How guest experts tell stories about environmental socio-scientific issues in an undergraduate class

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How guest experts tell stories about environmental socio-scientific issues in an undergraduate class

Anne Marie A. Casper and Meena M. Balgopal

Department of Biology, Colorado State University, Fort Collins, CO, USA

ABSTRACT
To broaden perspectives presented in undergraduate courses, instructors often invite guest speakers, yet there is limited research on students’ perceptions of guest speakers and the potential influence they may have on student learning. In this exploratory study, we describe how senior undergraduate students, in a natural resource management capstone course, perceived guest speakers, who were invited to lecture on environmental socio-scientific issues. Through qualitative content analysis (guided by frame theory) of student interviews, student artifacts, and transcripts of lectures, we determined that, compared to other speakers, ‘memorable’ speakers (1) told stories, (2) evoked emotion, and (3) either explained theory only after sharing cases studies or intermittently explained theory while sharing a case (rather than beginning with theoretical explanations followed by case studies). Because storytelling was a consistent theme across the ‘memorable’ speakers, we posit that this instructional strategy can be effective in engaging students. We make recommendations for how instructors can select or prepare guests in interacting with undergraduate students.

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Introduction

In light of current global climate change and scepticism about science, effective communication about environmental socio-scientific issues (SSIs) is vital (Fischhoff & Scheufele, 2013; Rockstrom et al., 2009). How people communicate about SSIs influences policy and decision-making at local to global scales, and at a time when these policies likely will have the potential to have long term and large-scale ramifications, it warrants further study (Bäckstrand, 2003; Harvey et al., 2018). It is challenging for experts to communicate to different and diverse audiences, and experts’ intuitions about communication strategies may lead to miscommunication (de Bruin & Bostrom, 2013). Instead of relying on intuition, de Bruin and Bostrom (2013) argued that it is important for experts to assess what information audiences need to make decisions and then test how this information can be effectively communicated. Ineffective scientific communication can erode public trust in scientists (Fischhoff & Scheufele, 2013; Kueffer & Larson, 2014; Mooney & Kirschenbaum, 2009). Within the field of natural resource management (NRM), professionals

CONTACT Anne Marie A. Casper aramaticasper@gmail.com Department of Biology, Colorado State University, Fort Collins, CO 80523, USA
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have a range of different expertise and knowledge. Not all are trained as natural scientists, for example. However, similar to general science communication, NRM communication to the public or non-specialist audiences can have important outcomes – namely, the decisions that may result in environmental management strategies that range from effective to destructive (Estes et al., 2011).

Undergraduate NRM curricula allow students to explore relevant environmental science content within the broader conversation about management of natural resources, working with diverse stakeholders, and implications of policies. NRM courses not only expect students to develop content knowledge, they allow students to improve their communication skills. Although communication strategies are not necessarily part of the formal curricula, such strategies are modelled by experts or materials that are integrated into such courses (Dufresne et al., 1996; Roth, 2005).

In undergraduate classrooms students interact with and learn from multiple people, including their primary instructor, each other, and possibly teaching or learning assistants, but they may also learn from experts who are invited into the classroom. Guest speakers are often invited to broaden the perspectives of the instructor (Glenwick & Chabot, 1991; Lambert, 2003; Mullins, 2001). However, low quality guest speaker interactions may detract from, rather than support, learning (Fawcett & Fawcett, 2011). While there is extensive research on how students learn from instructors, each other, and teaching and learning assistants, it less clear what makes a guest speaker effective in the classroom environment (Metrejean et al., 2002). Published studies tend to focus on guest speakers in business courses, where theory and application are bridged by practitioners in non-academic settings (Kamoun & Selim, 2007). Yet, given the timely focus on SSIs and decision-making in natural resource and environmental management, which is often integrated with social and cultural values, we argue that studies like ours can inform other educators who integrate similar SSIs into their science courses.

The approach that guest speakers and instructors use may differ (Mullins, 2001). While classroom instructors often strive for unbiased science communication, guest speakers are often invited because of their expertise or unique personal perspective. This is important because the language and examples we use when speaking influence how our audience interprets our messages and perspectives (Goffman, 1986). Moreover, when topics are political in nature, such as with SSIs, people often use specific words or examples that sway others’ opinions, as frame theory explains (Druckman, 2001). According to frame theory, communicators can influence how an audience interprets a topic by focusing or highlighting certain facts or positioning the issue from a particular angle. Hence, when NRM courses rely on guest speakers to share their experiences, it presents the opportunity to examine how their framing of environmental SSIs affect students’ perceptions of their understanding of the issues.

