Research Article

Science News Stories as Boundary Objects Affecting Engagement With Science

Joseph L. Polman¹ and Jennifer M.G. Hope²

¹University of Colorado Boulder, Boulder, Colorado
²McKendree University, Lebanon, Illinois

Received 11 August 2013; Accepted 31 December 2013

Abstract: This paper explores how participating in a program spanning an informal science institution and multiple school sites engaged youth with science in a different way. In particular, teens in the program selected and researched science topics of personal interest, and then authored, revised, and published science news stories about those topics in an authentic publication venue with an outside editor. Through five case studies analyzed according to a sociocultural framework for engagement understood as involving actions, interests and identifications, the authors describe how the news story artifacts became “boundary objects” inhabiting several intersecting social worlds. These boundary objects are often mediated by adults acting as brokers spanning communities. The properties of the news stories that enable them to act as boundary objects include their mutability and shareability as electronic draft documents created in distributed learning environments and responded to by an editor based at a distance, their flexibility in terms of genres for expressing the meaning and importance of science, and their portability across space in the form of print- and web-based publications that are valued by multiple communities. Implications for developing youth identities while fostering participation in critical thinking about science are discussed, along with further research needed on understanding the power of personal connections to health, and the role of brokers.


Keywords: science literacy; sociocultural issues; learning communities; boundary objects

Despite historic precedent (e.g., Dewey, 1938) and more recent educational policy trends (e.g., National Research Council, 1996, 2011) calling for student-driven classroom experiences, it is rare for an American high school student to encounter and have the opportunity to research topics of personal interest in a science classroom. However rare, when student interest and study content do intersect, a “third space” that merges “home, community, and peer networks with ... more formalized institutions of work, church and school” can be created that can play a key role in successful learning (Moje et al., 2004, p. 41). Such spaces are in line with calls in the Framework for K-12 Science Education (National Research Council, 2011) for a citizenry educated in the sciences and technology. Or, as Moje et al. put it, such efforts can be “important in supporting youth in learning how to navigate” (p. 41) both high school and the years of life to follow.

The Science Literacy through Science Journalism (SciJourn) project, where this study is situated, attempts to create hybrid, third spaces in which young people can engage with science through journalism. SciJourn began with the recognition that practices of professional science journalists—such as making use of multiple, credible sources—relate to skills that scientifically

Contract grant sponsor: National Science Foundation; Contract grant number: DRL-0822354.
Correspondence to: Joseph L. Polman; E-mail: joseph.polman@colorado.edu
DOI 10.1002/tea.21144
Published online 30 January 2014 in Wiley Online Library (wileyonlinelibrary.com).

© 2014 Wiley Periodicals, Inc.
literate adults could use long after they graduate from high school (Polman et al., 2010; Polman, Newman, Farrar, & Saul, 2012; Saul, Kohnen, Newman, & Pearce, 2012). Distributed across multiple school sites, an informal science institution, and a university, SciJourn encourages reform-based science teaching involving a hybrid journalism model and the production of science news stories for a print regional science newspaper and online publication. In print form, SciJourner appears as a polished newspaper, with the requisite banner heading, headlines, bylines, and student-written articles resulting from a rigorous editorial process demanding high standards of quality journalism. Online, at scijourner.org, readers find an interactive news magazine featuring even more stories relevant to teens and related to science content. The educational initiative does not aim young people toward careers in science journalism, but instead involves participants in practices of science journalism that are intended to have broad applicability across life. For instance, as future adult decision-makers and citizens, youth can benefit from knowing how to search for science information, evaluate the credibility of the information they find, and put that information in its scientific context—for instance, is it nascent science or well established consensus? Youth who understand the relevance of the science to their own and others’ lives, and make sense of the concepts and ideas referenced in the information, are also better prepared for adult life. Professional science journalists have developed norms for these practices, and the SciJourn initiative adapts these practices for general education in the hope of educating a new generation who can critically engage with science information for personal decisions about issues such as health and public policy related to science (e.g., fracking, climate change, smoking).

In this article, we explore how youth selecting and researching science topics of personal interest, and then generating and publishing those ideas as science news stories, has engaged them with science in a different way, in part because of the ways the news story artifacts became “boundary objects,” or “objects which inhabit several intersecting social worlds” (Star and Griesemer, 1989, p. 393). Through case studies, we describe how these boundary objects based on personally meaningful topics open opportunities for developing youth identities while fostering participation in critical thinking about science.

Theoretical Framework

Star (1988; Star & Griesemer, 1989) coined the term “boundary objects” in her studies of scientists in the workplace to describe the role played by things both physical (lab reports) and theoretical (ideas) in navigating complex interactions. In the years since, studies in organization and workplace research have utilized and elaborated upon this concept to include the frames of boundary crossing/crossers to analyze the ways in which experts in multiple fields interact (e.g., Engeström, Engeström, & Karkkainen, 1995). Finding this frame useful in their own work, educators have also applied these terms to complex interactions between groups of teachers (Dillon, 2008; Tsui & Law, 2007), as well as interactions among teachers and students within school systems (Buxton, Carlone, & Carlone, 2005). Buxton et al. adopted the term “boundary spanners” to encompass concrete objects and individuals as well as concepts in their study of an urban math and science high school program.

In their review of literature related to “boundaries,” “boundary objects,” and “boundary crossing/crossers,” Akkerman and Bakker (2011) found 323 articles published in educational/social science journals in the years 2007–2009. Akkerman and Bakker refer to the concepts of boundary crossing and boundary objects as having become “an explicit part” of both cultural historical activity theory on expansive learning (citing Engeström, 1987) and situated learning theory on communities of practice (Wenger, 1998). They succinctly summarize Star’s concept of the boundary object as an illustration of “how artifacts can fulfill a specific function in bridging intersecting practices” (p. 134). Analysis resulted in a presentation of four ways learning happens.
through boundaries: identification (e.g., othering, legitimating coexistence), coordination (communicative connection, efforts of translation, increasing boundary permeability, routinization), reflection (perspective making and taking), and transformation (confrontation, recognizing shared problem space, hybridization, crystallization, continuing joint work at the boundary, maintaining uniqueness of intersecting practices).

The results of Akkerman & Baker’s review encouraged researchers in this growing field of inquiry to embrace Star’s original definition of the term “boundary objects” (which she clarified in 2010) in future work to achieve greater focus in analysis. In our current work, we use this definition: “objects which are both plastic enough to adapt to local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites... The objects may be abstract or concrete” (Star and Griesemer, 1989, p. 393). An example of concrete boundary objects in the context of this study of youth science news production are the texts that get produced in one community such as an ISE program or high school classroom, get read and edited in another community such as a university, and in turn get read in a public venue on the web or a printed newspaper. An example of an abstract boundary object is a set of criteria for judging the adequacy of these science news stories, which grew out of research and reflection within a university context, but which are interpreted and understood within diverse learning environments differently. As Akkerman and Bakker suggest, we perceive “boundaries not only as barriers but also as potential resources for learning” (2011, p. 153).

Wenger (1998) paired the notion of boundary objects with that of “brokers” and “brokering.” Wenger’s use of the term boundary objects is consistent with Star et al.’s, and includes artifacts, documents, terms, and concepts around which communities of practice organize their interactions. Brokers are agents who carry or transform practices across the boundaries of communities of practice, often with the use of boundary objects. An example of a broker in our study context is the former science news editor who brokered certain practices from the professional journalism community for use in the study’s learning environments organized for youth.

In order to understand how the science news stories created by youth in educational environments act as boundary objects, we take a sociocultural perspective (Wertsch, 1998) and use practice theory to interpret human action and identity in communities of practice as individuals and artifacts move through time and space (Lemke, 2000). Practice theory examines how participation in social practices produces and reproduces the social order, through changes in the identities of persons and knowledgeable skills in practice (Lave & Wenger, 2005, p. 143). Our analyses focus on individual participants’ “engagement,” which we examine through their actions, interests, and identifications (Hope, 2012; Polman et al., 2010; Polman & Hope, 2012). Though engagement is often related to cognitive mastery (Polman, 2006), which in this sociocultural view would be evident through changes in the quality of participation in practices, we do not focus in this paper on mastery learning. In the case studies below, we examine these three facets:

A. Actions, or actual involvement with the science news stories. An example of an action is talking with others (non-teachers) about a science topic or current event.

