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Constructing "Authentic" Science: Results from a University/High School Collaboration Integrating Digital Storytelling and Social Networking

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Abstract This study explores the implications of a redesign of a college course that entailed a new partnership between a college neuroscience classroom and a high school. In this course, the college students engaged in original research projects which included conducting brain surgery and behavioural tests on rats. They used digital storytelling and social networking to communicate with high school students and were visited by the students during the semester. The aims of the redesign were to align the course with science conducted in the field and to provide opportunities to disseminate scientific knowledge through emerging technologies.

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This study investigates the impact of these innovations on the college and high school students' perceptions of *authentic science*, including their relationship with science-centred communities. We found that these collaborative tools increased college students' perceptions that authentic science entailed communication with the general public, in addition to supporting prior perceptions of the importance of conducting experiments and presenting results to experts. In addition, the view of science as high-status knowledge was attenuated as students integrated non-formal communication practices into presentations, showing the *backstage* process of learning, incorporating music and youth discourse styles, and displaying emotional engagement. An impact of these hybrid presentation approaches was an increase in the high school students' perceptions of the accessibility of laboratory science. We discuss how the use of technologies that are familiar to youth, such as iPads, social networking sites, and multimedia presentations, has the potential to prioritize students' voices and promote a more inclusive view of science.

Keywords Science education · K-20 partnerships · Authenticity · Education reform · Professional community · Digital storytelling · Learning technologies · Science communication

Introduction

In recent years, some science educators and researchers have been investigating possibilities for increasing the use of student-centred practices at the college level in order for students to experience science as the discovery of knowledge (National Research Council 2003). In many classrooms, college science teaching relies on lecture rather than student-centred approaches (Walczyk and Ramsey 2003). Kindfield and Singer-Gabella (2010) write, "undergraduate science courses typically immerse students in a flood of detail, offering little sense of the conceptual connections or lines of inquiry – much less the norms of practice – in which such details gain significance" (p. 59). Some calls for reforming college science education aim for immersing students in a more authentic experience in which they participate in research and develop the cultural tools and conventions of the science community (cf. Brewer and Smith 2011; Driver et al. 1994). An assumption behind this focus on *authenticity* is that increasing the level of scientific inquiry and research in college classrooms can help bring students closer to the actual practices of professional scientists.

There are issues to consider when striving for authentic science as practiced by scientists, as classrooms have different sets of norms from the science practiced by scientists in labs. Brickhouse et al. (2000) describe how at the grade school level, the norms of schools and classrooms result in a *school science* that differs substantially from the work of professionals. Even at the college level, there are still important gaps between college classrooms and the practices of scientists. For example, college students create products for grades, which leads to a completely different set of norms and practices from those of scientists who may be engaged in activities such as writing up their research for conferences and journals, or working on the development of a new medicine or other types of product.

Another issue is that striving for *authenticity* presumes an agreed upon notion as to what is authentic, yet this notion may differ between individuals and is not predetermined by a rigid set of criteria. While the term *authentic* is often used to refer to a science that is closer to what is practiced by scientists (National Research Council 2003), students' voices can push boundaries and have a role in determining what counts as science (Barton and Tan 2009). In general, calls to enculturate students into a community of scientists need to take into account that communities are not static and that authenticity within any domain is not even clearly defined. Rahm et al. (2003) write that striving for authenticity by focusing on professional settings "embodies a passive view of the learner and the teacher, treats authenticity as static rather than dynamic and as fixed rather than emergent, and ignores the potential of transformations of learning environments by its participants." (p. 738). They argue that rather than focusing on having students replicate the professional practices of scientists, the goal should be an emergent notion of authenticity that entails ongoing student involvement and incorporates all participants' experiences. This perspective on authenticity is in line with others who recommend that science be taught in ways that accord with student interests and are tied to community concerns (cf. Buxton 2006; Mueller et al. 2012; Wallace 2004), and what we (the authors) intend when we use the term authentic.

Without the sustained involvement of students, reforms to make science classrooms resemble scientists' labs may not fully succeed in enculturating students into science-centred communities. For example, some students may feel blocked from science if they experience a sense of disconnection between their cultural practices and those of scientists, if science is portrayed as formal or too *hard* (cf. Lemke 1990), or if students are not taught the cultural norms directly (Settlage and Southerland 2007). Changing the classroom may not bring more people into science if it does not consider students' perceptions, experiences, and positioning relative to science. Further, classrooms that include student-directed experiments yet do not include the communication practices of youth may not reflect the evolving field as investigators (particular young investigators) are doing much more in terms of sharing their work with colleagues and the general public through social media.

One possible approach to rethinking authenticity is to consider how practices related to science education can be hybrid, drawing on the ideas, actions, and backgrounds of all participants (e.g. Moje et al. 2004). Bhabha (1994) describes how hybridity emerges even in the context of power differentials because of the *Third Space* in which individuals strive to make meaning as they draw on the discourses of different groups. In applying these ideas to authenticity in science education, Wallace (2004) elaborates, "The Third Space, then, is an abstraction of a space/time location in which neither the speaker's meaning nor the listener's meaning is the 'correct' meaning, but in which the meaning of the utterance is hopeful for either co-construction of interpretation or new hybrid meanings." (p.908). Similarly, Zeichner (2010) describes third space as entailing a rejection of binaries and an acknowledgment of the ways in which people integrate competing discourses in order to make sense of the world. These third spaces can lead to partnerships in which different forms of knowledge are valued, and in which hybrid practices develop that contain elements of both groups. The hybrid third space can be seen as a bridge between the world of science and the students' everyday worlds (Moje et al. 2001).

