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Science Teachers' Use of Mass Media to Address Socio-Scientific and Sustainability Issues

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Abstract The currency, relevancy and changing nature of science makes it a natural topic of focus for mass media outlets. Science teachers and students can capitalize on this wealth of scientific information to explore socio-scientific and sustainability issues; however, without a lens on how those media are created and how representations of science are constructed through media, the use of mass media in the science classroom may be risky. Limited research has explored how science teachers naturally use mass media to explore scientific issues in the classroom or how mass media is used to address potential overlaps between socio-scientific-issue based instruction and education for sustainability. This naturalistic study investigated the reported and actual classroom uses of mass media by secondary science teachers' to explore socio-scientific and sustainability issues as well as the extent to which their instructional approaches did or did not overlap with frameworks for SSI-based instruction, education for sustainability, and media literacy education. The results of this study suggest that secondary science teachers use mass media to explore socio-scientific and sustainability issues, but their use of frameworks aligned with SSI-based, education for sustainability, and media literacy education was limited. This paper provides suggestions for how we, as science educators and researchers, can advance a teaching and learning agenda for encouraging instruction that more fully utilizes the potential of mass media to explore socio-scientific issues in line with perspectives from education for sustainability.

Keywords Socio-scientific · Media · Sustainability

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Mass media have become increasingly significant mediators of modern society. By the end of the nineteenth century newspapers and magazines provided news and entertainment to the populace. In the 1920's, radio became an important medium for the public, and television was developed by the mid 1940's (Pakman 2010). More recently, the advent of internet-based technologies has dramatically altered the face of media in today's modern societies. The dominant media forms of the past have become part of a complex web of media in which users can readily access, interact, and create information for geographically dispersed audiences. As an example of the ways in which media has evolved, consider the case of Facebook. Four college students created the application in 2004; by February 2010, over 400 million people were actively using Facebook (Facebook 2010). These users post information about their personal lives, share links to news stories created by traditional media outlets (e.g., newspapers), offer commentary about any number of issues, organize interest groups, post video, play games, and so on.

Media are evolving at extraordinary rates, and individuals in modern society are accessing, using, influencing and being influenced by media in ways that have not been previously observed. We believe that even casual observers of schools, education systems, and educational research would readily agree that these areas have not held pace with the rapidly changing landscape of media and how the new media landscapes impact teaching and learning.

The emerging field of media literacy is developing capacity and frameworks for examining mass media use in education (Hobbs 2006; Scheibe 2004; Thoman and Jolls 2004) but the more traditional content disciplines have been slow to respond to this challenge. The field of science education is a prime example. A distinct movement, as evidenced by the current special issue, within science education is pushing the field to shift curricular foci from decontextualized representations of scientific formalisms to issues-based problems to which learners can draw connections to their lived experiences. These issues are featured within media through formal news reports, dramatic or artistic representations, interactive discussions and more. It seems very likely that when teachers and students explore current issues related to science that they do so, at least in part, through media. However, we have little empirical evidence of what teachers and students are actually doing with media and how media may be impacting science learning.

Conceptual Framework

In this study, we were particularly interested in how science teachers used media in their classrooms in the context of issues that are societially relevant and have potential to connect personally to the lives of students. The issues to which we refer have been labeled socio-scientific issues (SSI; Zeidler et al. 2002). SSI are real-world issues that are socially significant and rooted in science. These issues tend to be ill-structured in that they are complex, subject to various knowledge domains, and areas of open inquiry. The solutions to these issues are not readily apparent; in fact, multiple plausible solutions exist and part of the challenge of negotiating SSI is attempting to anticipate outcomes of various solutions which have unique strengths and weaknesses. SSI are necessarily associated with scientific concepts, principles and theories, and reasoned analysis of SSI requires the consideration of scientific evidence. However, scientific evidence alone is rarely the only factor that ought to be considered in developing a course of action or opinion. SSI, by definition, connect to social factors including political, economic, ethical, and humanistic factors. Therefore, it becomes necessary for SSI decision-makers (who may be consumers making personal choices, voters, legislators, etc.) to consider scientific ideas and data along with other forms of knowledge (Sadler 2009).

The current special issue highlights a particular perspective on SSI: education for sustainability (EfS). From our perspective, many SSI can be classified as sustainability issues. Sustainability is arguably one of the most important themes nested within the SSI construct. However, we consider SSI-based education as extending to a broader range of issues than only those relating to sustainability. For example, we have done work exploring student argumentation in contexts—gene therapy and cloning—that did not feature sustainability (Sadler and Donnelly 2006). We also acknowledge that EfS is not limited to the SSI-based approach. Sustainability remains a debated construct, but it is generally defined as the practice of meeting "the needs of the present without compromising the ability of future generations to meet their own needs" (Hart 2007, p. 691). Education with the aim of promoting sustainability is consistent with the SSI approach in that both highlight the necessary inter-relationships between science and society (Laws et al. 2004), but there are aspects of EfS that extend beyond the scope of SSI approaches (Lidgren et al. 2006).

Mass media provides another dimension of education that overlaps with elements of SSI and sustainability and yet extends beyond these dimensions in unique ways. In its simplest form, we define mass media as tools or instruments used to convey a message and intended to reach large numbers of geographically dispersed audiences simultaneously. Mass media can be classified according to their purpose (e.g., instructional, informational, or entertainment), level of interactivity (i.e., ability to alter content), and mode of communication (e.g., print, visual, auditory, or digital). A focus on mass media, however, is not limited to a study of the categories and types of media, but is also based upon the underlying message that is transported through media and the meaning-making that occurs as a result of transporting that message.

The objective of media literacy education (MLE) is to make audiences aware of the socially constructed nature of media. This means teaching *about* mass media—not just teaching *through* mass media. MLE encourages audiences to understand that authors of media choose what to show us and highlight some features while ignoring others. Therefore, MLE focuses both on the construction of mass media and the messages it transmits. Hobbs (1996) and Aufderheide (1993) outlined five core concepts addressed by media literacy education programs:

- All media are constructed with specific purposes for specific audiences.
- Media construct (and are constructed by) representations of reality.
- Individuals interpret individual meaning from messages.
- Media messages have social, political, aesthetic and economic implications.
- Each form and mode of communication has unique characteristics.

Research has shown that media have agenda-setting abilities (Martinson 2004), and in the case of socio-scientific and sustainability issues where individuals negotiate multiple perspectives on contemporary issues, media have the potential to strongly influence what people think and decisions they make. The currency, relevancy, and changing nature of socio-scientific and sustainability issues necessarily warrant the use of current resources beyond the science textbook; however, we propose that teachers and students also need to consider the construction of various forms of text in order to be more critical consumers of information. Figure 1 illustrates how we think about the conceptual overlap between these three areas.