B. Interests, or openness to and stance toward aspects of the action in the moment (situational) and across time and place (persistent). An example of a situational interest is finding a connection between a science concept and life. An example of a persistent interest is someone consistently seeking and considering science information relevant beyond the classroom or learning context.

C. Identifications, or ways that actions connect to people’s identity affiliations, in the past, present, and future. An example of identification is when people consider themselves knowledgeable about a science topic and aligned with others informed about science issues; they may view themselves, and/or are viewed by others as “science” people.
In other words, engagement involves an individual’s situational and persistent interests and participation in, as well as identification with, particular practices as embodied in actions. Each of these facets has been the subject of extensive educational research.

Our sociocultural approach to understanding actions is most heavily influenced by Wertsch (1991, 1998), who stresses that all actions are mediated by cultural tools (or mediational means) that have individual, social, and cultural histories, and by practice theory, which stresses that sets of actions are assembled into regularized practices in communities (e.g., Wenger, 1998). We see interests in actions and practices as triggered in situations (Renninger, 2009) with particular conditions (Azevedo, 2011), such as the opportunity youth in this study had to write science news stories about topics that they found personally relevant. Persistent interests result in sustained engagements in actions and practices over time that present rich opportunities for learning (Azevedo, 2004, 2011; Barron, 2006; Renninger, 2009). The individuals interacting in learning environments belong to multiple communities of affiliation and practice, and their past, present, and expected future identifications with those communities strongly influence their stance toward the actions (Gee, 2000; Nasir & Hand, 2008; Nasir & Saxe, 2003; Polman & Miller, 2010; Wenger, 1998; Wortham, 2006). We follow Dreier (2000) and Wortham (2006) in tracking how particular events relate to longer-term trajectories of identification. One-way changes in trajectories of identification happen is through shifts in how people position themselves with respect to a community, and how they are positioned by others with respect to a community (Davies & Harré, 1990; Polman & Miller, 2010). The physical and psychological context in which actions take place matters, so we consider where learners and others interact and act as contributing to their significance (Wertsch, 1998); we understand particular school or out of school learning environments as existing within larger ecological systems of activity (e.g., Cole, 1996).

When considering trajectories of identification over time and space, researchers have found it useful to apply a metaphor of a social identification “accreting” (Polman, 2006; Polman & Miller, 2010) or “thickening” through repeated “interdiscursive objectification” (Wortham, 2006). Relatedly, Leander (e.g., 2002) has discussed how “laminations” of identification occur across time and space. Boundary objects can become “identity artifacts” (Calabrese Barton et al., 2013; Leander, 2002) and contribute to laminating identifications if they serve to position those who use them as certain kinds of people, in ways that are repeated across time and space.

In the following, we use the above concepts in an attempt to fulfill Akkerman and Bakker’s (2011) recommendations that further research on boundaries take a micro perspective, describing who experiences a particular discontinuity in which interactions or actions. In this way, it becomes possible to study how sociocultural differences play out in and are being shaped by knowledge processes, personal and professional relations, and mediations, but also in feelings of belonging and identities (p. 153).

Research Context and Author Roles

Polman was principal investigator of the SciJourn project from 2008 to 2012, which was supported with funding from the National Science Foundation. Hope was a graduate research assistant on the project from 2009 to 2012. We were part of a large team including co-principal investigators and graduate students at the university as well as numerous teachers who co-designed and co-developed the approach to integrating science news reading and writing that became the context for this particular study (see Notes section). For an overview of the SciJourn approach, see Polman et al. (2012); general information on the project can be found at http://www.scijourn.org. Details on how to implement in K-12 classrooms can be found in Saul et al. (2012); Journal of Research in Science Teaching
the co-design of the approach with teachers is described in Kirshner and Polman (2013). There is a
literature on the relation of science literacy to journalism practices, but it is beyond the scope of
this article (see Polman, Newman, Saul, & Farrar, in press).

From 2008 to 2012, SciJourn included diverse groups of learners facilitated by three program
facilitators at an informal science education (ISE) program and 43 teachers at 25 middle and high
schools and across the St. Louis metropolitan region in the Midwestern United States. The ISE site
is a youth development initiative that runs an intensive summer series and a Saturday academic
year program for students between the summer before 9th grade, and the summer after 12th grade.
The program is administered by a large community-based organization’s community-based
programs initiative, and it provides a work-based environment that focuses on science, technology,
engineering, and mathematics (STEM) in the form of a paid apprenticeship into STEM outreach
work. See Polman and Miller (2010) for further information on this program. At the time of this
study (2009–2011), the program included around 120 youth. It is organized into what they call
“components,” which are groups of six to twenty youth who report to an adult supervisor and work
together on various outreach programs. From 2009 to 2012, SciJourn was a component of the
program, with participation ranging between 6 and 12 teens at any one time across the four
summers and three academic years. Of the total of 23 youth who participated in the SciJourn
component, 91% identified as Black and 9% as White (one of the two Whites was a child of an
immigrant); 52% were female and 48% male. The university partnered with the director of this
program in planning and researching the science journalism activities of the youth and their
supervisors. In Summer of 2009, the group of seven SciJourn participants in the intensive program
served as the first pilot of a hybrid youth journalism approach, which teachers subsequently
adapted for high school classroom implementation.

The SciJourn school sites ranged geographically across urban, suburban and rural locations;
the schools were mostly public but a few were private parochial. The schools served
socioeconomically diverse students as well—they ranged from quite affluent with less than 5% on
free and reduced lunch to over 75% on free and reduced lunch. Ethnically, the students represented
the norm for the St. Louis region, which is primarily White and African-American, with a few
Asian, Latino, and Middle Eastern students. The 43 teachers all participated in a 2-week intensive
summer professional development program (15 in the 2009–2010 pilot group, 15 in a 2010–2011
group we called “Cadre 1”, and 13 in a 2011–2012 group we called “Cadre 2”) in which they
learned how to write science news articles under the guidance of an experienced science news
editor, and worked with our faculty and graduate students to prepare and co-develop instruction
incorporating the reading and writing of science news.

Over several years of implementation from 2008 to 2012, SciJourn grew into a distributed
activity system, and it involves a set of hybrid activities. Some of these activities, such as
conducting “fishbowl” pitch sessions and interviewing stakeholders and experts, were developed
in the informal science environment, and then transported to the schools. Other activities, such as
“Readaloud-Thinkalouds” where teachers reveal their critical reading and metacognition while
examining a contemporary science news article, were developed initially in the schools and
subsequently adapted in the informal science environment. These activities involve learners in
critically reading and authoring science news. Youth participants follow an authoring process,
where they pitch, research, draft, and ideally revise original science news stories. The project runs
a science news publication venue called SciJourner, which is published on the web (http://www.
scijourner.org; see Figure 1) and in a glossy print newspaper format (see Figure 2). The managing
editor of SciJourner is project Co-PI Alan Newman, a PhD chemist who worked for two decades
as a science news editor with the American Chemical Society. Newman maintains rigorous
editorial standards, with two goals for SciJourner: publish high quality science journalism by and

Journal of Research in Science Teaching
for teens, and develop the science literacy of participating reporters. The editorial process involves supervisors in the ISE and teachers in the school submitting any articles they wish (most submit all) to the editor of SciJourn by email attachment; the editor then marks up the draft using Microsoft Word’s “Track Changes” feature, focusing largely on content rather than grammar and style; teachers and sometimes peers assist one another in preparing revisions of the articles; teachers and supervisors do not usually require participating youth to do more than one revision, but most students who are willing to do a second or third revision are able to complete an article published online (see Kohnen, 2012, 2013). Common responses by Newman to student work include questions like, “Says who?” when information is unattributed to a source, and, “How much will this cost?” when an innovation is presented abstractly.