Further elaborating on the possibilities of hybridity, Varelas et al. (2005) describe: "Hybridity challenges unity and helps us see how seemingly different and opposing views may be held together, actually working together to allow individuals to function in different settings." (p. 513). They also explain that navigating the different practices might allow participants to "challenge and reshape parts of both practices." (p. 513). Rather than striving for a classroom science that bears a thin resemblance to scientists' work, it is possible that classrooms could cultivate the development of hybrid cultural practices, in that they combine features from student and scientist communities in emergent and creative ways.

In order to increase accessibility and interest in science, it is important to investigate how authenticity is co-constructed within educational settings. In this study, we examine the impact of an innovative approach that combines student-directed research in a university classroom with the use of social media, digital storytelling, and a partnership between the university and a high school classroom. Students documented their work through digital stories using iPads and shared their experiences with local high school students through an education social networking site and on-site visits. In this approach, efforts to make classroom activities approximate the work of scientists are combined with the use of technology and presentation formats that are designed to increase student communication and involvement.

Questions include:

1. How does the use of a technology-mediated approach that integrates digital storytelling, social networking, a university/high school collaboration, and an emphasis on mastery of core competencies in science impact participants' experiences and learning?
2. How does the use of a technology-mediated approach to college teaching combined with a university/high school collaboration impact participants' perceptions of "authenticity" in science? How does it impact how students view themselves in relation to science?
3. How can this project inform planning for student-centred college courses? What are the implications of this innovation for efforts towards a more student-centred science, with a co-constructed authenticity?

Background

"Authenticity" in Science Education

At the college level, recent efforts to reform biology education have centred on promoting deep conceptual understanding of the content, interdisciplinary approaches, and direct experiences engaging in experimental design. The recent Vision and Change report (Brewer and Smith 2011) focuses on core concepts and competencies, describing how the college biology classroom should become more interactive, inquiry-based, and focused on communication. The goal of such reforms is to provide opportunities for students to develop deep content knowledge and work in ways similar to scientists rather than to memorize terms. Studies have found that changing to a research-based biology lab course can positively impact college students' interest, confidence, and inclination towards research (Berg et al. 2003; Brownell et al. 2012).

Similar to college-level science education reforms which have focused on increasing the use of process-oriented, social, and lab-based approaches to instruction, there have been reform efforts at the K-12 level that have aimed to better reflect how science is experienced in the real world (NGSS Lead States 2013). Changes include greater emphasis on scientific practices and process skills such as experimental design and communication of results (National Research Council 2000; NSTA 2016). In order to have students at the K-12 level experience "authentic science" in the form of open inquiry, some projects have implemented the structure of scientist-teacher-student partnerships with the goal of bringing high school science closer to the practices of scientists (cf. Hsu and Roth 2010). Studies have shown positive results in terms of student and teacher participants' knowledge and understanding of the generation of scientific knowledge (cf. Bell et al. 2003; Houseal et al. 2014; Hsu and Roth

2010; Zhang et al. 2010). Further supporting the use of inquiry-based instruction at the K-12 level is the integration of multisensory and collaborative approaches which can address many students' learning needs and therefore support inclusion (Alexakos 2001).

The interest in an authentic science that reflects practices of scientists is not new, as researchers for the past few decades have been exploring ways of having science instruction better resemble the science conducted in professional settings (cf. Chinn and Malhotra 2002; McGinn and Roth 1999). Further, the idea of *science for all* has at times been connected to the idea that students will find science more compelling if given opportunities to engage in authentic science opportunities (Buxton 2006). While many high schools have labs, which theoretically could allow students to work through problems that do not have predetermined *correct answers* and to work with evidence (cf. Toth et al. 2002), often high school students are assigned *cookbook labs* or prescribed experiments (Clough and Clark 1994; Saunders 1992). These labs have been criticized for projecting an inaccurate view of science due to issues such as having known rather than unknown outcomes, and series of steps to follow rather than exploration. Even labs at the college level have been criticized for this *cookbook* quality as well (Brownell et al. 2012). In addition, there is a lack of consensus regarding what exactly constitutes *authentic* science (Abd-El-Khalick et al. 2004).

It is important to interrogate the idea that authentic science only constitutes a direct reflection of scientists' lab work, as there may be important elements of authenticity that are ignored by this view. Buxton (2006) discusses how versions of authenticity that prioritize *being scientists* are static and predetermined and do not sufficiently consider the learners' perspectives. He refers to this view of science as "canonically authentic science." (p. 702). Radinsky et al. (2001) describe two approaches to authenticity, *simulation* and *participation*. In simulation, the classroom is altered in order to better resemble a professional community, an approach which can have similarities to the *canonically authentic science* that Buxton describes. The second approach, participation, enables youth to take part in the relevant communities themselves, rather than just re-creating models of them in the classroom. Aiming for participation could facilitate greater ownership on the part of the students, as they are directly involved in the generation of scientific knowledge.

Another perspective on authentic science is that it should be meaningful to students in the context of their own lives (Barton and Yang 2000). Barton and Yang argue that rather than students having to adjust to reflect the practices of scientists, science should adjust to students' needs and interests. Similarly, Buxton (2006) proposes an alternate view of authenticity as taking as "its starting point the interests, perspectives, desires, and needs of the students." (p. 700). An implication is that simulating scientific practices will not necessarily make students feel like scientists, particularly if the barriers between students' home cultural practices and the cultural practices privileged in science classes are very different.