SSI-based instruction can be characterized by the use of a SSI as the central organizing feature of an instructional episode or unit. The goals of this instructional strategy are to make students more aware of ways in which science interacts with their lives, to build

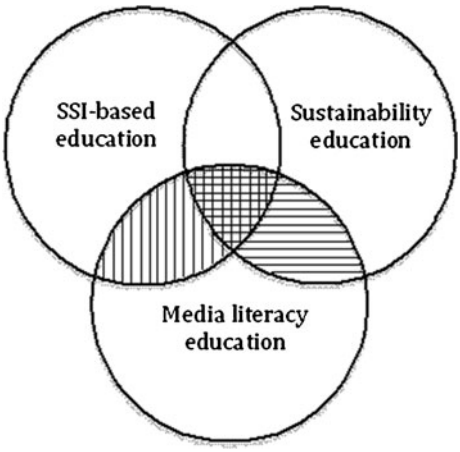

Fig. 1 Conceptual framework

student understanding of related science content, and to support student engagement in higher-order reasoning practices including argumentation, position-taking and decision-making. Effective SSI-based instruction tends to scaffold student explorations of scientific and social factors associated with the issues under consideration and to provide opportunities for students to reflect on and refine their own ideas (Sadler 2011). EfS can use similar approaches, but differs in that EfS has a specific agenda—to promote more deliberate care of our planet. There is growing consensus among researchers that conceptions of sustainability must include consideration of environmental, economic, and social factors (Summers et al. 2005). In turn, EfS aims to provide opportunities for students to develop the knowledge, skills, and values necessary to "participate in decisions about the way we do things individually and collectively, both globally and locally" (Council for Environmental Education 1998, p. 3). Conceptually, we can say that this overlap between approaches in SSI-based instruction and EfS exists because each approach adopts an issue-based perspective, addresses multiple perspectives, and seeks solutions using ongoing inquiry.

Research Focus

The goal of this study was to investigate the extent to which science teachers use mass media to explore socio-scientific and sustainability issues. Specifically, this study explored science teachers' use of non-instructional mass media (NIMM), or media that were not created with the *initial* intent to be used in the classroom. Our purposes for making this distinction were three-fold. First, we reasoned that instructional media such as textbooks or websites made by educational publishers are typically supplemented by teacher support materials for classroom use. Investigating the ways in which teachers use these materials merits investigation, but would involve looking at how teachers use the materials compared with how the authors of media suggested their use. We were interested in looking at the new ways in which teachers used media created for other purposes (i.e., informational or entertainment). Second, we were interested in investigating how teachers used resources that students and adults were likely to access outside of the classroom. Research has shown that students rely on mass media more than textbooks or teachers for their information about science (Reis and Galvao 2004). Third, we needed a way to make the study

manageable. Considering the duration of our study (9 weeks of data collection), we felt the number and types of mass media used by science teachers could be overwhelming and we wanted to maximize our understanding of what was happening in the classroom. This meant limiting the types of mass media to which we attended. The following two research questions guided the study: 1) What are science teachers' reported uses of mass media to address socio-scientific issues and sustainability? 2) How do teachers use mass media to address socio-scientific issues and sustainability in their classrooms?

Review of the Literature

Media Literacy Education

In general, the goal of MLE is to develop students' ability to access, analyze, evaluate, and create media (Hobbs 2003). Accessing media involves locating sources of information that align with your goal for information seeking. Analyzing media involves examining a piece of media for specific elements that will advance your understanding of the media's message. Examples would include examining media to determine the author, the intended audience, the intended message, and the relevant content. Evaluating media involves determining the value of the media. To determine value, one might examine the relevance of embedded information, the accuracy of information presented, the credibility of findings, the adequacy of information presented, or its usability. Creating media demonstrates an individual's ability to participate in their society by creating a message that can be shared with others.

Science Classroom Use of NIMM

Researchers in the fields of mass communication and public understanding of science have long understood that media are limited in their ability to fully present scientific information. The transfer of information between scientists and journalists, for example, is often limited by a variety of factors including the journalists' understanding of the underlying concepts and process of scientific inquiry and the scientist's ability to communicate his or her work in a way that is understandable to the general public (Hartz and Chappell 1997). Research has also shown that public perceptions of and reservations towards science are influenced by both negative and positive presentations of science in media (Nisbet 2002), and that representations of science and scientists in media affect students' and teachers' conceptions about science (Reis and Galvao 2004; Michail et al. 2007).

While teachers and students prefer media presentations of science to those found in textbooks because of the poetic and narrative codes employed (Halkia and Mantzouridis 2005), they typically lack knowledge of which questions to ask to understand underlying messages of media (Zimmerman et al. 2001) or the ability to critically examine text for accuracy or credibility (Norris et al. 2003; Phillips and Norris 1999). Further, when classroom use of media is reported, media are used to initiate discussions or to highlight connections between science and society, and rarely to encourage critical evaluation practices (Jarman and McClune 2002). Hobbs and Jensen (2009) suggests that using media in science classrooms can "provide more authentic educational experiences for students when combining the educational objectives of science educators with media literacy experiences" (p. 8). However, research is lacking on teachers' classroom use of NIMM to develop students' understanding of science. Through attention to the primary skills

developed through MLE and how teachers use media to address SSI and issues of sustainability, we may gain a better understanding of how teachers decipher the inherent messages of media and use these sources to develop more sophisticated understandings of science in their students.

Using Media to Explore SSI & Sustainability

Content analyses of media have revealed that some media sources like newspapers readily explore SSI and other relevant science topics making them valuable sources of information about science for teachers (Dimopoulos and Koulaidis 2003). Kachan and colleagues (2006) confirmed that teachers do, in fact, make use of newspapers to highlight socio-scientific and sustainability issues. Studies involving researcher interventions have found that teachers and students are capable of accessing news articles that focus on SSI (specifically, issues in biotechnology and climate change) and that students are capable of analyzing the scientific concepts presented in media as demonstrated by their ability to identify the related scientific concepts and intended message of the media (Almqvist and Ostman 2006; Dori et al. 2003; Elliott 2006; Solomon 1992). Kolstø (2001, 2006) found that secondary students and preservice science teachers are capable of evaluating news briefs focused on SSI and issues of sustainability. When prompted, preservice science teachers evaluated the accuracy of the information presented, the credibility of the author and her findings, and the adequacy of information presented. Korpan et al. (1997) also found that students evaluated the adequacy of newspaper claims as demonstrated by their requests for more information when reading news briefs. Similarly, Almqvist and Ostman (2006) and Solomon (1992) discussed the process used by secondary students' when determining what information related to SSI to 'privilege' on the internet and during television broadcasts indicating their ability to evaluate media sources of scientific information. Limited research has examined teachers' use or student outcomes related to the creation of media focused on SSI or issues of sustainability. We are only aware of one publication that describes student creation of media- in this case a television program—related to socio-scientific or sustainability issues (Watts et al. 1997). However, the quality of the programs and ability of the students to adequately or accurately portray the scientific issue was not discussed.