In addition to Newman’s feedback to individual article submissions, SciJourn participants were guided by a set of “SciJourn Article Writing Criteria” associated with science literacy that clarify the ideals for science news stories being sought for publication in SciJourn. The project team developed these criteria over a period of years using an iterative process. The original version, developed by Alan Newman, Laura Pearce, Wendy Saul, Nancy Singer, and Eric Turley, was first offered in 2010. An elaborated description of the criteria can be found in Front-Page Science (Saul et al., 2012) or on the website, Teach4SciJourn.org. An overview of criteria appear in Table 1:

During the second year of the project, the university team and the pilot group of teachers developed a shared notion of focusing on science literacy practices that we collectively hoped would be useful to students 15 years after they graduate from high school, which is in alignment with the goals of the Framework for K-12 Science Education (NRC, 2011). We have specified five
practices which have application to everyday life, which we agree could be useful to students 15 years after graduation, and which correspond to the five criteria for news articles above (see Table 2).

The criteria for articles and the five practices were developed and refined in consultation with participating teachers, and inform how the teachers discuss science news reading and writing in their classrooms. For students, the practices are instantiated in their work developing and authoring science news stories. For instance, the student in Case #4 below saw how building mold could affect him and others who live in his community. He searched for information related to building mold on the Internet, evaluated the credibility of various sources, and utilized several of them to make sense of this environmental hazard. He then explained to potential readers of his article what mold is, how it forms, and the dangers it causes for people, according to contemporary research studies.

Journal of Research in Science Teaching
Thus, science news articles are privileged artifacts, which we view as “tangible displays” of our vision of science literacy. The first drafts and revisions of articles provide evidence of the progress learners are making toward learning the practices we are targeting as learning goals. Teachers attempt to facilitate and scaffold these practices and students inscribe tangible evidence of science literacy practices into their articles. When providing feedback to article authors, teachers and the editor seek to focus on these five aspects of the article, rather than grammar, spelling or other generic aspects of writing, in order for the revision process to result in more expert science literacy practices.

Research Questions and Methods

The research questions for this study emerged from one of three broad research questions from the overall SciJourn grant. This broad research question was “What is the nature of the engagement in science the project’s apprenticeship model to journalism practices adapted for...
educational contexts] invites?” During the pilot year of the project (Summer 2009 through Spring 2010), our university-based project team noticed that some of the engagement we were seeing among students and teachers might be due to the science news stories acting as “boundary objects” being mediated by “brokers” such as the editor, in the sense that Wenger (1998) uses those terms. Two of the events spurring this emergent idea were retrospectively examined, and are described below (see Cases #1 and #3). Accordingly, Polman and Hope formulated the following research questions, which guide this study:

(1) How do student-generated science news articles or conceptual artifacts serve as boundary objects between communities, affecting the engagement of participants with science?
(2) If boundaries are being crossed, what are the boundaries involved, and who serves as brokers to the passage between and beyond those boundaries?

In order to respond to these research questions, we utilize interpretive case studies (Erickson, 1986; Polman, 2000) to understand the participation and development of individual youth working on science news stories within and beyond the SciJourn learning environments. Within the context of the SciJourn project, several case studies were undertaken to explore the concept of student engagement with science and technology among participants. In both the ISE and the formal classroom settings, the data sources for the cases include observational fieldnotes taken by Polman, Hope, and other participating researchers from 2010 to 2012, interviews of learners and teachers/facilitators conducted by Hope (see Hope, 2012), and artifacts created by participants—specifically, draft news articles, editor comments on drafts, revised news articles, and published news articles. We pay particular attention to science news articles as artifacts, because of our desire to understand whether and how they act as boundary objects in the SciJourn activity system. Findings of these case studies have been presented at a variety of research conferences (see Polman, Hope, & McCarty, 2010; Polman, Saul, et al., 2010), a dissertation (Hope, 2012), and other research papers in preparation, and they were utilized in this study as follows.

In the summer of 2009 at the informal science site, seven high school students (two males and five females) were selected as SciJourn participants by program staff based on commitment to the summer program and potential to contribute to the project’s goals. Seven of the students were African-American, and one was a White first-generation immigrant from Eastern Europe. Throughout the 8 weeks of the summer program, daily observations and extensive field notes were taken to document the program’s development as well as individual student engagement. Analysis of these documents along with focus group and individual interviews with four of these participants provided the basis for the development of our action, interest, and identification framework for engagement as well as the Youth Engagement with Science and Technology (YEST) Survey (Polman, Hope, et al., 2010; Hope, 2012). From fall 2009 through summer 2011, observational notes were taken at selected Saturday and summer sessions of the program, and all article drafts and final versions were collected. Interviews were conducted with seven of these participants. Four case studies of engagement were developed based on the initial group’s data, and two from subsequent participants; the latter two are included in our results below—Case #3 (Cassondra—all names are pseudonyms), and Case #4 (Terrence), which began in a school and continued in the informal site.

Case #1 (Nora) and Case #2 (Teresa) below were the impetus for this study, and were identified retrospectively after the 2009–2010 school year was over, so the data for those cases are the draft and final news articles, and interviews with the students’ teachers, whose classrooms were part of teacher case studies; they do not include student interviews (see Hope, 2012;
Kohnen, 2012). Nora (Case #1) was a member of a 9th grade introductory Biology class at a suburban public high school which included a largely White population of students, with 12% African-American and 2% Asian; nearly 20% of students at this school were on free and reduced lunch.

Teresa (Case #2), Terrence (Case #4), and Molly (Case #5) participated in classes at three different high schools taught by teachers who were selected for Hope’s larger engagement study based on initial observations conducted by project team researchers. Factors considered in Hope’s classroom selection included the teacher’s degree of implementation, class type, school demographics, and willingness to participate. Purposeful classroom study selection supported the intention to focus the engagement research on classroom situations most likely to represent “best case” implementation. In the SciJourn classroom, the “best case” scenario was viewed by the project team as one in which the teacher exhibits a high level of engagement. He or she was highly involved, or active, in classroom implementation strategies; exhibited interest in science journalism as a mechanism for improving student science literacy and the project overall as well as its role in his/her own classroom; and identified him/herself as an integral part of the SciJourn team.

Three students were selected for student case studies from each of the three classrooms, based on initial levels of engagement as illustrated by their YEST Survey responses and their observed participation in SciJourn (i.e., Hope purposefully selected students with low and high engagement with science and technology and with SciJourn). All three classrooms were located at schools in the St. Louis Metropolitan Area and taught by veteran teachers, however they varied in size, demographics, and type. The Environmental Science elective class of fifteen students which involved Teresa (Case #2) was situated at a large public suburban high school located on the outer edge of metropolitan sprawl attended by nearly 92% White students from middle to upper class families (6% free and reduced lunch). The advanced Chemistry class that included Terrence (Case #4) was a group of sophomores at a large public high school where the student body is made up of 97% African American students, nearly 70% of whom are eligible to receive free or reduced lunch. Molly (Case #5) was a member of a required Introduction to Chemistry class for 9th graders at an affluent all-girls Catholic school with slightly more diversity among the student body, although still majority white.

In summary, 16 student cases were assembled and analyzed using the engagement framework. This involved content analysis of observation notes, article artifacts, and interviews according to the broad categories of action, interests, and identification. To select the cases reported in this study, ways that objects crossed boundaries of multiple communities were additionally coded, and the actions of “brokers” who mediated boundary crossing. The first four cases described in the Results section were then purposefully selected to show the range of ways that opportunities for boundary crossing were taken up among the 18 cases, and the fifth case was purposefully selected to show some of the ways that opportunities for boundary crossing could be constrained by organizational choices made by teachers. Two of the case studies below are from the 2009–2010 school implementation of SciJourn (Case #1–Nora, and Case #2–Teresa), one is from the 2010–2011 school implementation of SciJourn (Case #5–Molly), one is from the 2010–2011 out of school implementation of SciJourn (Case #3–Cassondra), and one began in a school classroom and ended in the out of school context (Case #4–Terrence).