A notion of authenticity that is negotiated between all participants may allow for a more inclusive view of science. Rather than being predetermined, science can be viewed as a collective accomplishment in which participants draw on their own cultural resources and discourses to co-construct meaning (cf. Buxton et al. 2005; Siry et al. 2012). Buxton (2006) writes, "By taking a stance that is more inclusive than the 'expert' model that dominates canonically authentic science, these studies point to the creation of dynamic and fluid, bottom-up constructions of authenticity that I refer to (after Barton 1998) as youth-centred authentic science." (p. 702). Similarly, Rahm et al. (2003) adopt a systems approach, arguing that authenticity is an emergent property based on the meaning-making activities of scientists, teachers, and students as they engage in projects. They describe a need for "sustained involvement and experiences over time" and "ownership of such experiences by the participants (teachers, students, and scientists)" (p. 738). As another example of an expanded view of authenticity, Braund and Reiss (2006) describe the need for enhancing laboratory-based school science with virtual world experiences that are accessible through information technologies.

In this study, we explore the negotiation of authenticity in the course as college students engaged in digital storytelling about their research and participated in a social networking site in which they interacted with high school students.

The Potential Role of Technology in Emergent Authenticity

Studies have suggested the value of web-based learning for content area achievement, higher-order thinking, skills in problem solving, and workforce preparation (cf. Cradler et al. 2002). The use of computers can also be specifically beneficial to science education because of opportunities to visualize complicated concepts and processes (cf. Plass et al. 2012). Certainly not all uses of technology are transformative, as sometimes a particular modification can just replace of aspects of instruction without any improvement (Hughes 2005), such as writing on a Smartboard in place of writing on a chalkboard. However, some uses of computers can contribute to collaborative learning environments that can transform the ways in which people learn (Pea 1994).

Digital Storytelling Digital storytelling entails structures similar to traditional storytelling, yet combines the author's voice with enhancements such as video, music, and images. Given the immersion of many students in various uses of technology in their social lives, the use of digital storytelling has the potential to increase students' perception of relevance (Sadik 2008). Further, digital stories have been shown to advance certain twenty-first century literacy skills, including digital literacy, technology literacy, visual literacy, and information literacy (Robin 2008).

Rather than being a replacement for traditional methods of communication, the use of digital storytelling can transform the impact of an assignment, with the multimedia nature allowing for varied ways of communicating content and different learning outcomes. Yang and Wu (2012) describe that through the process of creating these stories, "students are challenged with thinking critically about effective combinations of content and multimedia elements while considering the audience." (p. 242). This focus on how a specific audience will receive the content has the potential to enhance the authenticity of a task. Yang and Wu also write that digital stories "allow opportunities for student control of the learning process and self-expression, fostering learning confidence, task value; and learning motivation." (p. 340). Another benefit of digital storytelling is the possibility for communication from many to many, and greater opportunities for personalization of communication (Robin 2008).

In this particular project, the multimedia aspect of digital storytelling allowed for the communication about rather complicated surgical procedures in ways that writing alone could not have communicated. In addition, the multimedia format facilitated the use of youth discourse styles and emotional expression as students worked to tell stories of their research in ways that would appeal to their high school audience.

Social Networking In recent years, some classrooms at the K-12 and college level have been using social network sites for educational purposes (cf. Roblyer et al. 2010). Social network sites enable members to share information about themselves, post photos and videos, provide links to articles, have group discussions, and comment on shared content. Boyd and Ellison (2007) define social network sites as web-based services that enable participants to create a profile, connect with other users, and view the connections of others within a bounded system.

Many college- and high school-aged youth spend extensive amounts of time on social network sites such as Facebook and Instagram, which enable them to portray their identities (Pempek et al. 2009) and build social capital (Ellison et al. 2007). The students' networked social existence contrasts with the typical environment of a classroom, where discussion is often conducted using IRE (Initiation-Response-Evaluation) dialogue (Lemke 1990). Information exchange is therefore mediated by the teacher, giving students few opportunities to interact with each other.

The use of social networking for educational purposes has the potential to decrease teacher-mediated instruction and increase peer-to-peer collaboration which can lead to a shared sense of responsibility for learning (Zhang et al. 2009). Social networking can be particularly useful in distance partnerships, given the potential for communication across space and time. Edmodo was the social networking site chosen for this particular project, since it has a similar structure to Facebook and is therefore a familiar way for students to communicate. The use of Edmodo is supported by other studies that found it beneficial for increasing responsibility and engagement (Balasubramanian et al. 2014) and encouraging student-student discussion without intervention from the teacher (Holland and Muilenburg 2011). While there have been studies that investigate the potential benefits and issues with using social network sites to teach high school science (e.g. Dohn and Dohn 2017), there has been little investigation into the role of these sites in contributing to an emergent authenticity that includes students and scientists.

Social Interaction in Science Education

In order to investigate the impact of digital storytelling and social networking on perceptions of authenticity in a behavioural neuroscience course, we draw on theories of social interaction. Interaction with members of a professional community is essential for students to learn the discourse and practices relevant to the discipline (Lave and Wenger 1991). Wenger (2000) describes how in a community of practice, participants can have varying levels of skill, and central participants (such as a professor) help to enculturate peripheral participants (such as students). In a socially situated perspective on learning, the incentive for acquiring new information and skills does not emerge only from intrinsic interest in the content, or from a system of rewards and punishments such as that offered by grades, but also from the desire to contribute as valued members of a community.

However, science is often portrayed in classrooms as being impersonal (Pomeroy 1993), objective, distant, and too hard for most people (Lemke 1990) which can end up leading to a sense of alienation from science, particularly for students from non-dominant backgrounds (Barton and Yang 2000). Scientists may also be constructed as clever and singular in their focus (DeWitt et al. 2013). Since learning and emotional involvement are intricately tied (Osborne et al. 2003), a view of science as overly distant may interfere with students' sense of identity and therefore their desire to pursue science knowledge in the future.