This collective body of research shows that teachers *report* using media in their classrooms to address SSI and issues of sustainability and are capable of engaging in media literacy practices. Further, researcher interventions have shown that secondary science students and preservice teachers have the ability to access, analyze, evaluate, and create media. The current study moves beyond these findings to examine both teachers' reported and actual use of media to address SSI and issues of sustainability and how their use may or may not be aligned with perspectives in MLE, SSI-based instruction, and EfS. Additionally, while prior research has primarily focused on teacher and student use of one type of media (i.e. newspapers, television, or internet), this study adopts a broader approach by including all possible forms of NIMM, or those media that were not created with the initial intent to be used in the classroom.

Methods

This study was a naturalistic investigation (Lincoln and Guba 1985) which used a grounded theory approach (Strauss and Corbin 1998) to examine secondary science teachers' general

use of NIMM. The goal of naturalistic inquiry is to uncover the nature of a phenomenon as it naturally occurs in time and space, and as a result, is participant and context-dependent. Teachers' use of NIMM was the phenomenon under investigation. Because the study aimed to document classroom practices in situ, use of media was explored in the absence of researcher interventions. As an approach, grounded theory complements the naturalistic inquiry paradigm in that it seeks to uncover how and why a phenomenon occurs (Strauss and Corbin 1998). The investigation reported here—teachers' use of NIMM to address SSI and issues of sustainability—was part of a larger study that examined all incidents of teachers' NIMM use (Klosterman 2010).

Research Site

This study was conducted at a K-12 university research school located in the Southeastern United States with a diverse student population. Students were diverse in terms of gender (48% female, 52% male), socioeconomic status, and racial-ethnic composition (51% Caucasian, 24% African American, 16% Hispanic, 5% multi-racial, 3% Asian). This school was chosen as the research site for two primary reasons. First, the school's mission is to engage in innovative teaching strategies, many of which include the use of technology and media. As this study aimed to explore how (and not just if) teachers use NIMM, purposive sampling of the participants was needed to increase the probability that NIMM use would be observed. Second, the research team had experience working with students, teachers and administrators in this school. The ability to situate this work in one school with which we were familiar was an important affordance for the study because of the multiple, dynamic influences on teaching practices. Given our theoretical orientation, which draws from sociocultural theory (Brown et al. 1989; Daniels 2001), we found that situating our investigation in one school with which we were well acquainted allowed us to better understand ways in which the broader school culture influenced teachers' NIMM use.

Research Participants

All secondary (grades 6–12) science teachers (n=6) at the school agreed to participate in the study. The study proceeded in two distinct phases (described in subsequent sections). Three of the teachers were chosen to participate in the second phase of the study due to their frequent and diverse use of NIMM as identified in the first phase and through online documentation of the prior year's instructional activities. The educational background and teaching experience of the participating teachers, as well as the course(s) they taught at the time of the study are shown in Table 1.

Data Collection and Analysis—Phase I

As illustrated in Table 2, data were collected in two phases to uncover the complexity of teachers' NIMM use to explore SSI and issues of sustainability (SUS). In response to the first research question, we engaged teachers in a semi-structured interview around their reported use of NIMM. To begin the interview, and to ensure everyone was in agreement about the focus of our discussions, we provided the teachers with a definition of NIMM. Questions for the interview were informed by previous research on classroom use of mass media (Jarman and McClune 2002; Kachan et al. 2006; Tuggle et al. 2000).

During the initial interviews, teachers discussed their classroom use of NIMM in terms of both their applied and hypothetical uses. Two researchers independently read all six

Table 1 Participant profiles

Teacher	Highest degree earned	Yrs of Tchg. experience	Course(s) taught	Grade level
Amanda	MEd (Science Education); MA (Architecture)	19	AP Environmental Science; Marine Science	11th/12th
Betsy	MEd (Science Education)	4	Physical Science	8th
Charlotte	PhD (Pharmacology)	3	Earth Science	6th
Dennis	EdS (Science Education)	6	Chemistry	11th/12th
Hugh	MEd (Science Education)	10	Life Science	7th
Melissa	EdS (Teacher Leadership)	11	Earth Science; Biology	9th/10th

interview transcripts in their entirety to get an overview. This initial review of the data revealed that each transcript consisted of a series of specific conversations in which teachers spoke of their applied uses of NIMM. These *episodes* became our primary unit of analysis. Specifically, an episode was characterized by the applied use of NIMM in the science classroom that was surrounded by a clearly explainable sequence of instructional events and was accompanied by a stated purpose by the teacher as to their use in the science classroom. We characterized types of NIMM used (e.g., newspapers, television or digital media) and determined whether episodes related to SSI, SUS, neither, or both. Lastly, we used an a priori coding scheme adapted from research in MLE (Hobbs 2003, 2006) to analyze how media were used. Table 3 provides a list of these codes and how they were adapted from MLE to accommodate the use of NIMM in science classrooms. Both teacher actions and their intent for student engagement with the media were characterized using these codes. While the coding scheme guided our analysis, we remained open to the possibility that each category would need to be refined to account for NIMM use in science classrooms and that additional patterns or themes may be identified.

We began by analyzing two episodes from each teacher (for a total of 12 episodes). Representative quotations for each of the categories were selected by the researchers and compared. All similarities and differences in the categorizations of data were discussed. Our subsequent discussion revealed that, while neatly described in MLE literature, the four categories used to characterize teachers use of NIMM did not account for the subtleties of NIMM use found in science classrooms. We reviewed and refined our conceptualization of

Table 2 Data collection matrix

Research phase	Research question	Participant criteria	No. of participants	Data sources
Phase 1	What are science teachers' reported uses of mass media to address socio-scientific issues and sustainability?	All secondary science teachers at local university research school	6	Interview
Phase 2	How do teachers use mass media to address socio-scientific issues and sustainability in their classrooms?	Frequent user of non-instructional mass media (relative to other teachers) Maximum likelihood for using non-instructional mass media	3	Classroom observations; online class agendas; classroom artifacts

Table 3 A priori codes adapted from MLE and used in data analysis

Code	Description
Access	Accessing sources of non-instructional media and identifying the educational merit of those sources for science.
Analyze	Determining the author of media, the intended audience, the intended message of the source, or the embedded scientific content.
Evaluate	Judging the value of the source in terms of the accuracy of the scientific content, its credibility, its adequacy, its relevance, or its usability in terms of enhancing one's scientific literacy.
Create	Creating written and visual representations of science for a geographically diverse public audience.

the four media literacy categories until full consensus was reached. We engaged in a second round of analysis consisting of one new episode for each teacher in order to compare our refined conceptualizations to a new set of data. This round of analysis resulted in an inter-coding consistency greater than 80%. Again we discussed and negotiated our categories until consensus was reached. We independently reviewed a third set of new episodes (one from each teacher for a total of six episodes). Due to the high level of inter-coding consistency (greater than 90% across all six episodes and four categories), one researcher reviewed and coded the remaining five episodes.

