) = -3.11$, $p <.01$, $d = .23$], personal value of science [$t(152) = -3.06$, $p < .01$, $d = .23$] and general value of science items [$t(152) = -4.59$, $p < .01$, $d = .34$] of the BioQuiz. These results suggest that the students' interest in science, science self-efficacy, and personal and general value of science improved over the period of time the intervention was conducted. Modest effects were observed in each case, the largest of which was observed for interest in learning science ($d = 0.42$), which represents the greatest improvement pretest to posttest. No statistically significant change in the attitudes toward biosecurity items was observed, $t(152) = -0.23$, $p = .82$, suggesting the students' participation in the BioStories project did not influence their attitudes toward biosecurity.

Table 4 about here

While these results suggest that students' participation in the BioStories project impacted positively on these aspects of their attitudes toward science and science learning, qualitative analysis of student interview data served to illuminate the factors that may have attributed to the observed attitudinal shifts. Specifically, these factors (presented below) provide further insight into the aspects of the project that enhanced students' interest and enjoyment in science.

Factors students attributed to their enhancement of interest and enjoyment in science

Analysis of students' responses to the BioQuiz revealed the greatest improvement pretest to posttest for interest in learning science ($d = 0.42$). In seeking to understand the factors that students attributed to their enhanced interest in science, a number of themes were generated following thorough reading and re-reading of the interview transcripts. Ultimately, four themes were drawn from the aspects of the project most frequently identified by students as being positive or enjoyable (Table 5): *Writing differently in science*, *Stimulating imagination*, *Student-centred pedagogy*, and *Engaging learners with diverse interests*. Specifically, these themes complement our understanding of the attitudinal shifts identified by the quantitative BioQuiz analysis by revealing the ways in which writing hybridized scientific narratives about biosecurity enhanced students' interest and enjoyment. Significant findings relating to each of these themes are discussed below.

Table 5 about here

Writing differently in science. Students' comments at interview revealed that writing differently in science – both in terms of the genre (i.e., hybridized scientific narratives) and topic of their writing (i.e., biosecurity) – impacted significantly on their engagement in science learning. Six students in the case study class articulated that writing differently in science was an aspect of the project that they enjoyed, while eleven students claimed that they specifically enjoyed writing stories.

Not surprisingly, writing stories in science was a novelty for many students, and one which they enjoyed, as the following excerpt exemplifies:

Researcher	What did you like about BioStories?
Student 13	Making up a story in science. You never get to do that.
Researcher	Okay, so how does this type of writing compare to other writing you've done in science?
Student 13	Heaps different, because we usually do formal reports after we do experiments. This was totally different, writing stories.

Six students expressed the notion that story-writing was not something they had previously associated with learning science. As Student 3 explained, "When [*the teacher*] was like, we're writing a story, I didn't know what he meant, because a story for science? … [I]t's not really a subject where you can write a creative story".

When comparing BioStories to the type of learning activities in which they regularly participate during science classes, students appreciated engaging with a different genre. "I thought it was good that we didn't just have to write a report, we could put it in a story and be more creative than just writing a report about it … you don't have to be so full-on detailed and factual. You still have to, but with this you can have a bit of fun with it and make an interesting storyline to go with it" (Student 16).

In addition to writing stories in science, learning about biosecurity, a topic they knew little about, proved to be a significant talking point at interview. As Student 17 explained, he learnt "a lot about all the different topics and what they actually are. I didn't even know what citrus canker was". An increase in students' awareness of biosecurity issues may have also contributed to the observed improvements in their personal and general value of science reflected in the BioQuiz data. For example, what asked what she learnt through the BioStories project, Student 8 explained, "Just what biosecurity is, how it works and how important it is, and everything. And how we can't bring pests into Australia or we endanger ourselves".

Stimulating imagination. Seven students articulated that they enjoyed writing BioStories as it enabled them to exercise their imagination and creativity. When asked what she thought of the BioStories writing tasks, Student 19 commented that "writing the stories and coming up with creative ways to write your stories" was an enjoyable aspect of the project. In the following excerpt, Student 22 explains that she enjoyed being able to use her imagination, as opposed to "just writing information":

Student 22	I liked having a website that we could log on to, it was more interactive and it was kind of a bit more practical than theory I reckon, and you got to use your imagination a lot more. It was good to do that and made it a lot more enjoyable for me rather than just writing

	information about the biological incursion.
Researcher	Do you get much opportunity to use your imagination in science?
Student 22	Not really, it's mainly just all facts and science.
Researcher	So what did you enjoy most?
Student 22	I liked being creative that was probably the best thing. You got to use your imagination a lot more.