The methods described above imply important limitations on interpretation of our results: because the out of school context and classroom contexts from which the cases were drawn were limited to “high implementation” contexts, we cannot generalize to the full range of implementation decisions within distributed SciJourn activity system. The findings on how boundary objects operate in these cases should be interpreted as a set of possibilities for how
boundary crossing is associated with important opportunities for shifting the nature of youth engagement with science.

Results

The five descriptive case studies in this section, which are summarized in Table 3, represent our analysis of how science news articles and the conceptual criteria utilized by the editor and other members of the SciJourn community serve as boundary objects around which engagement of participants hinge. Within each case, we examine what boundaries (if any) are crossed, who serves as brokers across boundaries, and what mediational properties of the objects facilitate boundary crossing.

The first case, in which a young woman explores alternative medicine as treatment for headaches, involves boundaries between talking about personal health concerns in school, as well as boundaries between western and eastern medicines. The second case involves an article about rare diseases which became a focal point at a suburban school for the promise of authentic science news writing. The third case shows a teen bringing in graphic design skills and interests to her reporting, and thereby repositioning herself within the learning community while capitalizing on the opportunity for expanding her skills. Fourth, a young man’s desire for self-expression finds an outlet in science news writing that provides him newfound recognition in his school context due to a story about a local problem with building mold, transforming his identifications there, as well as leading to a job opportunity where he crossed into new territory for him. And finally, a fifth case shows how one teacher’s decision to randomly assign article topics and not pursue publications limited her student’s opportunities for engaging with science through boundary crossing.

Case #1: Nora Connects a Family and Cultural Practice to School Science

Nora’s experience demonstrates the development of a science news story as a boundary object crossing the barriers often erected between school and the outside world, as well as between Chinese-American communities practicing alternative medicine and the Western medical community. The editor of SciJourn acted as a broker of practices for thinking about science information, and the criteria he used for thinking about qualities of publishable articles served as a conceptual boundary object.

Nora was a Chinese-American 9th grader in an honors Biology class when she first was involved with SciJourn. In 10th grade, she was enrolled in the first of 3 years of an “Authentic Science Research” class taught by another SciJourn teacher. The class at her school was a 3-year sequence in which students designed and conducted original research with mentoring of university researchers. Thus, she had a persistent interest in school, and academic performance, including in science. Her teacher involved the 10th grade students in their first year in conducting secondary research for science news stories, as a means for them to learn some of the skills they would need for their primary research later. In the spring of 2010, Nora developed a story on alternative medicines that grew out of her own experiences with “cupping” as a treatment for her migraine headaches.

As described by Nora, cupping is a procedure “in which a rounded glass cup is warmed and placed upside down over an area of the body, creating a suction that holds the cup to the skin.” This story was relevant to Nora because it related to a cultural practice advocated by her grandmother, and she had personally found that the alternative medicine treatment reduced the severity of her own chronic headaches. So when offered the opportunity to connect a science or health issue from her life to the assignment in her class, she had a situational interest in exploring cupping and alternative medicines. Nora’s interest was situational in that it simply grew out of her experiencing relief from her headaches, connected with the opportunity in class to explore a health issue; she did
<table>
<thead>
<tr>
<th></th>
<th>Nora</th>
<th>Teresa</th>
<th>Cassandra</th>
<th>Terrence</th>
<th>Molly</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Actions</strong></td>
<td>Drafting, revising, and publishing a science news article on cupping as an alternative medicine.</td>
<td>Drafting, revising, and publishing a science news article on CISP, an orphan disease.</td>
<td>Drafting, revising, and publishing a science news infographic and a video on teen pregnancy.</td>
<td>Drafting, revising, and publishing a science news article on building mold. Movement from back to front of class, and to ISE.</td>
<td>Incomplete (lacked attribution and lede) assigned article on potassium.</td>
</tr>
<tr>
<td><strong>Identifications</strong></td>
<td>Positioned self as good student. Editor positioned her and grandmother’s experiences as valid.</td>
<td>Positioned self as academically sound student. Teacher positioned her as school-engaged, science-fluent, and headed toward college.</td>
<td>Positioned self as good at school and computers, on trajectory toward college. Positioned self in program as antagonist.</td>
<td>Positioned self as writer. Positioning by teacher initially as unsuccessful in chemistry with academic difficulties, then later by teacher and others as having strong academic potential.</td>
<td>Viewed self as creative writer with a future as a novelist. Self- and teacher-positioned as good student academically.</td>
</tr>
</tbody>
</table>

(Continued)
<table>
<thead>
<tr>
<th>Communities</th>
<th>Nora</th>
<th>Teresa</th>
<th>Cassondra</th>
<th>Terrence</th>
<th>Molly</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Western medical research community.</td>
<td>Orphan diseases &amp; CISP communities.</td>
<td>Program group doing science news reporting</td>
<td>School and district.</td>
<td></td>
</tr>
<tr>
<td>Brokers</td>
<td>Editor</td>
<td>Classroom teacher; Editor</td>
<td>ISE graduate student facilitator; Editor</td>
<td>Community program. Editor; Classroom teacher &amp; school admin; Program admin</td>
<td>Classroom teacher</td>
</tr>
<tr>
<td>Boundary Objects</td>
<td>Drafts and edits of article; article published online and in print</td>
<td>Drafts and edits of article; article published online</td>
<td>Drafts of infographic; social media surveys and interviews; published infographic online</td>
<td>Published article online and in print</td>
<td>NA</td>
</tr>
<tr>
<td>Mediational</td>
<td>Electronic drafts exchanged between author and editor, related to quality criteria adapted from professional journalism.</td>
<td>Value placed on publication by school, and by future educators (resume-worthy).</td>
<td>Graphical and audiovisual displays impress diverse audiences, and play to her strength with computers, while minimizing her weakness with textual expression.</td>
<td>Value placed on publication by school and by community organization offering summer job.</td>
<td>NA</td>
</tr>
<tr>
<td>properties</td>
<td>Creates tension and need for negotiation of conflicting communities’ perspectives.</td>
<td>Connecting distributed community (a tiny % of overall population).</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3 (Continued)

Journal of Research in Science Teaching

SCIENCE NEWS STORIES 327
not exhibit any persistent interest in learning about the science of alternative medicines. In the first draft of this story, Nora described only positive claims about the efficacy of this and other alternative medicine practices, and these claims were unattributed to sources. She made statements such as “Scientists are finding,” and “It is believed.” She made unsupported claims, like “aromatherapy, acupuncture, and etc. are known to work, but like everything else in the world, people like it and dislike it.” A story draft created by a student such as Nora and simply submitted to her teacher to receive a grade would not have become a boundary object. But because Nora’s draft story was submitted to the editor of a regional science newsmagazine with genuine journalistic rigor, it became a boundary object.

The SciJourner editor responds to student submissions with extensive commentary and feedback to students, using Microsoft Word’s “Track Changes” feature. In most cases, students have never seen such direct and substantive input to their writing. In his response to Nora, the editor stressed, “You ... need to attribute your information to credible sources. You can’t just make statements,” and sprinkled the article draft with challenges of “According to who?” (three times) and “Says who?” (another three times). In response to her assertion that “It is believed that these medicines are becoming more popular because scientists have finally come to their senses that nature’s remedies are the best,” the editor replied, “Are you just making this up or did you find sources that say that?” He stressed, “I don’t want you to advocate for or against alternative medicines...”

As with most students whose teachers were participating in SciJourn, Nora was not required to work on revisions. Many students elect not to pursue repeated revisions, but she made the choice to respond to Newman’s challenging edits, which represents a level of free-choice engagement with science that is not often the norm in or out of school. Nora took these responses from the editor, and in many ways swung from an overly uncritical stance in the positive direction to an overly negative stance. In her first revision of the article, Nora reorganized and removed some content, and added the perspective of a credentialed scientist on the practice: “Professor Edzard Ernst of the department of complementary medicine at the University of Exeter says that ‘cupping could cause burns’ and ‘there is no evidence for its efficacy.’” She concluded this draft with the statement, “I’d encourage this to anyone seeking natural, alternative treatments, but I’m not guaranteeing that it’ll be the best decision you’ve made for yourself.” Interestingly, the student had neglected some of the science in support of alternative medicines in this revision, so she received some encouragement from the editor and her teacher to seek out credible sources supporting alternative medicine practices. Nora’s third revision included reference to the National Center for Complementary and Alternative Medicine (NCCAM), which is part of the United States National Institutes of Health, and to research cited by that body on cupping’s positive efficacy. This revision also referred to findings of an allergist from the American College of Allergy, Asthma and Immunology (ACAAI) in Phoenix.