In contrast, high levels of emotional engagement can encourage identity development in science. Sociologist Randall Collins (2004) describes how feelings of group membership and interest in particular activities emerge from series of what he calls "successful interaction rituals" which are characterized by a build-up of mutual focus, the development of a common rhythm and mood, emotional energy becoming attached to the symbols, and, consequently, an increase in positive feelings associated with the group. Previous studies have investigated how classroom interaction rituals can bring about a sense of membership and identity in secondary school classrooms, leading to even abstract concepts in science becoming associated with positive emotional experience (cf. Olitsky 2007b). In college classrooms, positive emotional climate due to high-intensity dialogic interactions can also lead to a sense of group membership (Bellocchi et al. 2013). In addition, participation in successful interaction rituals can be effective in reducing the salience of status boundaries between differently positioned participants in partnerships (Olitsky 2017). Studies also show that a sense of community can emerge when high school students have the opportunity to work alongside scientists in labs (cf. Hsu and Roth 2010). Collins (2004) argues that the emotional contagion necessary for successful interaction rituals is contingent upon bodily co-presence. However, there has been little research into whether emotional contagion is possible when using digital storytelling or social networking sites.

In examining the role of the use of technology on social interaction and identity in science, we also draw on Goffman's (1959) ideas about the role of frontstage and backstage performances in the presentation of self. Goffman describes that in workplaces, people keep the preparation aspects of their work hidden in the *backstage* in order to provide an image for the audience in the *front stage* that is as flawless as possible. For example, in restaurants or theme parks, the visitors enjoy a seemingly perfect, almost magical experience. However, the work that happens behind the scenes, which contains all the imperfections, arguments, mistakes, and messiness, remains hidden. Similarly, in both high school and college classrooms, science can be portrayed as distant and objective (Lemke 1990), with the messy backstage of mistakes, collaboration, frustration, and argument hidden. Frontstage performances in science classrooms can solidify boundaries between teachers and students, and between students and science (Olitsky 2007a). In addition, science journal articles and presentations use insider vocabulary and often do not highlight errors and struggle.

By following the recommendations in Vision and Change (Brewer and Smith 2011) and focusing on student-directed experiments, the process of practicing scientific inquiry may become demystified and promote collaboration rather than social distance between professor and students. In this paper, we show how the professor's changes in integrating technology to create a community of engaged colleagues allowed for more expression of "backstage" learning processes, emotional connection, and educational purpose for the college students, which had an impact on breaking down the barriers, enhancing the depth of their participation, and leading to an emergent authenticity.

Methodology

Because there are not many studies that focus on college courses that combine digital storytelling with social networking and a high school/college partnership, this study is partly exploratory, intended to investigate the general impacts on the students, the connections between participants, and the perceptions of authentic science that emerged from this experience.

We were influenced by Guba and Lincoln's (1989) criteria for authenticity, which specify an iterative relationship between research questions, theory, and data analysis. While the initial questions for the study were general and concerned with the impact of modifications to the course, more specific interests such as examining hybridity and emotional engagement emerged from preliminary analyses of the data. Guba and Lincoln's criteria also highlight the importance of catalytic authenticity, which entails the use of research for positive change. While the semester-long course that is the focus of this study ended, the results of this study have been used by the professor to inform revisions to this course as well as the design of future courses.

Participants

College Students

Participants ($N = 14$, 5 male and 9 female) in the study were mostly junior and senior biology and psychology majors in an upper-level behavioural neuroscience lab course at Saint Joseph's University. The class met twice for lecture and once for a 3-h lab per week. Students worked on research projects in teams of two. One student dropped the course for personal reasons.

High School Students

Eighty high school students participated in the collaboration. The high school students are from a suburban area and were taking an upper-level anatomy course. Small groups of high school students (7–9) were partnered with the college student research teams (2 per team) for the duration of the semester. Although the high school students were able to engage with the research of all of the college student teams, each group shadowed one team closely to establish a working relationship.

General Procedures

As a part of the course requirements, the 14 students in the undergraduate behavioural neuroscience course conducted a semester-long, student-directed research project. In the course, students learn a range of topics that are essential to understand the neurobiological underpinnings of behaviour such as evolution and hormones. Once the foundational material has been covered, the class then delves into the neural control of specific behaviours from aggression to mating. To give students an intimate understanding of that body of literature, the professor, Dr. Elizabeth Becker, added a research component to the class. Rather than learning the content and conducting labs with predetermined outcomes, students engage in semester-long, self-designed research studies. At the beginning of the semester, students were given a list of brain regions and asked to select one to study in more detail. Students then selected partners based on mutual interests and commenced work on their study of the effects of a lesion (brain damage) in a particular region of the brain and its consequences on behaviour. Students are engaged with every stage of the process from research and design to disseminating results through a research paper and presentation. The course also requires that students participate in ethics training before working with the research animals.

In past iterations of the course, students appreciated the opportunity to do independent research, but the professor noticed that the final presentations of their projects were lacking in depth and substance and that students perceived the assignment as "busy work" and "just one more presentation". While she found that her students were engaged in the course overall, she thought that perhaps the presentations were lacking because the "final report for a grade" structure was discordant from the more authentic experiences they had throughout the course. Although presentations are seemingly authentic within professional settings, since scientists regularly deliver content in this format, the professor perceived that working for a grade in a college class and presenting to eager colleagues are fundamentally different experiences.

Her dissatisfaction with these final presentations was part of her incentive to revise the behavioural neuroscience course. She describes, "busy work…. So, I figured I needed to make the activity more authentic and more meaningful." The professor implemented multiple changes in the course with the goal of increasing student engagement through the use of technology, which included students using iPads to document their experiences in the class and create videos of their semester-long project, rather than convey their experiences in the more traditional format of an academic research presentation. The professor worked closely with Joseph Montcalmo, Director of the Academic Technology group at the University, and other academic technology staff members, to create the infrastructure. The team created training sessions on digital storytelling, in-class workshops, and rubrics for the video assignment.