Data Collection and Analysis—Phase II

To address the second research question, we engaged in a series of classroom observations for three teachers over a nine-week period. The three teachers—Amanda, Charlotte, and Hugh (pseudonyms)—were chosen for their diverse and frequent NIMM use as reported in the initial interview. We observed each class on a regular basis at least twice a week and sometimes more frequently if a teacher indicated probable use of media. Detailed field notes were taken during the observation periods. Video recordings of each class and classroom artifacts, such as copies of print media and student worksheets, were used to verify and supplement field notes.

The refined a priori codes from MLE (access, analyze, evaluate, and create) were applied to the data to characterize teachers' actual NIMM use when addressing SSI and SUS. Comparison of codes resulted in a high level of consistency between the two researchers (greater than 90%). Both researchers then iteratively analyzed the data to create a narrative summary of each teacher's overall NIMM use to address SSI and SUS. The summaries were combined to create cases that described science teachers' NIMM use when addressing SSI and SUS. The third researcher reviewed both the codes and cases against the initial data set to check for consistency between the data and the first two researchers' interpretations.

Results—Phase I

Episodes of NIMM Use

Analysis of the interview transcripts revealed that episodes of NIMM use were identifiable in every interview transcript. Table 4 illustrates the number of episodes identified in

Table 4 Number of episodes identified as reported by teacher

Teacher	Newspapers/ magazines	TV/films	Trade books	Digital	Total no. episodes
Amanda	2	2		1	5
Betsy	1	2		2	5
Charlotte	3	3			6
Dennis		2	1	1	4
Hugh		2	1	2	5
Melissa	1	3			4
Total	7	14	2	6	29

comparison to the types of NIMM used in each episode, and the total number of episodes identified.

All six teachers reported using NIMM at some point during the school year. Of the 29 episodes in which teachers spoke of applied uses of NIMM in their science classrooms, teachers reported most often using television and films (48%), followed by newspapers and magazines (24%), digital media (21%), and trade books (7%). Most of the television and films consisted of streaming video available on YouTube or documentary films that highlight specific scientists or field-work related to a certain topic. Newspaper and magazine use consisted of teacher and student engagement with local news reports as well as articles found in magazines to which the teachers personally subscribed. Digital media consisted of teachers and students using the internet, and in two episodes, the use of commercial video games. Dennis and Hugh each reported using trade books.

The nature of teacher and student engagement was categorized according to the four MLE categories and is illustrated in Fig. 2. The MLE categories were useful analytic constructs, but in reviewing the data, the need for additional means of characterizing classroom practices became evident. More specifically, we deemed it necessary to note potential differences in teacher and student roles. Exemplars for each of the categories are provided in Table 5. In all of the 29 episodes, students were engaged in accessing NIMM. Although this seems like a promising result, in all but one of these instances, students passively accessed media. We distinguished between passive and active access to media to

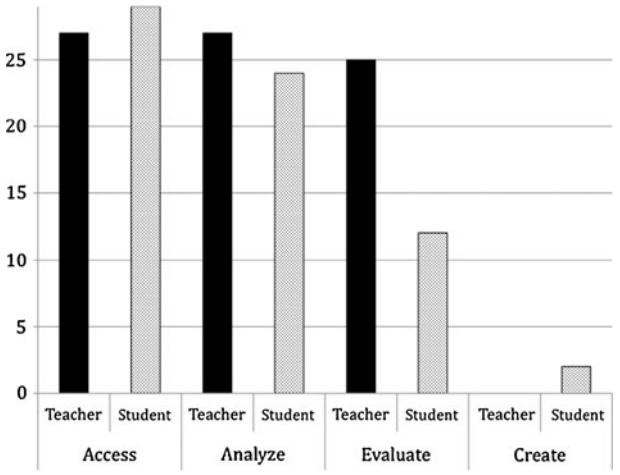

Fig. 2 Number of episodes in which teachers and students engaged with media according to four categories adapted from MLE

Table 5 Exemplars of NIMM use by MLE category as reported by teachers

Category	Role	Example
Access	Teacher	"A [peer] was reading it 1 day and I asked her about it and then I went to Barnes and Nobel and bought myself a copy and I'm not a very avid reader, but this book, to me, reminded me why I personally had fell in love with the subject of chemistry. So it's an autobiography [of Tungsten] so to speak as well as tying in the history." (DI1; 385)
	Student	"They just got done doing a research paper where one of their sources had to be an [online] news article." (BI1; 32)
Analyze	Teacher	"We saw a video on seahorses and it was talking about the seahorse trade in China and the fact that we really don't have a good sense about these animals and yet China is taking massive numbers of them for medicine. I said, 'you're looking at this through an ecological lens and conservation lens….so look at what you see in the video." (AI1; 278)
	Student	"So they had to summarize certain things that were coming out of the film related to like, why was he afraid to actually publish his work? So they had to just pull out of the film different things that were said and thinking about that time period and the effect of the plague on that." (MI1; 271)
Evaluate	Teacher	"And I chose the video to make sure they are entertaining. One was like a huge monster that looked like an arachnid that came around the corner. It was like the size of a building and why couldn't that really be, you know, alive? You can't have an exoskeleton and be that large on land because an exoskeleton is not built to support that type of weight." (HI1; 218)
	Student	"And there were some things in there [the film] that I had to say to them, 'What do you know about this? And how do you know this might not be accurate?' And they were like, 'oh, ok, they use TEDS now, they use turtle excluder devices so we don't have such a great kill of turtles with the shrimp fleet." (AI1; 257)
Create	Student	"They created a green screen video about weather. That was interesting." (CI1; 479)

denote involvement in processes of actually finding the media. Passive access involved situations in which a consumer (i.e., a student) engaged with media but the media were found and selected by a different individual (usually a teacher). There was only one episode in which the teacher did not report accessing media. In this episode, Betsy had her students use the internet to research alternative energy sources.

More teachers than students analyzed and evaluated NIMM in the 29 episodes reported, and teachers and students more often analyzed than evaluated media. With the exception of the one episode discussed by Betsy, we found that if students were asked to engage in accessing, analyzing, or evaluating media, then the teacher was similarly engaged. The creation category was unique. Creation of media was relatively rare (two of the 29 episodes), but when it did occur, students, and not teachers engaged in the practice.

While it was not our initial intent to order the four analytic categories, we did not find any cases of teachers (or students) engaging in evaluation or creation without first engaging in one of the prior categories (access or analyze). To engage in evaluation, some level of analysis was needed; teachers and students could not evaluate media without first identifying the criteria being judged. Additionally, the number of episodes in which

students created or evaluated media was less than those which contained access and analysis. Although we did not necessarily anticipate this progression, this hierarchical organization of the categories makes sense in light of Bloom's taxonomy (Bloom and Krathwohl 1956). The ordered nature of media practices also explains why more episodes of creation were not observed. According to the revised Bloom's taxonomy (Anderson and Krathwohl 2001), creation is the most cognitively demanding practice.