Not only do guest speakers likely frame their personal experiences in different ways, they also use different delivery strategies. Anecdotes, case studies, and personal narratives can all fall under the informal category of science storytelling. Some science communication experts argue that it is through stories that speakers can maintain the attention from audiences, elicit emotional reactions, and persuade through illustrations (Solomon, 2002). People are generally drawn to subjective forms of communication and are more likely to remember and act on issues if they feel moved by the them (Dahlstrom, 2014; Jones & Crow, 2017; Kreuter et al., 2007). Memorable communication that leads to
action is arguably particularly important for SSIs, which have important real-world ramifications.

Although people colloquially use the term, stories, to capture a variety of narratives, within the discipline of science communication, there are specific elements of storytelling that have been identified (Leipzig, 2018; Nisbet & Scheufele, 2009; Norris et al., 2005). When guest speakers share personal experiences and knowledge, rather than cover foundational material or introduce skills, examining their use of storytelling can be informative because it presents the opportunity to analyse audience perceptions and reactions. In turn, education researchers can design meaningful classroom experiences that prepare students to understand how human decisions can impact environmental and socio-economic systems (Casper et al., 2016).

**Theoretical framework**

The specific way that someone describes, or frames, a situation, including the words and salient information provided, influences how others respond to and interpret the information (Druckman, 2001; Entman, 1993; Goffman, 1986; Vliegenthart & van Zoonen, 2011), as is explained in frame theory. People interpreting information also use frames to synthesise and incorporate new information (Druckman, 2001; Entman, 1993; Goffman, 1986). It is through frames that the audience is oriented to make meaning of an SSI. For example, Harvey et al. (2018) found that climate science-denying blogs about polar ice caps and polar bear populations framed their discourse around scientific uncertainty as problematic, arguing that any level of uncertainty was reason to not accept arguments about anthropogenic climate change. In contrast, climate-based blogs framed uncertainty very differently, arguing instead that there was a high level of confidence within the climate science community about the impact of decreased sea ice and polar bear population.

In frame analysis it is important to distinguish between frames, which describe content features, framing, or contextual features (Vliegenthart & van Zoonen, 2011). Frames can also be used to describe the characteristics of a situation or interactions (Lewicki et al., 2003). Goffman (1986), credited for developing frame theory, argued that it is only through the frames we apply to information that the information gains meaning. Because each person communicates based on different experiences, beliefs, and knowledge, their frames and the way they interpret data differ.

People often use different frames to describe SSIs depending on their perspective (Druckman, 2001; Kolsto, 2006). For example, hydraulic fracturing, or fracking, is described as important to energy independence by some, and as something that needs to be outlawed by others (Hilson, 2015; Williams et al., 2017). This type of framing of information can influence how people interpret information (Druckman, 2001). However, each person’s background knowledge and perceptions of others’ perspectives on a topic will impact the influence of frames on an individual’s beliefs (Druckman, 2001; Lewicki et al., 2003). According to Groffman et al. (2010), science communication is more effective if the information is framed in a way that is relevant and applicable to the target audience. Some argue that science communication has adhered to a deficit model, assuming that the public lacks knowledge needed to make decisions (Sturgis & Allum, 2004). Because decision-making is informed by many components including values, social identity, trust, and balancing trade-offs, a simple transmission of information
does not mean that an informed general public will interpret the data as scientists do (Groffman et al., 2010). However, by framing content in a relevant and accessible way, science communicators are more likely to influence how the target audience makes decisions and act (Groffman et al., 2010).

Storytelling allows communicators to frame information in a way that differs from explanatory or expository approaches. Although some experts question the value of storytelling when communicating sciences (Dahlstrom, 2014; Katz, 2013), others purport that it is a powerful teaching tool (Fawcett & Fawcett, 2011). Storytelling can be an effective science communication tool, particularly when communicating to non-specialist audiences (Dahlstrom, 2014). Narratives provide a larger context for comprehending and storing information, provide a better framework for understanding cause and effect relationships, and are often associated with increased recall, easier comprehension, and shorter reading times (Dahlstrom, 2014). These benefits make storytelling a potentially important instructional delivery strategy in undergraduate environmental science classes.

Due to the lack of research on (a) what makes guest speakers effective in undergraduate classrooms and (b) how the framing of material influences the way students interpret new information, we explored how undergraduate students responded to different guest speakers’ presentations in an upper-level NRM course. Specifically, we addressed the research questions: (1) what common characteristics do ‘memorable’ guest speakers have, and (2) what instructional delivery strategies (e.g. framing) did ‘memorable’ guest speakers use? Additionally, since many speakers described their instructional delivery as storytelling, we also asked (3) are those using self-described storytelling actually integrating elements of storytelling?

**Methods**

**Course context and study participants**

We performed this study in a capstone course for NRM and Rangeland Ecology majors. Capstone courses are taken by final-year (i.e. senior) students, who are expected to draw on disciplinary content and skills learned throughout their degree programme to create a final project. Within the NRM programme, this course allowed students to synthesise their culminating knowledge to solve problems and create a management plan for an SSIs of their choice reflecting what NRM professionals likely encounter.