In response to the third revision, the editor stated, “WOW! I’m blown away. This is remarkably well written and smart. Outstanding job. I am accepting this for publication.”

Through her interactions with the editor and her science teacher, and the acts of researching, writing, and revising this article, barriers that often separate portions of students’ lives were broken down for Nora. The editor’s comments on the quality of Nora’s article were based on her incorporation of two key SciJourn writing criteria (see Table 1): the ideal of scientific contextualization, which prioritizes distinguishing between established and tentative science, and the norms for attributing the basis of expertise of multiple, credible sources. When applied to topics of deep personal relevance to students, the criteria serve to turn news articles into boundary objects connecting students’ lives to science content in ways uncommon in the traditional science classroom. In the case of alternative medicines advocated by and practiced by Nora’s family, and
also folk remedies practiced in other communities, the possibility of insensitive dismissal of cultural practices by dominant Western medicine is quite real. In many contexts of formal science education, alternative medicines and other non-mainstream Western ideas would simply be left out of the curriculum. Once they are brought in to a hybrid space incorporating informal and formal learning environment practices as well as adapting professional practices, such ideas may provide the basis for cultures coming into dialogue with one another, as the editor tried to encourage in this case. Our hope is that, 15 years down the road, the seeds of such experiences may encourage Nora to broker practices like these ways of using science information to her home and personal life, as well as any appropriate civic discussions.

In this case, we see that electronic drafts became material boundary objects, and the criteria for judging articles in SciJourner (see Table 1) became conceptual boundary objects. The material texts were passed back and forth between a student at a school and a university-based science editor who brokered adapted practices from the professional journalism community. The criteria he used became a conceptual boundary object which re-mediated Nora’s experience with science, such that it was connected in a new way to her personal and cultural life.

**Case #2: Teresa’s Article Becomes an Internet Sensation**

Teresa’s experience shows how an article published on the Internet in a juried venue can attract the attention and praise of not only her teacher, but also her wider school community and the worldwide community of people who are concerned about a rare disease, thus giving a school assignment lasting significance in her life and potentially the lives of others affected.

“Teresa,” a young White woman at an affluent suburban school, took a Biology class in the 2010–2011 school year, her teacher’s first year with SciJourn. Because of time concerns, her teacher did not involve his students in writing science news stories until the end of the school year, after state content exams had been completed. With several weeks left in the school year following the high stakes test, the teacher implemented what he called a “mini-course,” very similar to his experience in the teacher professional development the summer before, in which students were encouraged to select topics of interest and personal relevance to themselves for further research. Teresa was a good student with a persistent interest in school but no particular affinity for science. Like many of her peers, she intended to go to college. Largely because her aunt had recently been diagnosed with the rare disease Chronic Inflammatory Immune Demyelinating Sensory Polyradiculoneuropathy (CISP), Teresa chose that as her topic. The teacher and editor encouraged Teresa to use her aunt’s experience to introduce the seriousness and extent of “orphan diseases”, those so rare that the U.S. government does not deem it cost-effective to fund treatments.

Her article development with feedback from the editor was similar to that of Nora, so for the purposes of this paper, we will focus on what happened after Teresa’s article was published in SciJourner online. Teresa’s teacher Luke was first of all excited that his implementation strategy “worked”: three of his students researched, wrote, and revised articles to the editor’s satisfaction and were published online. In addition to posting printouts of the articles in his classroom, the teacher distributed the news of his students’ accomplishments, including links to the students’ work on Scijourner.org, to his peers in the science department and to school administrators. Administrator copies were subsequently posted in a display case inside the front door of the high school for teachers, students, and guests to see daily. He did this because he perceived the accomplishment of publishing a news article in a regional science newspaper with an editorial process as something that was worth sharing outside the class. Thus, Luke acted as a broker for other readers in his administration to make use of the articles as demonstrations of how students in the school community were engaged with science, in a way that is more common for activities such as science fairs. The school district communications office wrote a story about the three
articles published in SciJourner, and published the story on their own district website, with links to the articles and quotes from the teacher.

A national organization involved with orphan diseases found the story on Scijourner.org through web searches, and interviewed the student about the subject. Teresa’s article receives thousands of “hits” (as of Dec 2013, the total is over 7,000) as a result of it being linked to and the topic being searched for on Internet search engines. Teresa’s teacher was thrilled at the attention this story brought to his students, and the opportunity for them to engage in science writing that could help them simultaneously gain skills, find science relevant to their lives by exploring topics of their choice, and at least in some cases gain valuable “resumé-building” experiences. This happened largely because her school community highly valued competitive publication in a rigorous outlet that was regional and based at a local university, and because such publications were commonly used as a cultural tool in her affluent community as items representing accomplishment on resumes and college applications in a way that “normal school assignments” were not. All this happened before Teresa’s story was published in print in July 2010 (see Figure 2). But it resulted in Teresa’s teacher planning the subsequent school year (2011–2012) around quarterly rounds of SciJourn news article “blitz” writing units, and the school developing a culture of valuing student science news beyond the classroom.

In this brief case, we see that students publishing online in an authentic, valued venue, allows the online publication to become a boundary object garnering interest from the wider school community and special interest communities on the web. This is in part due to “network effects” made possible by the number of people connected to the Internet: although Teresa’s subject was a rare disease, the web offers access to “niche” communities which although representing a very small percentage of the population represent large numbers of people across the planet.

Case #3: Cassondra Takes Advantage of Graphical Expression

Cassondra’s experience in the ISE program shows how a flexible form of a science news story—that of a science news infographic—became a boundary object allowing her to introduce graphic design skills from another context into an activity involving consideration of numerical aspects of a phenomenon as well as how to make use of various sources of information. An adult with graphic design experience brokered the combination of Cassondra’s skills with the science news genre. Interviewing and surveying teen mothers, in her role as a “reporter for a science newsmagazine,” enabled Cassondra to cultivate higher status identifications within her network of peers.

Cassondra was an African-American young woman in the ISE’s youth program. Like other teens in the program, Cassondra was admitted in part based on a reference from a collaborating community-based organization. She had been in the foster care system, due to her mother’s drug problem, and she attended a struggling urban high school. After a rough beginning to middle school when she reported she had spent much of the year out of class because of fighting, she committed to applying herself in school. She positioned herself as a good student, saying she had been on the honor roll since. At home and at her school, she had a persistent interest in computers and graphic design, which she said she intended to pursue in college.

But Cassondra’s positioning within the program at the ISE was initially not as positive as the academically-focused life she described outside. She was, according to her own description, a “crabby” and sometimes blunt person, which made her difficult to work with in a group setting, despite seeing herself as having a strong work ethic. Her supervisor and our own observations indicated she spent a considerable amount of time off task (with her head down or using online social networking), disengaged from program activities and peer interactions, and her peers and adults often interpreted her mumbled “crabby” comments as antagonistic. She joined the SciJourn
group in fall 2009, but struggled with attendance and integration into the already-established group. In addition, there were numerous disfluencies apparent in her early efforts at writing in the program. It took Cassondra most of the following summer 2010 program, when she completed her first news story, to find her place in the program, both socially and in terms of project goals. Once over that hurdle, and with the guidance of a graduate student facilitator involved in the project, she began to incorporate graphic design tools for her next two projects that proved pivotal to her engagement and her positioning of herself and by others.