The professor also collaborated with a high school teacher, Ignacio Jayo, and a member of the high school technology staff, Philip Vinogradov, to craft the e-communication and on-site visit schedule for the high school students. Ignacio describes his incentive for participating in the collaboration, "I still struggle with the way science is 'taught' at public schools. Due to various established curricula, state tests and other reasons, students are seldom asked to 'do real science': to research, brainstorm, develop a question and then a novel experiment that has no known answers."

Using Edmodo, a social networking site geared for education, the professor's students communicated with the high school class about their research. They created profiles and posted weekly blogs containing pictures and videos within a discussion board located in Edmodo. The high school students then read their posts in small groups and replied with comments and questions. In addition, the high school students visited the university three times per semester, once to observe stereotaxic rat brain surgery and then twice to observe behavioural testing on post-surgical rats. Through the collaboration, the students were able to follow the progress of the professor's behavioural neuroscience class over the course of a semester.

Data Collection

Pre-survey/Post-survey SALG

During the first and last weeks of the semester, college students filled out an anonymous, online survey (Student's Assessment of their Learning Gains, SALG). The SALG assessment, hosted by the Wisconsin Center for Educational Research, was created in 1997 as part of an NSF-funded curricula and pedagogy initiative to assess the degree to which a course has enabled student learning. These types of measurements, which are focused on students' evaluation of the learning gains due to specific teaching methods, have been shown to be both valid and reliable (Hinton 1993; Seymour et al. 2000). The professor chose this assessment because of her introduction to it at a teaching workshop.

The assessment contained several Likert scale and open-ended questions and was designed to measure student's perceptions of their own learning in the areas of understanding, skills, and attitudes. Students were asked to rate the extent to which the statements related to them, from "none" to "a great deal" or "not applicable". In this assessment, we also collected demographic information and feedback about particular assignments and components of the course.

Fourteen students (100%) completed the first assessment. After one student dropped the course, 10 students (76.9%) filled out the final assessment. All statistical analyses were conducted using SPSS (version 19.0, SPSS, Inc., Chicago, IL).

Qualitative Analyses

Data sources on the college students' experiences included the digital stories that they created, video and written blog posts on an education social networking site (Edmodo), online surveys that they completed, and artifacts produced during the course including final reflection papers. For their final reflection, the students were asked to contemplate their experiences in the course, consider their accomplishments, and report on the impact of sharing their research with the high school students. Data sources on the high school students' experiences included blog posts on Edmodo as they interacted with the college students, responses to an end-of-semester questionnaire on their participation, and an end-of-semester reflection writing assignment. The data analysis was conducted after grades were already submitted, so students did not experience any conflicts regarding participation in the study and pressures due to grading.

From these data sources, we hoped to gain an understanding of how students constructed authentic science, the connections between lab science and their own lives, and the emergence of hybrid practices in the course. Data sources were coded for emergent themes in order to detect patterns in students' statements about science and about their own experiences. Codes included references to "authentic" or "real" science, depictions of science, and use of academic and non-academic forms of discourse. We used purposeful sampling (Strauss and Corbin 1994) for further video analysis and/or discourse analysis. By purposeful sampling, we refer to the selection of information-rich cases that allow for insight into issues of central importance to the study (Patton 2015). For example, excerpts that either conveyed an image of science as "too hard" or that subverted an image of science as "too hard" were analysed in order to deepen understanding of the impact of various forms of communication on the portrayal of science. From these incidents, we developed vignettes (Erickson 1986) that highlighted aspects of authentic science as constructed by participants.

In analysing the blogs and videos, we examined the talk for appraisal, "the attitudinal colouring of talk along a range of dimensions including certainty, emotional response, social evaluation, and intensity" (Eggins and Slade 1997, p. 124). For example, we explored adjectives, use of minor clauses, exclamatives, and other clause structures to determine the valuation that students ascribed to science and to their work. In addition, we examined indexicals (Wortham 1996), which are parts of discourse that can point to social groups, events, or other discourses. We examined these cues to see how the college students positioned themselves with regard to science.

Qualitative Results

Beyond "Canonically Authentic Science"

The professor had been teaching the behavioural neuroscience class for two years prior to the study by providing opportunities for students to conduct original research projects. By some definitions, her class may have been already considered *authentic* before the changes, since it emphasized collaborative research rather than memorization. However, over time, she became dissatisfied with the students' final presentations which she described as unenthusiastic, uninspired, and an inadequate representation of the strong research that the students had conducted over the course of the semester. As part of the changes to the behavioural neuroscience class, students worked in pairs to create videos and blogs that were not only directed towards the professor in order to receive a grade, but were also aimed at educating a high school audience. Through the use of technology, the course became better able to support a view of science as a social and participatory practice and a view of authenticity as entailing communication with general audiences.

Digital Storytelling Presentations In all of the student-created digital stories that served as the final products for the course, students drew on videos, images, music, and other types of sounds in order to present their research. There was a mix of cultural and discourse practices displayed, which included elements of formal science presentations, TV shows such as Bill Nye, comedy shows, reality TV shows, and other common formats. In most of the stories, in-depth explanations of the science content and the research process were interspersed with expressions of uncertainty and displays of emotion. The combination of deep science content and informal communication led to an emergent construction of authentic science as not only inquiry-based and content-rich, but also emotion-laden and participatory, with the messy *backstage* visible to the audience.