The course instructor was an NRM professor and the Graduate Teaching Assistant (GTA) was studying ecology education. The instructor had taught the class nine times previously; the GTA had assisted in teaching the class twice before. The lecture section met twice a week for 75 minutes, and the laboratory met weekly for 100 minutes. The professor and guest speakers led the lectures, and the professor and GTA led the lab sections. The course covered a range of topics that involved several different SSIs (Table 1), which mainly focused on water, energy, land use, and cultural perspectives. Guest speakers, invited by the professor, taught 60% (18/30) of the class periods, two of these were panels with multiple speakers. Speakers were either professionals in a field related to NRM or engaged citizens.

On the first day of class all students \((n = 45)\) were invited to participate in the study. The class comprised 29 men and 16 women, whose average age was 25 years. Students could
choose to not participate, only have their coursework analysed, or have their coursework analysed and participate in interviews. All but one consented to have their coursework analysed; 20 students also consented to and participated in two 20–60 minutes semi-structured pre-and post-interviews. All interviews were transcribed prior to analysis. Of the students who participated in the study (n = 44), 34 were NRM majors, two were Rangeland Ecology majors, and seven were NRM majors with a second major (three NR Economics, two Forestry, one Forest Biology, and one Journalism). While not all students reported their minors, all NRM students are required to have a minor or second major. Minors included Forestry, Ecological Restoration, Conservation Biology, Spatial Information Management, Political Sciences, Global Environmental Sustainability, Fisheries, and Environmental Affairs.

On the day speakers presented, but prior to their speaking to the class, each speaker was invited to participate in the study by having their lecture recorded and providing any

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>SSI content</th>
<th>Presenter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Systems thinking; Ecosystem Management</td>
<td>Social-ecological systems</td>
<td>Instructor/TA</td>
</tr>
<tr>
<td>2</td>
<td>Complexity, Uncertainty, Resilience</td>
<td>Social-ecological system function and management; Rangeland land-use case study</td>
<td>Instructor/TA</td>
</tr>
<tr>
<td>3</td>
<td>Professional ethics</td>
<td>Ethical roles and responsibilities.</td>
<td>Instructor/TA</td>
</tr>
<tr>
<td>3</td>
<td>Research Skills</td>
<td>Accessing diverse data</td>
<td>Librarian</td>
</tr>
<tr>
<td>4</td>
<td>Water</td>
<td>Water use in the western United States, water rights</td>
<td>Water Civil Engineer</td>
</tr>
<tr>
<td>4</td>
<td>Energy</td>
<td>Hydraulic fracturing</td>
<td>Geologist</td>
</tr>
<tr>
<td>5</td>
<td>Stakeholder Perspectives and Involvement</td>
<td>Coville National Forest case study</td>
<td>Instructor/TA</td>
</tr>
<tr>
<td>5</td>
<td>Stakeholder Perspectives and Involvement</td>
<td>Role-playing case study of Local River flood recovery</td>
<td>Instructor/TA</td>
</tr>
<tr>
<td>5</td>
<td>Stakeholder Perspectives and Involvement</td>
<td>Local River flood recovery</td>
<td>Small NGO</td>
</tr>
<tr>
<td>6</td>
<td>Energy</td>
<td>Energy Policies</td>
<td>Lawyer working in energy law</td>
</tr>
<tr>
<td>6</td>
<td>Water</td>
<td>Water Policies</td>
<td>Lawyer working in water law</td>
</tr>
<tr>
<td>7</td>
<td>Land Use</td>
<td>Land Use Policies</td>
<td>County planning department</td>
</tr>
<tr>
<td>8</td>
<td>Stakeholder Perspectives and Involvement</td>
<td>Citizen Panel: Local land, energy, and water issues</td>
<td>Local resident stakeholder panel</td>
</tr>
<tr>
<td>8</td>
<td>Stakeholder Perspectives and Involvement</td>
<td>Government Panel: Local land, energy, and water issues</td>
<td>Local professional stakeholder panel (e.g. land managers)</td>
</tr>
<tr>
<td>9</td>
<td>Stakeholder Perspectives and Involvement</td>
<td>Tribal Environmental Stewardship</td>
<td>Tribal Lawyer</td>
</tr>
<tr>
<td>9</td>
<td>Ecosystem Management</td>
<td>Payment for Ecosystem Services (PES)</td>
<td>PES researcher, graduate student not known to students in class</td>
</tr>
<tr>
<td>10</td>
<td>Scenario planning</td>
<td>Process of scenario planning, students applied to social-ecological systems in lab</td>
<td>Scenario planner, University faculty member</td>
</tr>
<tr>
<td>10</td>
<td>Education and outreach in Natural Resources</td>
<td>Wildlife-human conflict: Wolves in the Greater Yellowstone Ecosystem</td>
<td>Former teacher, current graduate student known to students in class</td>
</tr>
<tr>
<td>11</td>
<td>Adaptive Management</td>
<td>Ecosystem management – Rangeland grazing and Sage Grouse habitat</td>
<td>Federal land manager</td>
</tr>
<tr>
<td>11</td>
<td>Water</td>
<td>River management</td>
<td>Local City land manager</td>
</tr>
<tr>
<td>12</td>
<td>Land Use</td>
<td>Land conservation and planning tools</td>
<td>Land conservation planner</td>
</tr>
<tr>
<td>12</td>
<td>Land Use</td>
<td>Land trusts and conservation easements</td>
<td>Land trust manager</td>
</tr>
<tr>
<td>13</td>
<td>Stakeholder Perspectives and Involvement</td>
<td>Collaborative management – Wildland/Urban interface in fire adapted ecosystems</td>
<td>Large NGO</td>
</tr>
<tr>
<td>13</td>
<td>Stakeholder Perspectives and Involvement</td>
<td>Energy Industry and Land Management</td>
<td>County open lands manager</td>
</tr>
<tr>
<td>14–15</td>
<td>Group project work, course synthesis</td>
<td></td>
<td>Instructor/TA</td>
</tr>
</tbody>
</table>
presentation materials they used (e.g. PowerPoint presentations). All speakers consented to participate in the study.