In her first 9 months in SciJourn, Cassondra’s struggles with written text as a medium for expression tended to dominate the way that she was positioned by facilitators. She was not recognized as a strong contributor, and it was certainly not salient to those facilitators that outside of that work environment, she was recognized at school as a good student, and at home as someone who could be counted on to help others with computers. In school, she had enrolled in computer graphic design and multimedia classes, and she began to incorporate those tools in SciJourn for a story on teen mothers and their experiences with sexual education. Cassondra conducted the research for the story through phone, text, and social media interviews of personal acquaintances, meticulously recorded data, and then worked through numerous revisions of an infographic representing those data with the assistance of the graduate student facilitator, who herself had a strong background in graphic design. Eventually, Cassondra published the infographic shown in Figure 3, which represented a significant amount of thought on her part. In order to accomplish this, she built on practices from her computer graphics courses (e.g., drawing with Illustrator, copying and modifying images), but expanded them with consideration of numeric trends that put the phenomenon in context (i.e., the representations of different variables), as well as use and attribution of her sources (at the bottom of Figure 3). Thus, Cassondra’s draft graphical representations of teen pregnancy and sexual education experiences served as a boundary object to a new way for her to process and communicate social scientific topics in a largely graphical medium.

![Teen pregnancy infographic](image-url)

**Figure 3.** Teen pregnancy infographic.

*Journal of Research in Science Teaching*
In this process, Cassondra found an outlet for her persistent interest in graphic design, which the facilitator helped broker as important and useful to the construction of her infographic. Her supervisor complimented her graphical products in a way that she had not experienced when struggling with written text, and her peers expressed interest in the work she was doing, wanting to know how to create similar designs. Thus, she was positioned among her peers and project leaders as more competent, and her identification as an intended graphic design professional became more salient and consistent with how others positioned her. After the static infographic, Cassondra went on to produce a video story incorporating the infographic, as well as interviews she conducted of teen mothers.

Both the process of collecting the survey data for the first infographic and conducting the interviews for the video crossed boundaries between portions of Cassondra’s life. With the teen mothers she contacted, who were her social peers, Cassondra identified herself as a reporter for a science news magazine, which was a role she was proud to hold. The facilitators and administrators at the informal science institution saw beyond her difficulties with writing, and even began to consider greater potential for non-writing news production among others who may share her struggles. Others began to see her as she saw herself: as someone with resources and assets, on a positive trajectory toward college study. As she said:

[I am] proud of that, the video, everything I did inside there, but that’s the most one that I am really proud of . . . I can show it off to people . . . People be thinking just from where you came from, “Aw, you don’t got nothing,” and then they see your work, they’re like, “Dang, you did this?” People don’t believe it, like the video. Today when a lot of teens came in, they’re like, “You did it? The whole video, everything?” [And I said] Yes. It was like, “No.” Yes, I did everything. “The infographic?” Yes. “All of the talking?” Yes. I did everything in the video, all of the footage and everything. So, they were like, “Yeah that’s nice, you did all of that?”

Cassondra’s experience in the informal science program took advantage of a unique resource that some programs have over high school: a long time span of one and half years with opportunity for her to both struggle and eventually develop new ways of expressing herself and interacting with both science information and with others. Her draft and published infographics were boundary objects allowing her to utilize within the out-of-school program graphic design skills she had previously learned in school and honed at home. Using graphics for examining and representing a social science phenomenon numerically acted as a boundary object for new ways of using her graphic design skills. And conducting research through interviews and surveys, in the role of a reporter for a newsmagazine, allowed her to position herself with her age peers in a professional capacity.

Case #4: Terrence Moves to the Front of the Room, Then a Paid Position

Our fourth case illustrates the role of a supportive classroom teacher on a mission to promote her students’ learning among her peers and school administrators. As a vocal advocate, the teacher provided a kick-start to the case study student’s desire for the limelight. This relationship resulted in a surprising success for an otherwise unmotivated student of science, and the resulting news story became the object by which multiple boundaries were spanned. From the back of the class to the front row, from the mandatory Chemistry class to choice employment at the ISE, and from struggling school to district highlight, Terrence’s work bridged multiple gaps.

Terrence was a charming and outgoing African American sophomore male chemistry student at an urban school in the late Fall of 2010 when he began working on a science news article. His present school was his fifth school, due to frequent family relocations. He positioned himself as a
writer, and reported strong grades in English class, but his writing and other aspects of his performance in Chemistry class were not perceived as strong by his teacher or peers. Terrence’s experience as a journalist began with a few words scrawled on a piece of notebook paper, simply about mold, a topic which he said “came to me.” However, when his teacher Cynthia mentioned a current news story on the health risks of residential mold in a nearby apartment complex, Terrence’s interest piqued and was combined with potential for a strong story, despite ongoing writing fluency problems. Terrence’s teacher identified strongly as a helping professional, and provided extensive motivational reinforcement to his persistence across eight drafts, as well as out-of-class assistance. Cynthia assisted Terrence by providing quick feedback on substance that aided him in negotiating norms for science news—contextualization in a local place and event led to a focus specifically on building mold, and inclusion of a local angle about an apartment building closing due to mold.

Terrence’s eighth revision was published in the online SciJourner in March of 2011, leading to a transformation of positioning of Terrence by that teacher and others. He was subsequently positioned as having strong academic potential, through reference to his news story artifact; a printed version of the article, “Watch out for mold” was immediately posted on the classroom wall, and distributed by the teacher through email to school and district faculty and staff, somewhat similarly to Teresa’s teacher. His teacher’s enthusiasm for Terrence’s work led in part to inspiring other students (some with otherwise stronger academic performance) in his and a neighboring class to seek to publish articles, even as the end of the school year loomed. His own increased engagement was shown by his choice to move from sitting in the back of the room, to the front of the room.

Beyond the classroom, Terrence received acclaim for his accomplishment in a story about Terrence’s article on the school website, and then the local community newspaper published a story as well. Both articles included Terrence’s photo and quotes from him and his teacher, further feeding this attention-seeking student’s confidence. That same month, inspired by his success, Terrence applied for and was accepted into the SciJourn team at the informal science institution. In the summer of 2011, he took the lead on an investigative reporting venture regarding urban environmental contamination at a closed manufacturing plant. Thus, the boundary object of Terrence’s initial article enabled him to move physically across space into a paid position that allowed him to continue to develop his capabilities at expression while learning to think critically about the scientific elements of environmental issues.

Although some of the same broad strokes occurred in Terrence’s case as in Teresa’s, there were important differences. Teresa was a recognized good student in a high status district with many students preparing their resumes for college; Terrence was a struggling student in a struggling school with few children aiming for college and STEM careers, whose self-ascribed talents as a writer were not generally recognized. The boundary object of his news story, when combined with his own willingness to persist through multiple drafts in order to get published, helped him transform his identifications and engage with science in a new way, and also move into an out-of-school space where he had the opportunity to refine his skills by conducting investigative environmental reporting.

Case #5: Molly’s Constrained Choices Limit Her Engagement

Prior cases have shown the potential for student work in the SciJourn setting to cross physical and intellectual boundaries, particularly when teachers and/or project staff served as brokers for such crossings between disparate communities. Perhaps the power of the broker is best illustrated, however, in the counter-example provided by Molly, a student in the Introduction to Chemistry class at a private parochial all-girls school, taught by Mary in spring 2011.
Chemistry teacher Mary stands out from the crowd of SciJorn teachers in her motivation and enthusiasm for the SciJourn project, especially given her veteran status; Mary had been teaching at the same school for over 20 years at the time of our study. After modifying an honors course in the fall semester to incorporate science news writing, Mary decided mid-year to also add this writing component to the semester-long Intro to Chemistry course for freshmen as a modification to an existing “get to know an element” group project. Writing science news fit nicely within the school’s writing-across-the-curriculum initiative, and Mary felt confident, after seeing one of her own students through to SciJourner publication in the first semester, that she could support these younger girls in the process as well.

Mary’s approach to SciJourn, in which she fitted the writing of science news articles into existing coursework—for the honor’s course, a science fair type experiment—was viewed skeptically by the university-based SciJourn team, since what the students were working on in the traditional Chemistry classroom did not readily lend itself to newsworthiness, or for that matter, relevance to teen audiences. In fact, the article published by the student during the previous semester was an additional piece, not the original assignment given to the class; the student had pursued it on her own, and Mary forwarded it to Dr. Newman for editing. It is important to note that the student’s own motivation, assisted by Mary’s connection with the SciJourn project, but not truly brokered by her in the sense we’ve discussed so far, resulted in the publication. Nonetheless, the student’s work was lauded in Mary’s class and throughout the school, and the teacher’s excitement led her to increase student involvement in other courses during the second semester.