For example, in the one of the videos, the presenters, Kyle and Ian,[1] begin by playing background music, "Space Jam" by Quad City DJ's as they show their title slide. The music continues, and the video cuts to them dancing in a manner that resembles vogueing. They state, "Surgery is awesome. It is like nothing we had ever done before." In incorporating popular culture, using non-formal, emotion-laden language, and directly portraying themselves to the high school students as peripheral participants rather than experts, they convey a view of a science that is accessible to those who are willing to take the risk and enter. Through displaying the "backstage" of feeling unsteady in their new role as scientists, social distance between the college and high school student audience is reduced and science is rendered more accessible. Their approach differs substantially from the prior years' research presentations, in which students disseminated their findings in a formal, authoritative, and arguably disconnected manner.

Kyle and Ian's statements throughout the video hang together to portray a view of science that is not objective and distant, but instead as full of emotion. They draw on music to enhance the dramatic impact of their video, such as the soundtrack played as the rat recovered from the surgery that included lyrics, "I am a survivor … I am going to make it…" They then show an image of the rat's stitches immediately after surgery, stating, "That's disgusting… but he survived so we really can't complain". While "that's disgusting" connotes negativity, Kyle and Ian follow that comment by considering the rat's healing process. They describe how they wanted to begin testing right away, but "the rat was not ready". They then show a video of their rat washing itself, with a soundtrack, "This is the way we wash our hands on a cold and frosty morning." While their treatment of the surgery process in some ways seems light and humorous, it also incorporates the ebb and flow of intense emotions that can emerge in conducting this type of research.

These expressions of their own emotions, and the feelings conveyed through music and image choices, were juxtaposed with canonical science language, such as, "We used the same

[1] Student names have been changed.

parameters and habitat for both pre and post-surgery testing." Through their digital storytelling, the students implemented hybrid practices, integrating canonical science language with dramatic features and emotional expression that are not often privileged in science classrooms at either the college or high school level.

Throughout the video, Kyle and Ian frequently poked fun at the high status ascribed to science. For example, in an exaggerated and loud tone, they state towards the beginning of the film, "Although it may seem like we are accomplished world-renowned neurosurgeons, we were actually nervous." Not only do they show "backstage" emotion, but they also explicitly point to the idea that science is considered high status, and subvert this view.

In addition to expressing nervousness and disgust, the students also express joy. Towards the end of the video, Kyle and Ian say, "Did our lesions actually produce a decrease in the aggressive behaviour. YEAH!" The students then do a hand bump in an excited manner. In a formal presentation as occurred last year in this course, the results would be reported without any emotional expression, in accordance with the norms of science portrayed as objective and unbiased. Professors may convey this norm of objective distance to students by modelling a process in which a scientist would remain detached from the hypothesis. While the college students' written report indicates that they worked towards unbiased collection and analysis of data, their digital storytelling enables them to express their sense of joy and triumph when they find that their hypothesis was correct and the lesions did indeed decrease aggressive behaviour. The result is a hybrid presentation in which emotion and objectivity coexist.

As another example of the hybridity between professional scientists' and students' technology-mediated communication practices, Mia and Kayla's video showed the "backstage" emotional aspects of science through a video style that resembled a reality competition TV show in which participants engage in some type of challenge. Through suspenseful music, interviews that focused on participants' persistence through obstacles, and videos of surgery with voiceovers describing their feelings about events, the audience is brought into a story of individuals engaging in a test of skill and character. However, rather than a challenge of physical strength or survival, the challenge is surgery and scientific research.

In the opening of the video, the students use the camera's perspective and alternating silence and music in order to build excitement. The film opens with a faint sound of wind and a slow panoramic view of the campus. The camera then shakily moves towards the door of an unknown building, creating an element of suspense. Then, the camera shows the sign on the door "psychology department" and loud, fast instrumental music starts. Suddenly there is a time lapse video of students walking upstairs, similar to the opening of a reality show in which participants are about to undergo an exciting challenge. The title "Adventures in Behavioural Neuroscience" is then displayed. Calling their video an "adventure" further supports the reality competition theme.

Mia then describes how their project was a "roller coaster in every sense of the word" with "ups and downs". Next, their video shows images from the surgery. Mellow acoustic music plays underneath their description of their study using formal science language, "We lesioned the ventromedial nucleus of the hypothalamus which has been shown to be involved in feelings of satiety…. we hypothesized that the lesion would decrease the time it took for the rat to reach the food reward and take a bite. We also hypothesized that the rat would prefer the fruit loops over the pellets."

The film then moves to the first of several interviews in which Mia and Kayla ask each other questions. The content and style of the interviews resemble those in reality competition

TV shows during which participants reflect on their emotional reactions to challenges. The following is an excerpt:

> Mia: How did you feel when you found out how involved this class was? Were you nervous about how it was going to develop?
> Kayla: Honestly, I thought about dropping the class when I found how involved it was... I am glad I stuck it out… but I was definitely overwhelmed initially in that first week or two.

Continuing with this resemblance to reality competition shows, Kayla portrays their first lab experience: "I think the first shock came when we arrived at the lab and saw all these pigs' feet on the tables so that we could learn how to properly incision... But it was very effective." Given that the professor did not intend that session to be shocking to students, and given that this was the only video from the students that conveyed the pigs' feet lab as "shocking", it is likely that Mia and Kayla are indexing reality competition shows, a form familiar to them and most likely to their high school audience as well.

Similar to Ian and Kyle's video, Mia and Kayla subvert a view of science as objective and distant. For example, Kayla asks, "Did you like your rat initially?" Mia responds, "I really liked him and I was really sad when he did not like me." There is some laughter, and Mia continues, "I don't want to say he hated me...but he was not a fan of my presence." Rather than objective observers of a research subject, Mia and Kayla portray the rat as having likes and dislikes, and themselves as emotionally invested. Later, they describe sadness when they have to conduct the surgery.