In this way, engaging students' creativity and imagination stimulated their interest in learning science, as it challenged their perception that science is "just all facts".

Student-centred pedagogy. Not surprisingly, the student-centred nature of the BioStories writing tasks engaged students' interest as it enabled them to play an active role in their learning. "I thought it was fun how you could put it [*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 your stories up" (Student 18). Similarly, Student 9 explained that "We got to do it in a different way, compared to the normal way, where the teacher just stands up, and we had to do it ourselves". Indeed, the BioStories project afforded students autonomy over their own learning, as they chose the biological incursions about which they wrote, researched relevant scientific information and created their own BioStories. This enabled students to investigate particular incursions of interest to them, and communicate their findings in the form of a narrative that allowed them to "put a bit of your own stuff in there" (Student 17).

Engaging learners with diverse interests. Students' comments at interview suggested that writing BioStories engaged learners with diverse interests by enhancing the accessibility of science learning for those who didn't normally enjoy science, or found regular science activities more difficult, thus enabling students to experience success in completing the tasks. This is likely to be a reflection of students' enhanced feelings of self-efficacy (i.e., their perceived capacity for science-related tasks) as indicated by the BioQuiz results. For example, Student 22 explained that she felt she did well during the project, as she understood what she was required to do, in comparison to writing scientific reports:

Researcher	How did you find it incorporating science into the stories you wrote?
Student 22	Yeah, I thought that was pretty easy actually. You just had to make up a story and just put some science in there. It's not that hard to me, I reckon. It was a lot more easy than it seems, because at first I thought "How on earth I am going to do that?" ((laughs))
Researcher	How does the difficulty of this rate to the difficulty of the science you normally do in class? How do you feel it compares?
Student 22	I feel that it's a lot easier to do, plus getting the marks that you need. It's something that I understand and I get it so it's a lot easier than doing all the science reports.

For Student 12, writing in the first-person enhanced accessibility. As he 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".

For students who claimed they don't normally enjoy science, writing a story in science was engaging, particularly if they enjoyed English. As Student 9 explained, "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."

Collectively, these comments indicate that writing BioStories elicited students' situational interest in learning science related to the socioscientific issue of biosecurity, as they enjoyed writing differently, exercising their imagination and creativity, and playing an active role in their learning. In addition, writing BioStories engaged diverse learners by enhancing the accessibility of science learning and appealing to a broader range of interests.

Discussion and Concluding Remarks

> When [*the teacher*] was like, we're writing a story, I didn't know what he meant, because a story for science? Science is like one of those hard-core smart subjects and you need to pay attention, and it's not really a subject where you can write a creative story. I like English and everything, so I was like, *yay*! (Student 3)

This comment articulated by Student 3 at interview exemplifies the positive impact that writing differently can have on students' attitudes toward learning science. In this case, writing a hybridized scientific narrative about biosecurity engaged this students' enjoyment of English, and challenged his perception of what school science is traditionally like.

This study investigated the extent to which students' participation in the BioStories writing tasks influenced their attitudes toward science and science learning. In seeking answers to the research question articulated earlier in this paper, attitudinal data were generated through students' responses to Subscales 1, 2, 3, 4 and 6 of the BioQuiz, pre- and post-intervention, and semi-structured student interviews. Collectively, these data provide evidence to support the claim that the students' attitudes toward science and science learning (specifically, their interest in learning science, science self-efficacy, and their perceived personal and general value of science) improved through their participation in the BioStories writing tasks.

Quantitative analysis of students' responses to the BioQuiz demonstrated an improvement in their interest in learning science, science self-efficacy, and their perceived personal and general value of science. Modest effects were observed in each case, the largest of which was observed for interest in learning science (d = 0.42), which represents the greatest improvement pretest to posttest. Qualitative analysis of student interviews provided triangulating evidence to support the BioQuiz findings.