Given Mary’s unique approach, the SciJourn team was curious and thus a researcher was present in Mary’s freshman chemistry class each time she planned a lesson around science writing. Her goal for this group, however, was not actually publication, but rather a new way of writing about an element of the periodic table that would connect the chemistry in class with the world around them. This potential for connecting chemistry content with teens’ lives (renewed through SciJourn) was reminiscent of Mary’s enjoyable experience teaching a course entitled “Chemistry in the Community” in years prior. Mary started the semester by introducing journalistic writing elements (the inverted triangle, writing a catchy lede, etc) to the students through PowerPoint presentations and sharing print copies of SciJourner for independent reading during class. Otherwise, the class curriculum was the same as always, and for the element project, groups of three students were assigned to one of the elements at random, through the drawing of element names out of a hat. New this semester, each student would write a news article on the relevance of the selected element to a teen audience before collaborating with others in the element group to create an informative video for the class. From the outset, however, students were informed that they would not be required to pursue publication for their articles, but that this experience would be good practice for them to do so in a subsequent, higher level Chemistry course.

The experience of three students in this class was followed closely. One student, Molly, provides insight into the lack of successful brokering by Mary experienced by the class on the whole. Like most of her peers in the school, Molly was a high-achieving second-semester freshman focused on good grades. She had no interest in science, but did like to write. In an interview, she expressed that she spent free time writing novels. For the SciJourn project, Molly drew the element potassium, and she went about writing her article based on the human body’s need for it. Even though she considered herself a creative writer, and grasped immediately the journalistic structure of the element assignment, Molly did not see the purpose of writing in science class. She wished aloud that if they did have to write that the students could have at least had a say in their topic selection. Molly expressed repeatedly how she resented being assigned a
topic for her paper, and cited the articles on the topics of rubidium (the purple color in fireworks) and fluoride (as an additive to drinking water) she read for peer review as far more interesting topics.

Molly also expressed interest in an article she read in the print edition of SciJourner in class, entitled “The Kissing Disease.” In addition to a large above-the-fold color photo, what drew Molly to this article on mononucleosis was the “relatable” topic, since she shared drinks with her friends “all of the time.” Despite recognizing in other teen writing what makes a topic appealing, Molly was never satisfied with her own, nor did she respond to peer editor suggestions that she try a catchier beginning to her story. In her final draft, Molly made only the grammatical and phrasing changes suggested by her peer editor, and did nothing to add to the initial appeal of the article overall.

Thus, despite her interest in writing and identification as a creative writer, Molly languished in a writing assignment meant to increase her engagement with science and technology, even when presented with what she considered as strong examples written by other teens. Through this example, we see the missed opportunity for Molly’s article to serve as a boundary object through Mary (the potential broker) limiting the aspects of the science news process, and specifically because Molly felt her creativity stifled by the school-like nature of the assignment that had the potential to become something far more authentic. Choice of topic and interaction with the editorial process beyond the classroom—the SciJourn model’s key means of disrupting the familiar school norms for content and writing that served powerful purposes for our prior cases—were here stifled. Mary’s motivation—to encourage writing and to deepen the connection of her students to the science content—was strong and sincere, but as the SciJourn team feared, the process of fitting a learning experience focused on authenticity into the constraints of this more traditional classroom project did more to disengage at least one student from science writing altogether. Although from the teacher’s perspective her students should have been able to connect the chemistry to real life, as a student Molly did not perceive the opportunity that way, in part because she began the project with resentment against the topic she’d been randomly assigned. It should be noted, however, that since Mary never set out to publish the articles written in this particular class work, and the students wrote, peer edited, and revised, the teacher herself saw the outcome as positive relative to her previous implementations of the same assignment. It should also be noted that Mary continued to revise her approach toward more authentic opportunities for publication in subsequent years, in part based on these results.

Thus, despite her interest in writing and identification as a creative writer, Molly languished in a writing assignment meant to increase her engagement with science and technology, even when presented with what she considered as strong examples written by other teens. Through this example, we see the missed opportunity for Molly’s article to serve as a boundary object through Mary (the potential broker) limiting the aspects of the science news process, and specifically because Molly felt her creativity stifled by the school-like nature of the assignment that had the potential to become something far more authentic. Choice of topic and interaction with the editorial process beyond the classroom—the SciJourn model’s key means of disrupting the familiar school norms for content and writing that served powerful purposes for our prior cases—were here stifled. Mary’s motivation—to encourage writing and to deepen the connection of her students to the science content—was strong and sincere, but as the SciJourn team feared, the process of fitting a learning experience focused on authenticity into the constraints of this more traditional classroom project did more to disengage at least one student from science writing altogether. Although from the teacher’s perspective her students should have been able to connect the chemistry to real life, as a student Molly did not perceive the opportunity that way, in part because she began the project with resentment against the topic she’d been randomly assigned. It should be noted, however, that since Mary never set out to publish the articles written in this particular class work, and the students wrote, peer edited, and revised, the teacher herself saw the outcome as positive relative to her previous implementations of the same assignment. It should also be noted that Mary continued to revise her approach toward more authentic opportunities for publication in subsequent years, in part based on these results.

Thus, despite her interest in writing and identification as a creative writer, Molly languished in a writing assignment meant to increase her engagement with science and technology, even when presented with what she considered as strong examples written by other teens. Through this example, we see the missed opportunity for Molly’s article to serve as a boundary object through Mary (the potential broker) limiting the aspects of the science news process, and specifically because Molly felt her creativity stifled by the school-like nature of the assignment that had the potential to become something far more authentic. Choice of topic and interaction with the editorial process beyond the classroom—the SciJourn model’s key means of disrupting the familiar school norms for content and writing that served powerful purposes for our prior cases—were here stifled. Mary’s motivation—to encourage writing and to deepen the connection of her students to the science content—was strong and sincere, but as the SciJourn team feared, the process of fitting a learning experience focused on authenticity into the constraints of this more traditional classroom project did more to disengage at least one student from science writing altogether. Although from the teacher’s perspective her students should have been able to connect the chemistry to real life, as a student Molly did not perceive the opportunity that way, in part because she began the project with resentment against the topic she’d been randomly assigned. It should be noted, however, that since Mary never set out to publish the articles written in this particular class work, and the students wrote, peer edited, and revised, the teacher herself saw the outcome as positive relative to her previous implementations of the same assignment. It should also be noted that Mary continued to revise her approach toward more authentic opportunities for publication in subsequent years, in part based on these results.

Throughout the cases shared here and those analyzed and presented elsewhere, freedom of choice—of implementation strategy by teachers and of topic as well as form (news article or infographic, for example)—became themes among classes and individual projects deemed noteworthy for their success in fostering student engagement. Even when students first struggled to see the connection between a topic of interest and science, as in Nora’s case, the broker(s) involved were able to aid students in bridging the gap. By choosing not to target publication, and foregoing student choice of topic, student context and curiosity—key aspects of free-choice learning associated with out-of-school science education (Falk, 2001; Falk, Storksdieck, & Dierking, 2007)—went lacking. Inauthenticity and the absence of an external entity in the form of an editor served to demotivate at least one student who would have been predicted to thrive given her proclivity for writing.

Summary of Cases

Table 3 summarizes how the cases relate to aspects of engagement (actions, interests, and identifications), cross boundaries of different communities, involve brokers, and the properties of the science news story drafts and publications that contribute to crossing boundaries.