**Data collection and analysis**

After the course ended, all student interviews were transcribed and student written assignments were organised for analysis. Of the 20 students interviewed, almost all (18 students) mentioned a specific speaker or lecture, prompting us to reread students’ post-semester interviews to identify which guest speakers were referenced most often across participant interviews. Only a 1/3 of the guest speakers were described by three or more students, so these guest speakers appeared to be noteworthy to the participants. Hence, we labelled these guest speakers as ‘memorable.’ We also identified whether students who mentioned ‘memorable’ guest speakers referenced them in their written assessments.

We then conducted two rounds of analyses (Figure 1) using guest speakers’ instructional materials (transcripts of lectures and presentation materials). We first conducted an inductive analysis to ask: what common characteristics do ‘memorable’ guest speakers have? Recognising that there were patterns in instructional delivery that ‘memorable’ speakers used, we followed this with a deductive analysis to ask: what instructional delivery (framing and storytelling elements) strategies did ‘memorable’ guest speakers use?

**Student perceptions of guest speakers.** We conducted a qualitative content analysis of how students discussed the guest speakers’ presentations. We asked students how their ideas about how environmental SSIs and NRM were shaped by interacting with/ listening to diverse views. In our coding and analysis, we focused on whether students discussed speakers other than those they identified as ‘memorable’ and how students discussed material that conflicted with their own views. We were particularly interested in instances (a) when students discussed having their views changed by a speaker and (b) if the students perceived the speakers that had conflicting views as shaping their ideas. Because

![Figure 1. Process of deductive and inductive coding followed for analysis.](image-url)
the majority of student written assessment was a product of group work, our analysis of how speakers affected individual students’ learning outcomes was limited to students’ individual writing assignments.

**Common characteristics of guest speakers.** We performed our initial coding using QCAmap (Mayring & Fenzi, 2003). To explore how speakers framed their presentations, we conducted a qualitative content analysis (QCA) of the speakers’ presentations (Mayring, 2000). There are many types of content analyses (Weber, 1990), and QCA addresses some of the critiques of quantitative content analysis by acknowledging the larger context of the communication being analysed, not just the specific words used (Mayring, 2000). In QCA, components of the text are synthesised into categories, which are then refined through an iterative process.

To conduct our deductive qualitative content analysis, we started with Lewicki et al.’s (2003) disciplinary relevant frames developed for analysing intractable environmental conflict because the speakers all discussed issues relevant to environmental conflict (frame categories included identity, characterisation, conflict management, whole story, social control, power, risk, cycles, outlook, social systems, situational factors, and others.) We also coded inductively to identify any new codes before all codes were refined and collapsed into final categories. These codes were then used for another round of analysis of all transcripts – of both the ‘memorable’ speakers and other speakers. One of the final codes present in all lectures that students described as influential was self-described storytelling. To determine if the speakers were actually using storytelling strategies we deductively coded the influential lectures using Norris et al.’s (2005) characteristics of narratives. These codes were specifically developed for coding science narratives (event tokens, narrator, narrative appetite, past time, structure, agency, purpose, and role of the reader/listener).

One challenge we faced in data analysis was classifying the lecture when the course instructor presented her own research, filling the role of a guest speaker. This lecture was most frequently identified as memorable by students because of the instructor’s personal connections to her work. During our qualitative content analysis, we chose to exclude the lecture, as the frames the instructor used to discuss her research were spread throughout the course. However, we were able to include this lecture in the storytelling analysis since the characteristics of narrative were self-contained within a single lecture.