Mia and Kayla convey their hesitation at various points in the process, describing how they thought the course was difficult and how they were concerned with "messing up" during surgery. Responsibility to the high school audience is also portrayed as challenge, with accompanying fears and emotions. Kayla describes in the video, "I felt like this was the most important thing in the world to me at the time, and I was very nervous that something was going to go wrong. The fact that we had to do it in front of the high school students put that much more pressure on it... but once we got started... and remembering all we had gone through in terms of learning all the steps… I think that helped a lot." By describing their feelings of nervousness in the context of an "overcoming challenges" narrative, the backstage of uncertainty is visible.

Kayla also describes a feeling of triumph, "Something we had no experience before but it ended up honestly being one of the greatest experiences. We are happy to say our surgery was a success." Through vicariously experiencing the "ups and downs" of Mia and Kayla's story, the high school students may come to view science as more accessible to them, as it is conducted by real people with emotions similar to their own. The students may identify with the experience of initial fears that transform into a sense of accomplishment. Through the college students' creativity as they combine cultural practices in digital storytelling as a venue for communication about scientific research, science is depicted as a community in which emotional engagement is valid and welcome.

Blogging and Social Networking Throughout the semester, the college students blogged about their experiences in the lab, directing their posts to their high school audience. Their casual yet informative style displays the backstage of their learning processes, portrays themselves as occasionally struggling, and invites the high school students to participate. The following is an example:

> It's been a busy week for me and Ian… From handling and weighing our rat daily, to finishing our baseline tests, to actually conducting brain surgery, it's been chock-full of neuroscience-y goodness. But here it is, the moment you've all been waiting for (at least that's what Ian and I will continue to tell ourselves). Week 5 of our blog, Behavioural Neuroscience with Ian & Kyle, is here! In the event that it looks like something has gotten cut off, just give it a click and you can see it in all of its intended splendour! Like always, if you have any questions (why we're doing some of the things we're doing, where is our favourite place to get a hot roast beef sandwich, etc.) please don't hesitate to ask!

In this excerpt, the college students portray themselves in a very informal manner, as people who eat sandwiches, and poke fun at both themselves and the formality of science, joking that they expected the high school students to be focused on their project, "the moment you've all been waiting for" and that their blog post shows "intended splendour". They draw on hybrid presentation practices, including elements of talk shows and commercials, such as the phrase, "chock-full of neuroscience-y goodness" that index television food advertisements. Their digital storytelling effectively addresses a media-savvy high school audience, as it contains cultural references that students will find familiar, yet is also accompanied by depth of science content.

The college students' responses to high school students' questions in the discussion boards also show emotion, informality, and access to a messy "backstage" process, while being infused with science content. For example, in response to a student's question about the time and process of surgery, Ian and Kyle responded:

> Hey Chris. Thanks for your questions! The actual surgery procedure (starting with the first injection of Atropine and ending with the final suture being placed) took about 2 hours to complete. … It's important to make sure that he can support himself before putting him in the cage; the bedding can pose as a suffocation hazard if the rat is unable to get up and move himself. Personally, I feel like the most difficult aspect of it was actually getting over the fear of doing the surgery. It's totally different studying for weeks to perform the surgery and then finally being handed a scalpel and looking at your rat. The experience was incredible, however, and once I buckled down and realized I knew what I was doing, everything else was a breeze.

In this excerpt, Ian portrays himself as a learner, communicating that science is actually not too hard even if it seems intimidating at first. Overall, the blog responses provided many opportunities for the college students to make their learning processes visible to the high school students.

As another example, the college students had to respond to a question that the high school students asked regarding how they found the right coordinates for conducting the surgery. They needed this information to conduct stereotaxic surgeries, which utilize a system of coordinates in three planes to target and lesion regions in the brain. The college students explained:

> As for the coordinates, the paper we originally found them in was entitled "The Central and Basolateral Amygdala Are Critical Sites of Neuropeptide Y/Y2 Receptor-Mediated Regulation of Anxiety and Depression". Sounds riveting, I know, but it was the first

> thing we could find that included the stereotaxic regions of the medial nuclei of a rat's amygdala. Honestly this had to be one of the hardest parts of the entire process. The paper didn't even have anything to do with the research we wanted to conduct! We just used it for its specified coordinates of the MEA (medial amygdala). Once we got the coordinates, we brought them in to Dr. Becker who gave us the 'okay'. For anybody who wants to read the paper we mentioned above just click the link below:http://www.jneurosci.org/content/30/18/6282.f... See if you can find the coordinates like we had to do!

The statement "sounds riveting I know" acknowledges the distancing that science language can convey, yet through pointing directly at it, renders the content more accessible. By making fun of the technical terms, the college students position themselves on the same plain as the high school students, in that they are all struggling on unfamiliar terrain. In addition, they welcome the high school students into their activity, with the challenge, "See if you can find the coordinates like we had to do!" While we do not know if any of the high school students tried this or not, it still shows that the type of communication afforded by the social networking was inviting rather than distancing.

High School Visits The high school students were given an opportunity to come to campus to see the science class on three separate occasions. The first visit was on the day of surgery. The high school students were highly engaged throughout the 3-h procedures, asking questions of the student researchers and vying to get the best position to see each step. The two student surgeons that were observed performed the procedure, from memory and without instruction flawlessly. When it came time to stitch the rat, one of the college students started to cry. She later described it as a mix of emotions: complete exhaustion, amazement, and pride in what she had accomplished. It was a very raw emotion, one that the professor had seen from many students over the years, and was powerful for the high school students to observe. The high school students then responded with messages of support and congratulations.