Bandura (1986, 1997) proposed four sources of self-efficacy (i.e., mastery of experiences, vicarious experiences, verbal persuasion, and emotional/physiological states), of which, mastery of experience is the most salient source. In other words, students' self-efficacy improves when they experience success (Bandura, 1997). An important implication of this is that self-efficacy has been shown to correlate positively with students' engagement and achievement in science (Britner & Pajares, 2001; Kuppermintz, 2002; Lau & Roeser, 2002); therefore, tasks in which students experience success enhance their perceived science-specific self-efficacy, and are likely to impact positively on their engagement with learning and subsequent science achievement.

This research supports the statistically significant improvement in students' responses to the science-specific self-efficacy BioQuiz subscale. A number of students (e.g., Students 20, 22 and 24) commented at interview that they engaged with the BioStories tasks, even though they didn't normally enjoy science or found regular science activities more difficult. In other words, writing hybridized narratives enhanced the accessibility of science learning for these students. In this way, students' participation in the project developed their science-specific self-efficacy, as all of the students in the case study class successfully researched, composed and uploaded their BioStories to the website for peer review; in spite of the fact some had previously found science to be difficult or unenjoyable. This mastery of experience, as suggested by Bandura (1997), is likely to have impacted positively on the students' science-specific self-efficacy, as evidenced by the BioQuiz results.

An improvement in students' perceived personal and general value of science may be attributed to their engagement with a contemporary socioscientific issue. By their very nature, such issues are important real-world, social problems with conceptual or technological links to science (e.g., Kolstø, 2001; Sadler, Barab, & Scott, 2007); so, it seems reasonable to expect that engaging students with socioscientific issues, such as biosecurity, would increase their awareness and appreciation of the value of science to both themselves and society (see Prain, 2006).

Students' comments at interview revealed extensive evidence to support the statistically significant improvement in Subscale 1 of the BioQuiz, *Interest in learning science*, particularly as the students articulated positive experiences and perceptions of learning science through the writing of BioStories. Just as the 6th grade students reported positive experiences with the BioStories tasks in a previous study (Ritchie et al., 2011), the 9th grade students' comments in the present study suggest that they enjoyed writing stories in science as it presented a new way of writing in science lessons that enabled them to exercise their imagination and creativity while learning something new. Students expressed increased levels of interest in learning science, particularly for those who reported they did not usually enjoy science, or experienced difficulty in science. Writing BioStories also enabled students to take ownership and play an active role in the learning process. This evidence suggests that writing differently in science through their participation in the project triggered students' situational interest. Moreover, the statistically significant improvement in the interest items of the BioQuiz from pre- to post-test indicates that this situational interest was sustained as they engaged with the writing tasks in a meaningful and active way over the course of the project. According to the four-phase model of interest development (Hidi & Renninger, 2006), it could be argued that writing BioStories developed students' interest across Phases 1 and 2 of the model, as their situational interest was stimulated and maintained for the duration of the project. This finding is particularly important because the results show that the positive outcomes with 6th grade students can be reproduced with more challenging 9th grade students, a time when students in Australia begin to make important subject selections for high school that influence career decisions (e.g., Tytler, 2007).

No change in students' attitudes toward biosecurity (Subscale 6) was observed in this study. This particular subscale contained four items that asked students how interested they were in learning about particular issues pertaining to biosecurity, such as knowing more about how introduced species can threaten ecosystems in Australia. The mean score for this subscale was consistent with a 'medium interest' in learning more about these issues at pretest (2.81) and posttest (2.83). This level of interest is not surprising, as the students admitted at interview as having known very little about biosecurity, a new and interesting socioscientific issue for school curricula. Upon completion of the writing tasks, their interest in learning more was no greater than it was at the onset of the project. It would be interesting in subsequent studies to assess students’ attitudes to a range of socioscientific topics, to establish whether immersion in a particular socioscientific context enhances students’ desire to learn about other topics.

The results of this study support existing research into the benefits of writing-to-learn science strategies, particularly the utilization of more diversified writing tasks (e.g., Prain, 2006). The gains in students’ attitudes toward science and science learning reported in this study support the inclusion of writing practices that engage students in the construction of hybridized narrative genres in the science classroom. In particular, this writing-to-learn science strategy offers teachers a useful means of engaging students in the investigation and learning of socioscientific issues that are not particularly suited to inquiry-based methods, such as biosecurity, that might otherwise be taught in less engaging ways (e.g., traditional ‘chalk and talk’ and descriptive reports), if at all.