**Establishing trustworthiness of analysis.** For the analysis of the student perceptions, a trained inter-rater coder analysed 20% of the student interviews, resulting in 100% inter-rater reliability. For the analysis of guest speaker presentations, a trained research student coded all of the ‘memorable’ speaker presentations. After initial coding overall agreement was 85%; the coders had 100% agreement on five of the seven lectures and 50% agreement on two of the lectures. Following discussion, we reached 75% agreement (six out of eight codes) on the two lectures with disagreement. We subsequently discussed all discrepant codes till we reached consensus. When applicable, visual presentation materials (e.g. PowerPoint presentations) were analysed for triangulation and code clarification.

**Findings**

There were six ‘memorable’ speakers, and they shared five unifying characteristics in how they framed their communication, delivered content, and structured their
presentations (Table 2). These speakers all integrated personal connections into their presentations (personal), used affective language and examples (emotive), involved students in class discussions (engaging), and explicitly stated that they were using stories or anecdotes to make their points (storytelling). The sequencing and structuring of presentations differed from other speakers: they started their presentations with scenarios and used them to exemplify theory (case-then-theory), instead of starting with background information (theory-then-case). Only one of the 12 non-memorable speakers shared communication characteristics with the ‘memorable’ speakers (Table 2). This speaker was a graduate student in the NRM programme and was known to many of the students; therefore, she may not have been viewed as an outside speaker. Students’ familiarity with her may have influenced how often they mentioned her during interviews.

### Frames

#### Personal content

All of the ‘memorable’ speakers used personal framing, and 75% of the other speakers also drew from personal experiences. The speakers situated themselves within the context of
their presentation, instead of making themselves objective outsiders. Therefore, many of the presentations used this frame. For example, one speaker, a scientist, described his personal ties to the river and showed how it is important to him beyond simply as a study system (Table 2). The river’s health directly influenced his personal life; his interest and motivation for caring about it are not simply academic: ‘The River, is near and dear to my heart, I raft on the [River], I’ve been fishing up there. And as a scientist … I also study it, trying to figure out exactly what’s going on with the river.’ Another speaker, a tribal lawyer, explained how her personal knowledge helped her identify gaps in her formal education: ‘I went through four years of political science training here at [University]. And, if I wasn’t a Native person myself, I would have never known a tribe was a formal government.’ This speaker felt that the knowledge that tribes are a formal government, which is foundational to all of her work, was omitted from her formal education. She felt compelled to share this deeply personal piece of information to the NRM students. In both examples, the speakers shared their personal perspectives that helped shape their professional identities. Through anecdotes, listeners were persuaded by the experiences of the speakers.

**Sequencing of content**

The sequence of presentation (case or theory first) distinguished the ‘memorable’ speakers from the other speakers. All of the ‘memorable’ speakers framed their presentation as a case-then-theory, while the other speakers were split evenly between theory-then-case or weaving the two together.

For example, a geologist, who was not identified as ‘memorable,’ provided general background about geology and gas and oil production: ‘First off, a word about the word shale. When we start talking about hydraulic fracturing, shale is usually the rock type term that is used generally, certainly the term that is used in the media.’ After discussing the theory and technical information behind hydraulic fracturing, the speaker discussed cases of conflict around hydraulic fracturing in practice: ‘Another concern is the proximity of some of these drilling operations to people’s homes or to schools. And in [State], I’m not an expert on this … this has been a very politicised issue.’ This speaker started with background theoretical information and then only discussed cases to illustrate her point about the effect of hydraulic fracturing on local communities.

In contrast, a guest speaker from a large NGO described the context and stakeholder involved in decision-making about fire management of an area. Throughout this discourse she wove NRM theory throughout description of case. She discussed strategies for developing collaborations with diverse stakeholder groups by starting with evoking images of people (rather than theory):

That’s why I love this! It’s hard. How are you going to [manage this system]? But it’s there, it’s real; people live there. People live on the coast because it’s magnificent. And they feel touched by it. Even the builder, you know. He’s like, this system is in me. It’s that whole sense of place. And there are lots of studies around how people have this affinity to nature, affinity to place, biophilia.

Through embedding theory within her case, this ‘memorable’ speaker used the case to make the theory directly relevant.
Delivery techniques

The speakers communicated their messages using different delivery techniques: emotive, engaging, and explicit storytelling. These techniques allowed speakers to connect to their audience. Unlike the overarching structure frames, these delivery frames occurred only occasionally and did not describe the overarching presentation. Speakers who used emotive frames used language that drew on the listener’s emotions. One speaker used words such as ‘alarming’ and ‘concern’ to communicate how she reacted to the situation being described (Table 2). Similarly, the guest speaker from a small NGO talked about the collective desires of people who move to one community, putting a strain on available resources – such as the college town in which the students live:

_Unfortunately, we’re faced with a gigantic tragedy of the commons sort of situation here … Everybody wants to move here, everybody wants to live here, everybody wants to hike, dirt bike, four-wheel, camp, burn things, you know (laughs), trash things, shoot at things, and our public lands are becoming more and more of a mess._

The speaker framed this example around emotive terms and started off using the word, ‘unfortunately.’ Hence, his stance was clear by citing a concept about which NRM students are well aware and one described in a 1968 essay by Garrett Hardin. All of the ‘memorable’ speakers used emotive frames, compared to only 25% of the other speakers.