SSI and SUS

We believe that most media as well as science topics could have connections to SSI or SUS; however, those connections were rarely made explicit in the classes we observed. The percentage of episodes in which teachers addressed SSI, SUS or both are presented in Fig. 3. The lessons addressing SSI focused on the following topics: nutrient pollution in the Gulf of Mexico, alternative energy resources, farming and methane gas production, nuclear energy, and stem cell research. Issues of sustainability addressed as reported by the teachers included: mitigation of nutrient pollution in the Gulf of Mexico, sea horse trade in China, community service projects addressing alternative energy resources, methane gas production and sustainable agriculture. The topics of nutrient pollution, alternative energy, and methane gas production related to both SSI and SUS.

Teachers explicitly addressed SSI, SUS, or both in 31% of the reported episodes of NIMM use. In addition to these episodes in which teachers clearly identified a SSI and/or SUS focus, there were episodes in which teachers discussed media in such a way that SSI and/or SUS *could* have been a highlighted feature. These were classified as not addressing SSI or SUS, but having potential to do so. An additional 21% of the NIMM episodes presented opportunities for teachers to address SSI and/or SUS topics (see Fig. 4).

Hugh offered an example of an episode that demonstrated unmet potential for connecting media use to SSI or SUS. He used the commercial videogame *Spore* to illustrate and explore concepts related to natural selection. In the videogame, players build creatures using their choice of arms, legs, eyes, etc. Players then move through the gaming environment trying to survive as they encounter new species while adapting their avatar's

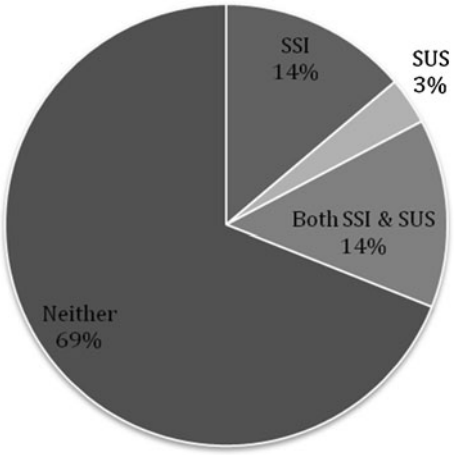

Fig. 3 Percentage of episodes in which teachers explicitly addressed SSI, SUS, or both out of total reported episodes of NIMM use

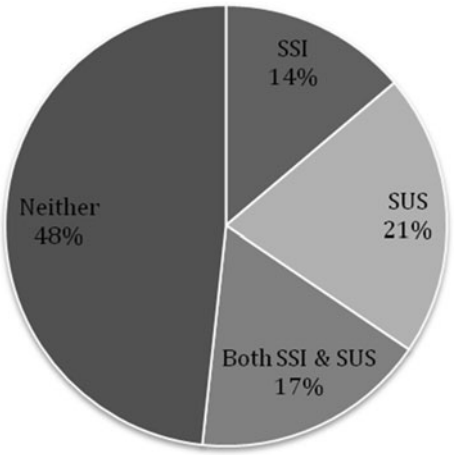

Fig. 4 Percentage of episodes in which teachers explicitly, or had potential to, address SSI, SUS, or both out of total reported episodes of NIMM use

physical and behavioral traits to dominate other species and accumulate points. Hugh explained this process further:

> You can choose your behavior. You can go aggressive or you can go social…You can either try to kill all the other creatures and get points or you can socialize with all of them and band together and create packs and stuff. Then you go to tribal stage where you have fire and you're in a tribe…Some go fishing, some need to go hunt, and some need to defend. So you control this little tribe. Then you go to civilization and you can control armies and whole civilizations…

Based on Hugh's discussion of *Spore*, it was clear to us that he did not use the game as a means of getting students to consider SUS; however, his statements also made it clear that issues of sustainability certainly could be addressed in the context of the game.

The analysis of reported episodes of media use further highlighted the need for field based investigations to more clearly understand the actual media practices of teachers and students.

Results—Phase II

Table 6 illustrates the total number of class periods observed over the nine-week period of data collection, the number of classes in which teachers used NIMM, and the number of episodes of NIMM use that were observed in which teachers addressed SSI or SUS. For

Table 6 Episodes of observed media use to address SSI and/or SUS

	Class periods observed[a]			Class periods NOT observed		
	Total	NIMM episodes	NIMM episodes w/SSI or SUS	Total	NIMM episodes	NIMM episodes w/SSI or SUS
Amanda	12	9	9	12	2	0
Charlotte	10	7	1	14	1	0
Hugh	12	12	2	12	11	0

[a] Classes met on a modified block schedule. In 9 weeks of instruction, each class met a total of 24 times

classroom observations, an episode was characterized by the applied use of NIMM in the science classroom that was surrounded by a clearly observable sequence of instructional events. The surrounding instructional events—those that took place before, during and after the use of media—were used to elucidate the teacher's purpose for using media in his or her science classroom.

Similar to teacher reports of NIMM use to address SSI and SUS, teachers' actual use was relatively infrequent. The use of NIMM to address these issues was more common in Amanda's classroom (environmental science), which one could argue is naturally aligned with topics that lend themselves to discussions of sustainability or other contentious issues; however, both Charlotte and Hugh were observed using NIMM to address SSI and SUS at least once during the nine-week period. Summary descriptions of each teacher's NIMM use to address SSI and SUS are presented below.

Amanda

Types and Focus of NIMM Use

Amanda primarily used print and audiovisual media in her classroom to address SUS and SSI. During the observation period, Amanda commented that she uses these types of media because of the unpredictable access to digital media at school; the filters on the school's internet service limited the media she and her students could access from the classroom. Even with a portable computer cart and wireless internet, Amanda was often blocked from using websites that may have been useful in her environmental science class.

Amanda was observed using two films, one journal article, four magazine articles, and two newspaper articles to address SSI and SUS. The media she and her students used focused on SSI and SUS such as population growth, deforestation, off-shore drilling, the introduction of non-native and invasive species, the impact of ecotourism, pesticide use, and the preservation of wetlands. Amanda used a variety of media sources, some of which were recommended by the AP Environmental science curriculum (e.g., *Tragedy of the Commons),* and others that were based on local environmental science issues (e.g., the introduction of non-native python species and the resulting potential bans on python pet ownership).