As described earlier in this paper, argumentation plays an important role in the negotiation of classroom discourse issues in the context of SSI education (see Zeidler et al., 2009). Notwithstanding the value of argumentation in this context, at the time of this study, the researchers were unaware of any current literature that associates argumentation with the development of positive attitudes toward science; however, diversified science writing tasks have been shown to motivate students, and impact positively on their attitudes and engagement. The current research suggests that broadening the types of writing with which students engage in the context of socioscientific issues, to include hybridized scientific narratives, can enhance students’ attitudes toward science and science learning. Although not discussed in the scope of this paper, this argument is further strengthened by the students’ demonstrated improvement in their awareness and understanding of issues related to biosecurity, and their conceptual understandings articulated at interview (see Ritchie et al., 2011).

In the context of this study, the development of positive attitudes and the writing of BioStories are intimately intertwined, as the construction of short stories about biosecurity enhanced students’ interest and enjoyment in the learning of science. This may be attributed to the way in which students manipulated the texts that they researched and the type of discourse with which they engaged in doing so. Just as writing BioStories enhanced the accessibility of science learning for particular groups of students, transforming and representing scientific information from Government websites in the form of hybridized narratives represents a change-of-text manipulation, which enhances situational interest by making information more accessible to readers (Hidi & Anderson, 1992). As Student 12 explained, “The writing we normally do in science, you can’t say ‘I’ or ‘we’, ‘they’”. Traditional scientific genres, such as expository and argumentative text, position students to adopt an objectivist standpoint (i.e., that of an ‘outsider’). Conversely, the construction of narratives positions students as ‘insiders’; particularly as they are able employ their natural, everyday discourse to negotiate the issue (Avraamidou & Osborne, 2009). Students often encounter difficulties writing in the third-person style typical of scientific genres, which can discourage them from writing in science (Wellington & Osborne, 2001). Narratives are the genre with which most students are familiar, they offer opportunities to connect students’ personal experiences with science ideas, and thus encourage them to express their thoughts in written language through being personally engaged (Hand et al., 2001; Wellington & Osborne, 2001). The students are therefore likely to perceive their story-writing experiences as interesting and personally relevant (i.e., more ‘real’), which can strengthen their engagement with the socioscientific issue, and encourage the development of more positive attitudes toward science.

In response to the study school's request that all students undertake the same program of study, all eight 9th grade science classes participated in the BioStories project. This requirement did not allow for the establishment of a control group who participated in the regular science curriculum. Such a design would have facilitated a comparison between the BioQuiz responses a treatment and control group, and allowed any possible interaction effects caused by the students' participation in the project to be explored. As such, it is not possible to determine whether the gains in students' attitudes toward science and science learning are more or less than those that may be achievable through any other novel, student-centred approach to the teaching and learning of biosecurity. Nonetheless, although this study does not offer a comparison to other pedagogical approaches, traditional or otherwise, its findings provide strong evidence that the writing of hybridized scientific narratives about biosecurity can be effective in developing more positive attitudes toward science and science learning, and subsequent engagement with school science.

The results of this study have provided some insight into the ways in which writing differently about a socioscientific issue can enhance the cognitive and affective components of students' attitudes toward science and science learning. At same time, it opens the avenue for further research into the role of affect in the negotiation of socioscientific issues. While the results of this study indicate that writing hybridized scientific narratives can impact positively on students' attitudes, can such writing also elicit positive *emotional* responses? This question is the subject of a follow-up study conducted with 12th grade students that investigates the ways in which positive emotional responses elicited by the writing of hybridized scientific narratives contribute to student engagement with socioscientific issues (Tomas & Ritchie, in press).

The findings of this study, conducted with 9th grade students, support similar findings from a study conducted with 6th grade students (Ritchie et al., 2011). In the context of ongoing concerns about students' disengagement with school science, and the importance of the development of scientific literacy, the results of these studies suggest that writing differently about socioscientific issues by merging scientific and narrative genres holds great potential for improving students' attitudes toward science and science learning, and thus their motivation, learning and achievement in the science classroom.

Acknowledgement

The research reported in this article was supported by an auDA Foundation Grant administered by Queensland University of Technology.

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Supplementary Information linked to the online version of the paper at Wiley-Blackwell

- *Crikey!* Part B – Extract
- Student Interview Protocol