**Engaging** frames were commonly used across all speakers (100% of influential speakers and 83% of other speakers). This may have been an artefact of what discourse styles that the course instructor values, yet it was something that was clearly appealing to the students. The speakers who used engaging frames drew the students out of passive listener mode and encouraged them to actively participate in class discussions, unlike speakers who simply required students to listen. For example, a speaker from a local restoration NGO asked students to draw from their previous discussions in class and relate this to his presentation (Table 2). By connecting to his knowledge of the larger class context he helped students understand how his material was relevant to the overarching goals of the class. By asking questions that required students to respond, he was more actively drew the students into his presentation. Similarly, the speaker from the large NGO invited students to react to the scenario she presented:

_So, those are the characters … If people are under stress and making decisions, do their values and norms kind of come into play? … Talk to me about what you think the different value systems are for these people?_

This speaker encouraged students to integrate their beliefs and knowledge to analyse the example that she described. The message she conveyed was that, as future NRM practitioners, they would have to interpret information. She was giving them the chance to be engaged now, as capstone students.

Speakers who explicitly stated they used **storytelling** or anecdotes to convey their information grounded their material in actual (versus hypothetical) situations and events. For example, the speaker from the large NGO described a conflict surrounding land management in an area with high wildfire risk by starting her presentation with, ‘… so I’m going to try to share some experiences with you through the venue of storytelling’ (Table 2). When she shared the story of the stakeholders and the situation, she demonstrated how she implemented practices rooted in NRM theory: ‘One way to get people who don’t
like each other to work together is you make them learn together. And, you also make them understand what’s in the head of the other person.’ The Tribal Law expert integrated multiple stories throughout her presentation, and named her discourse as such: ‘A story I told my class last week …’ While all of the ‘memorable’ speakers explicitly stated they were using stories or anecdotes, only 7% (i.e. one) of the other speakers explicitly stated this. Therefore, the explicit use of storytelling to frame the material presented was the characteristic that most strongly differentiated the ‘memorable’ speakers from the other speakers.

Beyond their explicit identification of using storytelling or anecdotes, all of these ‘memorable’ guest speakers used all of Norris et al.’s (2005) narrative elements: (i) event-tokens, (ii) narrator, (iii) narrative appetite, (iv) past time, (v) structure, (vi) agency, (vii) purpose, and (viii) role of the listener. The adherence to these theoretical elements of storytelling communication strategies supports the fact that speakers also explicitly identified their presentations as using storytelling (Table 3). As this was not an anticipated finding in this inductive, qualitative study, none of the guest speakers were asked about any formal training in science communication or storytelling.

**Valuing diverse perspectives**

Lectures that students identified as memorable were not the only lectures discussed in their writing. Therefore, we know that students were not simply listing the only guest speakers they remembered when discussing those who influenced their learning. In their final writing assignment students were asked to ‘describe a situation where another individual presented a perspective that challenged your own. What types of strategies do you use in this type of situation and how did you develop them?’ Most students responded to this prompt with one of the other-category lectures. Justin described one lecture as challenging his ideas, even though he did not describe the speaker as being particularly influential in his interview.

At times, views were presented that differed from my own, which provided a useful opportunity to ask questions and learn about varying perspectives. Stakeholders involved in the hydraulic-fracturing process were one such example. While I have been somewhat uninformed about the topic in the past, my general disapproval of fracking was put into question to some extent after listening to professional opinions. While I remain sceptical about the process as a whole, I now can approach the issue with a better understanding of the underlying processes, along with some appreciation for those involved in the process.

**Discussion and implications**

Undergraduate students in our study were responsive to certain discourse styles of guest speakers in their NRM course. Speakers who students identified as ‘memorable’ (1) used emotive language, (2) were interactive, and (3) presented case scenarios and examples before explaining the theoretical background, in addition to calling out the fact that they used elements of storytelling. We recognise that these characterise are interrelated and may, indeed, be embedded in one another. Presenting case studies or evoking emotion are techniques related to storytelling (Norris et al., 2005). However, our primary proposition is that outside experts, who are invited to classrooms as guest
**Table 3.** Examples of how guest speakers in an undergraduate natural resource management class used elements of narratives in their discourse (Norris et al., 2005).