Patterns of Use from a MLE Perspective

As illustrated in Table 7, Amanda actively accessed NIMM she used in the classroom to address SSI and SUS. However, we did not observe Amanda engaging her students in active access of NIMM. When Amanda used NIMM in her classroom, she provided her students with a copy and instructions on how they should engage with media. Amanda was observed analyzing the content, the intended message, the author, and the intended audience. Similarly, she engaged her students in analyzing the content and intended message of media, but not the author or intended audience. Amanda asked her students to analyze media for their content or intended message by asking them to summarize what they read or watched. She focused student attention on the content of media by asking students to summarize the content of what they read or watched, or by giving them a worksheet with guiding questions to answer. One guiding question, for example, asked students about the ecological niche of the Galapagos iguana while watching a film on the Galapagos Islands related to the human impacts of ecotourism. Similarly, Amanda and her students were observed engaging in analysis of the intended message during all nine episodes. For example, Amanda's students read, analyzed and engaged in critical

Table 7 Number of episodes in which teachers and students were observed engaging with NIMM to address SSI and SUS by MLE category and sub-category

Teacher (total # episodes)		Amanda (9)		Charlotte (1)		Hugh (2)	
MLE category	Sub-category	Teacher	Student	Teacher	Student	Teacher	Student
Access	Active	9	0	1	1	2	0
	Passive	0	9	0	0	0	2
Analyze	Content	8	4	1	1	2	0
	Message	9	9	1	0	0	0
	Author	5	0	0	0	0	0
	Audience	3	0	1	0	0	0
Evaluate	Relevance	9	3	1	1	1	0
	Accuracy	0	0	0	0	0	0
	Adequacy	1	1	0	0	0	0
	Credibility	2	3	0	0	0	0
	Usability	2	1	1	0	0	0
Create		0	0	0	0	0	0

discussions of Garrett Hardin's "Tragedy of the Commons" article from *Science* (1968). In another case, students read a botanical society magazine article, and Amanda challenged them to decipher and analyze the intended ecological message.

Students were not observed analyzing the authors of media Amanda provided; however, Amanda was observed analyzing the author in five episodes. Amanda discussed the authors of the NIMM, where they were from, and their occupation in order to explain the authors' perspectives and their impact on the creation of media. For example, Amanda discussed how several of the authors of the trade books she used in class were from Florida, and therefore witnessed the depletion and misuse of Florida resources firsthand. She also discussed how one of the authors was a reporter by trade, which explained why she used anecdotal information in her writing.

While Amanda was not observed engaging her students in the analysis of the intended audience of media, we observed her actively analyzing the intended audience of NIMM in three episodes. In one episode, she explicitly shared her process of analysis with her students. Before showing *The Lorax*, an animated film based upon the Dr. Suess book by the same name, she introduced the film as a kid's movie that was "not necessarily just for kids." Amanda then discussed the appeal of Dr. Seuss stories to a broad audience because of the valuable lessons they present. She told her students she wasn't showing the film "just for fun," and asked students to consider why she was showing the film as they watched. Amanda also analyzed media for their intended audience particularly in terms of how well situated her own students were as audience members. Based on these analyses, she periodically employed classroom reading strategies such as reciprocal teaching and jigsaw activities to help students tackle longer or more difficult reading passages.

Amanda and her students engaged in evaluation but considerably less frequently than analysis. Amanda evaluated media's relevance to her course, their adequacy, credibility, and usability. She also engaged her students in the evaluation of the NIMM's relevance, adequacy, credibility, and usability; but not their accuracy. When Amanda evaluated media, it was usually to share with the students her rationale for selecting the piece of media for use in the classroom, rather than a commentary on the scientific credibility of media. One exception was in her evaluation of "Tragedy of the Commons" in which she told her

students that *Science* was a respectable journal and therefore so was the article. She justified the article as a potential source of scientific information despite the fact that it was based upon moral and ethical arguments and not empirical evidence. Amanda also had her students evaluate the credibility of NIMM when she asked them to form an opinion on an issue after reading selected media. For example, she had her students read an article and associated editorial on off-shore drilling and asked them to develop an opinion and justify it with information from the articles. In essence, Amanda was asking her students to evaluate the credibility of claims made by the authors when forming their opinions.

Lastly, both Amanda and her students engaged in evaluating the usability of NIMM. For example, Amanda had her students read an article from *Smithsonian* about the potential human impacts on the sandpiper shorebird and horseshoe crab populations (Tucker 2009). She asked her students to examine how the scientists and volunteers discussed in the article collected and tagged the sandpiper. Students were then asked to offer an alternative experimental design. The article was deemed usable by Amanda in that it contained enough information to identify how the data on shorebird populations were previously collected.

From a media literacy education (MLE) perspective, Amanda used a diverse array of strategies to analyze and evaluate media herself, and to engage her students in the processes of analysis and evaluation. While Amanda actively accessed media and her own analysis and evaluation skills were clearly observed, she did not require the same level of attention to media by her students. Amanda had her students analyze media for their content and intended messages, and evaluate media for their relevance to the course and their credibility, but rarely engaged students in the critical analysis or evaluation of media beyond these few areas.

Alignment with SSI-Based and EfS Instructional Approaches

As previously mentioned, SSI-based instruction can be characterized by the use of a SSI as the central organizing feature of an instructional episode with the goals of making students more aware of ways in which science interacts with their lives, building student understanding of related science content, and supporting student engagement in higher-order reasoning practices. Education for sustainability (EfS) can use similar approaches, but differs in that EfS has a specific agenda—to promote more deliberate care of our planet. The adoption of an issue-based perspective, addressing multiple perspectives, and seeking solutions using ongoing inquiry are characteristic of both approaches.

Amanda used SSI and SUS connections in her lessons, and many of her lessons adopted an issue-based perspective. For example, on the very first day of class, Amanda had her students read an article from a local botanical society magazine and discuss the intended message of the author. The focus of the subsequent discussion was on sustainability, what being sustainable means, and why habitats such as swamplands are commonly thought of as ‘unsightly’ or ‘scary’ despite their importance for maintaining balance and preserving future generations of many species. Amanda explicitly encouraged her students to consider sustainability, environmental problems, human impacts on natural ecosystems and strategies for mediating those impacts.

Amanda highlighted multiple perspectives through the evaluation of media, and encouraged students to develop their own perspectives on SSI and SUS. When she had her students explore off-shore drilling, for example, she asked them to read a news article and an editorial on the issue. She emphasized the multiple perspectives presented in the two pieces and encouraged her students to take a position and support it with evidence. Although not required, one student—as a citizen and new voting-age adult—took the

initiative (as observed in a subsequent class) to contact his local government officials and express his opinion on off-shore drilling.

When Amanda had her students read the article about fluctuations in Sandpiper populations, she asked students to use the information presented for suggesting alternative experimental designs. While we wouldn't necessarily say this was encouraging students to pursue additional lines of inquiry in the sense that one would ask "what else could we explore that would help us approach or resolve this issue?" the fact that she was encouraging her students to consider experimental design is a significant first step towards SSI-based and EfS instruction.

Any time Amanda or her students explored a SSI, she also addressed the potential impact of decision-making and actions on the long-term impacts of our planet. Therefore, in Amanda's classroom, a focus on SSI was entirely consistent with a focus on SUS. This could be due to the nature of the environmental science course and its focus on environmental issues, but one could certainly argue that an issue-based approach with consideration of multiple perspectives is not a requirement of teaching and understanding ecological cycles and patterns.

Charlotte

Types and Focus of NIMM Use

During the nine-week observation period, Charlotte used media to address SSI and SUS only one time, and this example was clearly unplanned and incidental to the focus of her lesson. In this single episode, Charlotte asked her students to browse through a collection of newspapers and magazines in order to identify articles related to topics in Earth Science. This episode occurred at the very beginning of the school year and it was Charlotte's attempt to focus student attention on the topics she and her class would discuss during the coming school year. Of the 15 student pairs searching for articles, four pairs found articles related to the following SSI and SUS: global warming, the space shuttle program, alternative energy sources, and deforestation.