Journal of Research in Science Teaching
All the youth were engaged in the actions of researching, drafting, and revising science news stories. The opportunity to work on science news stories based on personal relevance and for potential publication allowed these youth to connect situational and persistent interests in the project. Some of the situational interests have to do with life events (an aunt diagnosed with a rare disease, a student’s experience with cupping), some with happenstance (a momentary spark of interest in mold), and some with their peer community (where teen pregnancy was prevalent) or cultural community (where cupping was an accepted alternative medicine practice). Persistent interests in school and academic performance helped drive some (Teresa and Nora), whereas others found an outlet for their persistent interests in a science context that they had not previously been able to apply (Cassondra with computers and graphic design, Terrence with writing). Teresa did not experience any profound changes in identifications, since her self- and other-positioning appears to have already been in alignment, but because of the reach of Internet publication, she forged a connection to the small percentage of population experiencing orphan diseases. Molly also did not experience changes in identification, though it appeared her identification as a writer could have been an asset in a less constrained implementation of the science journalism project. The other three youth described here experienced important shifts in positioning. In the cases of Cassondra and Terrence, adults in their communities recognized capabilities in them that they had previously identified themselves with. In Nora’s case, her cultural practices were put into dialogue with Western medicine, and she was positioned as mediating between perspectives.

Discussion

Akkerman & Bakker (2011) described four ways learning happens through boundaries, which all played a role in our case studies: identification of youth that legitimized their own desired positioning (e.g., Cassondra as a graphic designer, Terrence as a writer), coordination (communicative connections between authors and editor, as well as between a young woman and the distributed community concerned with rare “orphan diseases”), reflection (perspective making and taking about alternative medicine from a Western medicine as well as a personal standpoint), and transformation (hybridizing from text science news stories to science news infographics and science news videos). The sorts of identification, coordination, reflection, and transformation available to the participants in this study were made possible by the organization and structure of SciJourn as a distributed activity system spanning boundaries across multiple informal and formal learning environments, and facilitated by the work of brokers. Local nodes of activity—informal science institution program or school classroom—presented opportunities for youth to engage with science in a way that connected to other nodes of the SciJourn network, as well as to other communities.

Thinking about SciJourn from a boundary objects perspective helps us see the tensions and negotiations that arise in the project’s different contexts and implementations, in order to better understand the values and norms we want to encourage in the learning spaces we are trying to create. The science news story artifacts in both draft and published form crossed the boundaries of multiple communities. All of the artifacts originated in an organized learning environment (either a school class or out-of-school program), but were recognized by and responded to other communities. As seen in Nora’s case, properties of the draft news stories that enabled them to act as boundary objects include their mutability and shareability as electronic draft documents created in distributed learning environments which could be responded to by an editor based at a distance, and shared back and forth as revisions were made. Cassondra’s experience with science news infographics and video stories demonstrates that their flexibility in terms of genres for expressing the meaning and importance of science is a property that enables them to serve boundary crossing. Finally, they worked as boundary objects in part due to their portability across space in the form of...
print- and web-based publications that were valued by multiple communities. Both Nora’s privileged school community and Terrence’s more troubled school community valued the accomplishment represented by the publication in a tightly edited, well-produced and competitive venue based outside their schools. Teresa, Cassondra, and Terrence’s published articles connecting them to their wider communities led to cascading events and new participant trajectories. Thus, our analysis shows the article boundary objects recontextualizing personally relevant topics for youth, and mediating participants’ positioning as “competent outsiders” to science (Feinstein, 2011).

Put differently, our cases show how the concrete boundary objects of published science news stories served as identity artifacts (Calabrese Barton et al., 2013; Leander, 2002), conferring status as a different kind of person to those who had authored them. When successful, as in Cases #1–4, the youth saw themselves, and were seen by others, as individuals with a critical understanding of some science, who something to contribute to discussions of science in life. Further, it is worth noting that both the boundary objects and the identifications of individuals such as Cassondra and Terrence developed and changed over time. Cassondra’s and Terrence’s drafts shifted over the course of revisions to take on new qualities, in a dialectic exchange with the conceptual boundary object of the article writing criteria, mediated by brokers. As the qualities of their concrete article drafts shifted, learners’ perceptions of themselves and of science shifted, and their associated positioning by others shifted. The distributed network of SciJourn participants facilitated the transformation of the individuals’ objects and their identifications. The mutual development of objects and identifications is a powerful opportunity made possible by involving youth in the construction of artifacts valued beyond the classroom or site where they were created.

In 2011, the National Resource Council (NRC) called in their Framework for K-12 Science Education for high school graduates equipped to “engage in public discussions on science-related issues, to be critical consumers of scientific information related to their everyday lives, and continue to learn about science throughout their lives” (p. 24). SciJourn set out with the goal to improve student science literacy through the consumption and production of science news by emphasizing the value of the five science literacy practices outlined in Table 3. These practices are aligned strongly with several of the Science and Engineering Practices set forth by the NRC (e.g., asking questions, analyzing data, mathematical computation, and obtaining, evaluating, and communicating science information). While the influence of these practices on student science literacy through SciJourn has been reported elsewhere (Farrar, 2012; Polman, Newman, Farrar, & Saul, 2012), it is important to consider means through which unique strategies employed in informal education can be utilized to bridge the existing gap in student science learning created by the current “mile wide, inch deep” approach often taken to teaching science in schools.

Conclusion

The organization of SciJourn as a distributed learning community involving multiple entities—including an informal science institution, multiple schools and districts, and a university—afforded opportunities for transformation toward both greater agency for youth, and stronger connections with the world beyond the walls of any one school or building housing a community organization. Professional practices adapted from science journalism and associated criteria for evaluating youth news stories became tools which enabled facilitators (both in the classrooms and programs and at a distance serving the editor role) to assist youth in creating objects valued in their local community. Far too often, schools and informal science institutions are positioned as polar opposites, each with little to learn from the other, and no reason to collaborate. We encourage our fellow educators concerned with engaging youth with science to further explore not just what can
be developed in one environment and adapted in another, but how distributed systems involving ongoing nodes of activity can enable new forms of organizing learning.

We have many questions to further pursue within this line of inquiry. Within the SciJourn project, student topic choice yields more health-related stories than any other broad topic, and many relate to conditions students have either encountered themselves or witnessed in the lives of family members or neighbors. Across the SciJourn community, participating teachers and our team have been surprised at the number of teenage students who are interested in addressing personal health and wellness issues such as Teresa did in researching her aunt’s rare illness and Nora did with treatment for her own headaches. We have also been surprised to find many students who say their reporting on these issues led to conversations about health issues unlike any they’d previously had in their families, even when family members had been dealing with health conditions for extended periods of time. We would like to better understand how such interactions re-mediate relationships as well as understandings.

In addition to the role of news articles as boundary objects and the role of brokers examined here, we are very interested in further examination of the role that brokers such as the editor play in introducing practices from one community into another (see Kohnen, 2013, for an example). In addition, we have long-term questions about how to cultivate young people who participate in an initiative such as SciJourn for a constrained period of time becoming brokers of these science literacy practices to other groups. For instance, we hope that when a personal decision or political discussion comes up at home, they might draw upon this repertoire of practices. But we do not know how prevalent such changes could be, nor the range of consequences such brokering moves would have for those individuals interacting with various groups or communities.

We believe this line of inquiry is potentially important because the dominant science education practices of involving learners in direct science inquiry only get us so far. As Moje et al. (2004) pointed out, there are few studies of the integration of students’ out of school experiences and interests with school-based science literacy. Educators have long sought to reframe science literacy as preparing citizens to participate in democratic debates and policymaking related to science and technology, and to make personal decisions informed by current science (e.g., Aikenhead, 2006; Feinstein, 2011; Roberts, 2007). Our examination of science news artifact creation and use in a hybrid, distributed learning environment may enable us to better reach this goal.

All statements are the responsibility of the authors. We wish to thank the SciJourn community, including the teachers and students as well as research and development staff and advisors, for all their contributions to our lives and this work. We especially wish to thank Wendy Saul, Alan Newman, Cathy Farrar, Angela Kohnen, Laura Pearce, Cynthia Graville Smith, and Shannon Briner for contributing to and pushing our thinking.

References


Journal of Research in Science Teaching


Polman, J. L., & Hope, J. M. (2012) Personally relevant science news stories as boundary objects within and beyond a hybrid, distributed activity system. Paper presented as part of the symposium: Student created science artifacts as boundary objects that cross social settings at American Educational Research Association 2012, Vancouver, B.C.