<table>
<thead>
<tr>
<th>Narrative Element</th>
<th>Example</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Narrative Role of reader/listener</td>
<td>And the tribe was able to manage the Loach Minnow habitat itself and still provide some economic development. All they wanted to do is put in a few toilets for the tourists. Right? Now the state was pushing really really hard to have this endangered species habitat designated on the reservation. Any ideas why? – Tribal Lawyer</td>
<td>The speaker asks questions, clearly inviting the listeners to be engaged and think/interact with what the speaker is saying, regardless of if the students actually respond.</td>
</tr>
<tr>
<td>Purpose</td>
<td>N/A</td>
<td>The overarching interaction has a larger-structure purpose of occurring to hear perspectives from different stakeholders, and it is framed this way for all participants (students and stakeholders). – Stakeholder panel</td>
</tr>
<tr>
<td>Agency</td>
<td>But, they said we’re really not that great of partnerships. But . . . . We always had to work in partnerships. You know? You got a fire engine, I got a hard hat. What do you say we work together? So they said, we really are going to have to get better at partnerships and we want you guys to help us. – Large NGO</td>
<td>The speaker clearly explains how agency plays a role in what is happening, it is not just random, and people involved have power to create change.</td>
</tr>
<tr>
<td>Structure</td>
<td>I’d like to give you guys a little bit of background about [NGO] and then we’re going to talk a little bit about the Restoration Coalition, I’m going to talk about some of our early projects and some of our early challenges in the past year and a half aftermath of this epic flood event . . . . – Small NGO</td>
<td>The speaker explains the structure of his presentation.</td>
</tr>
<tr>
<td>Past time</td>
<td>Our goal has been to maintain an east-west corridor across that landscape. Because we know, not only did people, from at least 11,000 years [ago] . . . moved east-west across that landscape seasonally. And wildlife have as well. So one of our big goals have been to maintain that landscape, both for livelihoods but also for NR and connectivity across it as well. – Stakeholder Panel</td>
<td>The speaker clearly situates how time interacts with the events, and how historical events inform current actions.</td>
</tr>
<tr>
<td>Narrative appetite</td>
<td>They think of Indians as being something like a little bit of a historical artefact. Right, didn’t all of those folks die out years ago from small pox blankets and things like that? . . . . Not necessarily everybody, but I come across it quite a bit working in Indian law. And people were like, wow, are there any left. And, what, how does it matter? And the reality is that Indians are alive and well, and this is actually a picture of a White Mountain Apache tribal skate team. Right? They’re in traditional regalia, they’re adopting something very very modern. – Tribal Lawyer</td>
<td>The speaker takes prevailing sentiments that she grapples with regularly, juxtaposes them with reality, and then poses the question, ‘why does it all matter,’ to draw listeners into where she is headed.</td>
</tr>
<tr>
<td>Narrator</td>
<td>N/A</td>
<td>Each presenter is the narrator for the day. Their physical presence as a presenter clearly establishes them as a narrator.</td>
</tr>
<tr>
<td>Event-tokens</td>
<td>And as a scientist, as a civil engineer, environmental engineer I also study it . . . . what happens when you take water out, what happens when you put water in, how that affects the sediment, the algae and the fish, and all those things put together. . . . And then we’ll get into the River itself, flows, and conditions. What certain conditions mean and what can you do? What are our options? – Water Civil Engineer</td>
<td>The speaker provides an overarching context for his presentation, laying out the event tokens.</td>
</tr>
</tbody>
</table>
speakers, have the potential to influence undergraduate students as they make meaning of complex environmental and natural resource science topics.

The 'memorable' strategies we described were perceived by students as helping them to understand diverse perspectives and to step into the worlds of the guests. People are more likely to remember and act on issues, if they feel moved by them (Dahlstrom, 2014; Kreuter et al., 2007). Furthermore, people are drawn to listen to subjective forms of communication (Jones & Crow, 2017). This is important because the positions of these speakers varied greatly but were the views the students remembered. Hence, there are implications for who environmental educators invite to interact with their students. Instead of trying to use a distanced or didactic perspective, as some of the speakers who students did not identify as memorable did, it may behoove speakers to focus on sharing their perspective and helping students see through others’ lived experiences.

Neither storytelling nor emotive communication are characteristics associated with the post-positive nature of scientific inquiry (Doubleday & Connell, 2017). In fact, there are strong criticisms against the use of storytelling in science, due to fears that it will lead to skewed views of information and promote the conception that science does not work towards objective explanations (Downs, 2014; Katz, 2013). However, there is also evidence that storytelling and narrative discourse may be an effective way to communicate science to non-expert audiences, particularly since storytelling may help make the information more meaningful to listeners (Dahlstrom, 2014; Fawcett & Fawcett, 2011; Groffman et al., 2010; Solomon, 2002), increase comprehension and retention (Negrete, 2005; van Haneghan et al., 1992), help people visualise concepts (Prins et al., 2017), and make the language of science more accessible to broader audiences (Avraamidou & Osborne, 2009). Fuchs (2015) argued that narrative framing can be used as a methodological tool in modelling and simulation to help conceptualise new situations and that narrative is not only useful as a socio-historical context for embedding scientific knowledge, but that stories are also useful for directly conveying science knowledge.