Patterns of Use from a MLE Perspective

Charlotte's lessons over the duration of the observation period included a variety of instructional methods; however, her use of NIMM was much less frequent and diverse than expected from her initial interview in which she reported a wide variety and frequent use of NIMM in her classroom. When Charlotte used media, the surrounding instructional tasks were rather predictable. She provided clear instructions for what students should do with the media (which typically involved analyzing media for their content), and after student use of the media, she facilitated a whole class discussions.

During the one observed episode in which Charlotte used NIMM to address SSI or SUS, she and her students actively accessed media (Charlotte located the newspapers and magazines and brought them to class while her students actively sought individual articles to share). When the students were looking for articles to share, they had to analyze the content of media and evaluate media for their relevance to the course. When the students shared their chosen articles with the class, Charlotte engaged in analysis of media for their content and evaluated media for their relevance to the course. Additionally, Charlotte analyzed the media for their intended messages and evaluated the media for their usability. For example, one of the student groups shared an article that began with a picture of two

human lungs filled with pictures of trees. The students summarized the article and said it was about the depleting rainforests. Charlotte followed up by saying,

> They're talking about deforestation…and if we cut trees—the picture is in the shape of the lungs—and if we cut trees then it is related to the lungs—this is in the shape of the lungs [pointing to image] because it will affect the amount of oxygen we have.

In this example, Charlotte examined the picture and analyzed its intended message as the impacts of deforestation on humans. Later in the same episode, Charlotte demonstrated her evaluation of the usability of the articles presented. She talked to the students about the wealth of information available through newspapers and how they could use these resources to stay more informed about important issues that demanded their attention and participation as citizens.

Alignment with SSI-Based and EfS Instructional Approaches

Charlotte's use of NIMM to address SSI or SUS was not consistent with SSI-based or EfS instructional approaches. Issues were not central to the lesson, nor were ongoing inquiry or multiple perspectives highlighted. Charlotte addressed sustainability after students identified articles on deforestation and global warming, but not when discussing other SSI like alternative energy resources and the continuation of the space shuttle program. For alternative energy resources, Charlotte mentioned the possible use of methane gas from beneath the sea floor, but did not discuss economic ramifications or potential long term impacts on the planet. The space program was addressed from an economic perspective and whether the program should continue but did not consider environmental or social factors associated with space flight. Overall, Charlotte demonstrated relatively frequent use of media (in about a third of her class periods) but her instructional approaches with the media were limited, and she tended not to leverage media as a means of introducing SSI and SUS.

Hugh

Types and Focus of NIMM Use

Hugh's classroom was unique in that it was paperless—Hugh's students took notes, read from their textbook, created written assignments, and shared work with others via computers. Although located in the same school as Amanda, the internet filters on the computers in Hugh's classroom were lifted to afford this unique learning environment for his students. Hugh's paperless classroom was digitally based and included a variety of media types (i.e., newspapers, films, television, internet, and videogames), which were usually portrayed through the student computers. Hugh and his students used media in almost every class period; however, we observed only two episodes in which Hugh used NIMM (newspaper articles) to address SSI and SUS. In both episodes, Hugh provided a link from his online daily agenda for his students to access the news articles—both about the increased presence of non-native animal species in Florida.

Patterns of Use from a MLE Perspective

In the two SSI/SUS episodes, the online newspaper articles were an engagement piece to capture student attention. Media were used to illustrate real life examples of the topics Hugh was covering in class—poisonous versus venomous creatures and physical versus

behavioral adaptations. Hugh actively accessed both newspaper articles, but provided the link for his students to follow; therefore, students passively accessed the articles.

The daily agenda for Hugh's class was very structured, but the actual classroom atmosphere and progression of his class was much less organized. For example, in the episode in which Hugh asked his students to read an article about African rock pythons, Hugh gave no instructions for what students should do with the information from the article after they read it. Hugh analyzed the content of the article and identified it as containing information about poisonous or venomous creatures and evaluated the content of the article as being relevant to his class; however, he never made those connections clear to his students. In the second episode, in which Hugh asked students to read an article about Cuban tree frogs, he was slightly more explicit in his instructions regarding what students should do with the information. He asked students to make a list of the physical adaptations of the Cuban tree frog. Hugh checked in with his students at the end of 30 min to ask who read the article and how many felt they could create a list of physical adaptations after reading. Hugh clearly analyzed media for their content, and wanted his students to do the same, but as no students raised their hands, it was clear that what Hugh intended for students to do with media was not always actualized.

By using these two articles to illustrate real life examples of the topics he was covering in class, Hugh demonstrated his ability to evaluate media for their relevance to the course. There was no evidence during the observations, however, that Hugh (or his students) analyzed authors, intended audiences, or intended messages of media, nor was there any evidence to suggest that Hugh (or his students) evaluated the accuracy, adequacy, credibility, or usability of the information presented.

Alignment with SSI-Based and EfS Instructional Approaches

Although both articles highlighted in the two episodes above focused on the role of humans in the introduction of non-native animal species, the impact this has on the long-term survival of human and native wildlife, and possible regulations associated with the introduction of these species in the United States, Hugh did not actively raise these issues with his students. The articles explicitly addressed SSI and SUS, but neither was the focus of Hugh's lessons. Hugh did not use the articles to present multiple perspectives on an issue, or evaluate them as sources of information for ongoing inquiry. Students were not asked to use media to form any personal decisions on an issue, and therefore, neither episode illustrated the use of NIMM consistent with SSI-based or EfS instructional approaches.

Discussion and Implications

Socio-scientific and sustainability issues are among the most important challenges facing society, and the science education community has offered strong support for the inclusion of these issues as significant curricular foci within science classrooms (e.g., Pouliot 2008; Simonneaux and Simonneaux 2008; Zeidler et al. 2002). Given the contemporary and evolving nature of these issues, mass media serve as obvious sources of information for teachers and students working to better understand and/or to generate solutions for these issues. This suggestion is reinforced in considering the burgeoning influence of media on society in general and the prevalence of media use among adolescents (Lenhart et al. 2008). Considering these trends, we undertook this study to explore ways in which teachers use

mass media to address SSI and SUS in their classrooms. Our explorations included analyses of what teachers reported about their media use relative to SSI and SUS as well as how teachers actually used media for these purposes.