Our speakers identified themselves as using storytelling, and their presentations could be classified as such (Norris et al., 2005). Storytelling as a discourse style is important for environmental scientists who work with diverse community stakeholders, who may not be interested in theoretical and conceptual frameworks, and may find the language of science foreign and/or inaccessible (Avraamidou & Osborne, 2009). Rather, through storytelling, people can find common ground and transcend differences in their backgrounds. They can also empathise with tension that characters face (Gross et al., 2018). Particularly when addressing situations such as SSIs and NRM, where social components are inextricably linked with science, the use of narrative may help people understand complex multidimensional issues. Hence, by calling out storytelling, guest speakers in science courses may be helping future science professionals identify this as an important communication strategy. Stories are an everyday way of making sense of the world and communicating events that may help shift listeners’ perceptions of science as dogmatic, inaccessible, and irrelevant, towards conceptions of science as a relevant, accessible, dynamic process of building knowledge (Avraamidou & Osborne, 2009).

Using methodical, repeatable protocols to measure whether presentations are indeed stories is important before any decisive conclusions can be made about the effectiveness of storytelling in science pedagogy (e.g. Avraamidou & Osborne, 2009; Leipzig, 2018; Norris et al., 2005). While our speakers identified they were using storytelling and its
key elements (Table 3), interestingly, none of the speakers shared with us that they were formally trained in science communication theory. Even though we do not know if speakers intentionally used elements of storytelling or included them intuitively based on their own experiences of story, we believe that further studies on formal training and ability to communicate science through storytelling are important and valuable. Once there is a better understanding of the key elements of storytelling that facilitate learning, guidelines and trainings for speakers can help educators practically apply research to teaching.

Our findings about communication are particularly interesting in the context of the NRM course since the students were not necessarily science experts, the speakers communicating science were not all science experts, and as current and future NRM professionals, the students and guest speakers will likely communicate science with both experts and non-experts. Additionally, many of the issues in NRM are SSIs. Therefore, the use of storytelling, making personal connections, drawing on emotions, and foregrounding cases to illustrate theoretical concepts all help the learners find connections to the content, develop rapport with the speaker, and help break down the barriers around science as a specialised, foreign language (Avraamidou & Osborne, 2009; Fawcett & Fawcett, 2011; Groffman et al., 2010; Norris et al., 2005; Solomon, 2002).

Drawing guest speakers into the classroom and encouraging them to teach through stories also addresses one of the challenges for instructors using narratives to convey content – developing narratives for use in the classroom (Avraamidou & Osborne, 2009). Guest speakers who can share professional experiences that are meaningful not only have a wealth of real examples, they likely have a breadth of knowledge that will allow them to answer students’ follow-up questions about applied theory. Local speakers, such as the local NGO speaker in this study, may also have in-depth knowledge about local events that impact students’ lives, reinforcing student’s perceptions of the relevance of diverse stakeholders’ narratives. Course instructors may also want to coach invited guests to consider communication strategies that invite students to engage in discussion.

Our study focused only on students’ perceptions of their learning; it did not attempt to objectively measure student learning from any particular guest speaker. Additionally, not all students were at every lecture; near the end of the semester attendance was as low as 50%. Therefore, students could not discuss or evaluate speakers whose presentations they did not attend. Our study was conducted in an NRM course with graduating seniors; research in classes at other levels and with different student populations will help determine the transferability of our results.

In spite of any limitations, our exploratory study is relevant to formal science educators. For educators who aim to help students become informed citizens, prepared to make decisions in their personal and professional lives, our study has strong implications. In light of our findings, instructors may choose to (1) find guest speakers who are able to use effective strategies to engage students, (2) coach speakers on these effective strategies, or (3) challenge students to consider how best to communicate environmental SSIs to different audiences. Our findings, in combination with the limited research on guest speaker effectiveness (e.g. Metrejean et al., 2002; Mullins, 2001) and storytelling as a classroom science teaching tool (e.g. Fawcett & Fawcett, 2011; Solomon, 2002) demonstrate the need for further research on guest speaker communication and the use of storytelling in the undergraduate classroom.
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Disclosure statement

No potential conflict of interest was reported by the author(s).

Data availability statement

The data that support the findings of this study are available on request from the corresponding author via email (aramaticasper@gmail.com). The data are not publicly available due to their containing information that could compromise the privacy of research participants.

ORCID

Anne Marie A. Casper http://orcid.org/0000-0001-6557-4425
Meena M. Balgopal http://orcid.org/0000-0002-3846-9256

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