In discussing their classroom practices, the teachers participating in our study highlighted frequent use of media within their classes. However, in only about one third of the media-use episodes discussed did teachers make explicit reference to ways in which they used media to support instruction related to SSI or SUS. Upon further analysis of media that teachers discussed, we found potential connections to SSI and SUS in over half of the episodes. The teachers sampled were well aware of our focus on media; however, they did not know that we were particularly interested in their use of media to address SSI and SUS. Under these circumstances, one might expect teachers to over-report media use and more accurately report, or possibly under-report, attention to SSI and SUS. Interestingly, these expectations were only partly met in the analysis of classroom observation data. Data sets from the broader investigation from which the current study was subdivided indicated that teachers (other than Charlotte) actually under-represented their classroom media use (Klosterman 2010). In contrast, teachers' reported and actual use of media for addressing SSI and SUS was fairly consistent; approximately one third of overall media usage. However, these summary measures calculated across teachers actually mask important trends that emerged in individual classrooms.

Patterns of media use among the three teachers who served as our cases varied significantly. Hugh used media in nearly all of his class sessions, Amanda featured media in about half of her classes, and Charlotte used media in about a third of her classes. Given our sampling strategy (i.e., purposeful sampling of teachers whom we expected to use media frequently), the fact that the teachers in our study used media so often was not all that surprising. The more interesting result was the stark contrast in focus on SSI and SUS observed between Amanda and her colleagues. When Amanda was using media with her classes, she was usually using those media to engage her students in SSI and/or SUS. Sustainability, in particular, was a central theme for Amanda's class and she frequently leveraged media as a means of helping her students collect information about relevant issues. In contrast, Charlotte and Hugh made connections to SSI and SUS infrequently. Even in the few cases that SSI and SUS were raised in their classes, neither Charlotte nor Hugh did much to capitalize on the issue as a learning opportunity or explore the affordances of the media to more fully engage students in the issue.

Course content is a possible explanation for the disparities observed across teachers. Amanda taught environmental science, a class that naturally lends itself to the exploration of SSI and SUS. Charlotte taught Earth science, and Hugh taught life science. Course topics may, in fact, explain some of the differences, but it is unlikely that this alone explains the full extent of the differences. It can easily be argued that SSI and SUS are well situated within environmental science classes; however, the same argument could be made for earth science and life science. It should also be pointed out that Amanda's environmental science class was part of the high school Advanced Placement program; whereas, Charlotte and Hugh were teaching middle school courses. Amanda's AP class could have followed an ecological approach that prioritized disciplinary organization rather than the more issue-based approach adopted. Given the relatively high expectations for interdisciplinarity within middle schools and respect for disciplinary traditions within high schools, at least in the US context (McDonald and Czerniak 1994), it could also be easily argued that SSI and SUS fit better in middle school science as compared to high school (Sadler et al. 2006). We raise

these issues to point out that the distinctions observed among the teachers were far from inevitable at the study's outset.

All three of these teachers taught in a school that encouraged innovative practice, supported teacher professional development, and prioritized technological investment. The three also showed evidence of frequent media integration and taught courses that lend themselves nicely to the integration of SSI and SUS. However, only one of the three regularly supported student exploration of SSI and SUS through media. This result supports earlier research which suggests that teachers vary greatly in their approach to the integration of issues-based instruction within science education settings (Sadler et al. 2006). Sadler and colleagues postulated various teacher profiles to describe distinct ways that teachers conceptualize the role and utility of SSI as contexts for education. Amanda would easily be classified with the profile that actively and progressively adopted issue-based approaches. Charlotte and Hugh would likely be better described by a profile defined by teachers who recognized the potential value of issue-based instruction but were not necessarily active implementers. Given the distinctions in teacher ideas and approaches, it seems likely that professional development designed to support teacher use of SSI and SUS will need to be customized to respect differences in teacher assumptions and practices.

Another important finding was the overwhelming choice by teachers to use newspaper articles or other static print materials (such as trade books or magazines) as sources of media related to SSI and SUS. Newspapers and magazines offer a natural choice for content related to current issues (Dimopoulos and Koulaidis 2003). However, more dynamic media that offer teachers and students opportunities to actively participate in dialog and decision-making around contemporary issues are also available (e.g. Barab et al. 2005) and would be particularly well-suited for supporting student engagement with SSI and SUS. Hugh made use of more interactive forms of media including games, virtual environments and web 2.0 technologies; however, he did not leverage the affordances of these media types for SSI and SUS. Amanda, on the other hand, frequently turned to media as a means of connecting students to important issues, but she relied on more traditional, static forms of media. Research and innovations in teacher professional development related to how to support teachers' coordinated use of dynamic media practices and contextualized issues are certainly warranted.

This study illuminates issues associated with classroom based media literacy practices of teachers and students. Media literacy scholars posit four practices essential for media literacy: access, analysis, evaluation and creation of media. Our findings highlight important considerations for the translation of these practices in science education settings, particularly in the context of SSI and SUS. First, our work points to the need to not only provide students access to media but also the need to provide students opportunities to access media themselves. In almost all cases of media use with SSI and SUS, teachers presented the media to their students. One of the goals of issues-based education is to prepare students for future encounters with new issues as they arise, and a key element of that preparation ought to be developing practices associated with finding new media sources, not just reading and interpreting media sources (Sadler 2009). This result highlights the need for science educators and professional developers to help teachers better understand the significance of opportunities for student access of media.

In our study, teachers and students engaged in analysis and evaluation of media that address SSI and SUS; however, the range of these practices was somewhat limited. Teachers and students were more apt to analyze the content and messages of media as compared to authors and audiences. Analysis of authors and audiences is particularly important for socio-scientific and sustainability issues where bias, both intentional and unintentional, are prevalent and

abilities to anticipate bias are essential for informed decision-making (Kolsto 2001). Like an earlier study of teachers' interactions with media related to contemporary issues (Kolsto 2006), we found that teachers can and do engage in evaluation of media but that those evaluation practices vary substantially by teacher. Our teachers, like those featured in Kolstø's study, evaluated the relevance of media for their classes and to lesser degrees adequacy, credibility, and usability. However, teachers were less likely to create opportunities for students to engage in evaluation. Here again, this result highlights specific needs for teacher education and professional development related to how media ought to be used and the kinds of opportunities that sciences learners ought to have in science classrooms.

Media creation, the highest and most cognitively demanding form of media literacy was not observed in our study (at least in the context of SSI and SUS). We see unique but unmet opportunities at the intersections of SSI, SUS and media literacy. If we truly want to engage students in SSI and SUS, why not put the power and potential of media production in their hands. Accessing, analyzing and evaluating media relative to contemporary issues is essential for decision-making, but fostering opportunities for students to actually create media around SSI and SUS could lead to new forms of participatory scientific literacy.

The unprecedented access to media, new forms of media and relevance of those media to students' lived experiences offer new opportunities for featuring media as an integral part of science education. These new opportunities are particularly relevant for SSI-based and EfS instructional approaches. The current study offers an empirical exploration, drawing from a MLE framework, of how media are being used for addressing SSI and SUS in science classes and offers insights related to how the science education community may advance these efforts. Science teachers may be making use of media in significant ways, but many teachers would likely benefit from targeted supports to 1) more fully engage students in a broader range of media literacy practices and 2) take better advantage of the natural links between media and socio-scientific and sustainability issues.

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