The surgery had characteristics of a successful interaction ritual, in that it involved a mutual focus, extended time, and coordination of body language and emotion between participants. The high school students were in the position of collectively "rooting" for the college students, and the visits solidified a sense of membership between the two groups. The second and third visits were even more interactive as the high school students were matched with pairs of college students, and they observed and took part in behavioural testing of the post-surgery animals.

Impact on High School Students: Positive Emotions and Interest in Science

Many of the high school students' comments on the questionnaires indicate that interactions with the college students fostered a view of science as accessible to them. For example, one student described, "This experience was very different. I thought it was interesting to talk to college students about the project, and with them being not much older than you, they know how your mind works. What I mean is, if you asked a question they answered it in your dialect rather than using a whole lot of terms, that you had no clue what they meant. I think they should do this next year, it was a lot better than just sitting in a class learning, you learned from older peers." This student's comment suggests the value of having participants at varying levels of expertise involved in their learning. If learning science is like entering a community of practice, it makes sense that the teacher-student interaction in schools is not always sufficient, as even if teachers are not that much older than students, they are far removed in terms of science expertise. High school students may benefit from access to the college student peripheral participants who can help provide a bridge between their own worlds and science communities.

Other comments demonstrated the high school students' appreciation of the college students' knowledge, their willingness to share, and the ways in which they communicated. The following are some examples:

> You guys were great about explaining everything that was going on, which made it very easy to understand.

> I have to say it looked like you guys had a lot of fun with your experiment and shared the knowledge you guys had learned in a pretty clever/funny and easy to understand way.

Their comments show how the science that emerged from the experience became laden with emotions. The symbols associated with science therefore are likely to become get associated with positive emotional energy, which students can carry into future experiences with science.

Several of the students commented in the survey that their views of neuroscience have changed over the course of the semester and they are now considering studying science in college. In addition, in response to the question, "Has this experience influenced your interest in trying college science/psychology courses?" over 60% of the high school students reported a positive impact on their plans. Certainly, many of these students were already planning to take science and/or psychology courses. However, their responses suggest an inclination to take a greater number of courses than they would have taken otherwise, and/or the development of a greater interest in the courses. Comments included, "It has sparked even more interest in going into a medical/science field." Overall, the results of the questionnaire suggest that this type of partnership program can support positive views of science as a career.

Impact on College Students: Emergent Authenticity Focused on Communication

Many of the college students' reflections focused on the importance of communication about science to general audiences, and the value of gearing their efforts towards reaching people who were not as knowledgeable in science. For example, some of college students described how the course was enriching because they felt "responsible" to the high school students. One of the students described, "From my perspective, having a real audience, particularly high school students, increased accountability and student investment in the project presentations." Another student wrote, "For this class we had people that we needed to answer to and it wasn't only our teacher; it was our high school 'shadow'. These students were expecting weekly updates on our research... no longer will I think that the purpose of my lab work is receive a grade in a class." While college students sometimes consider their grades to be of great importance, in this class, students came to assign greater value to communication about science to others.

In many of the students' statements, the importance of communication was connected to the use of technology. For example, one student describes: "Today's society is so wrapped up in social media, and I think it is so important to be able to translate scientific findings into a format that may be accessible to all types of audiences, not just academia." This student, and many others, found value in using digital storytelling with a goal of research that is comprehensible to the general public. Overall, the ways in which the students describe their experiences within this course differ substantially from a view of "authentic science" as restricted to scientists' activities within a lab and the dissemination of their research in journals and at conferences. Instead, the college students portray an emergent view of authentic science in which scientific findings need to be accessible to broader audiences, which becomes possible through the use of multimedia presentations and asynchronous interaction afforded by technology.

The revisions to the course also had implications for the college students' understanding of the content. Several of the college students described how they learned more about the content because they had to communicate the results to a non-science audience. For example, one student discussed, "To provide them with the in-depth updates that they not only expected, but also deserved, we needed to know our project inside and out. I felt like my understanding of the research reached an entirely new level, and felt that I could answer any question regarding it with ease."

Quantitative Results

Through an analysis of the quantitative data, we worked towards addressing questions regarding learning gains. While emergent authenticity is a valuable goal, it is also important to consider whether these changes had positive impacts on students' perceptions of their own learning and their interest in neuroscience.

Pre-survey/Post-survey SALG

Mastery We used paired samples t tests to examine whether students' perceptions of their mastery of the material changed across the semester. Students rated their understanding of how ideas explored in class related to ideas encountered in other subject areas higher ($M = 5.4$) at the end of the semester than on the pre-survey (($M = 4.6$) $t = -3.207$, $p = .011$). Similarly, there was an increase in understanding that studying behavioural neuroscience can help people address real world issues from pre-test ($M = 5.0$) to post-test (($M = 5.7$) $t = -2.689$, $p = .025$). Finally, students expressed greater awareness of the ways in which neurobiologists try to understand the world from pre-test ($M = 4.7$) to post-test (($M = 5.7$) $t = -.246$, $p = .015$). Students rated their overall mastery of the course material higher ($M = 5.5$) at the end of the semester than on the pre-survey (($M = 4.2$) $t = -3.284$, $p = .009$).

Skills We used paired samples t tests to examine whether students' perceptions of their skills changed across the semester. Similarly, students rated their ability to critically read research articles higher ($M = 5.5$) at the end of the semester than on the pre-survey (($M = 4.5$) $t = -2.739$, $p = .023$). Students rated their ability to develop a sound scientific argument higher ($M = 5.4$) at the end of the semester than on the pre-survey (($M = 4.6$) $t = -2.228$, $p = .05$).

Attitudes We used paired samples t tests to examine whether students' attitudes about neuroscience changed across the semester. Neither enthusiasm for neuroscience nor interest in taking additional courses changed across the semester, $t = -1.406$, $p = .193$, and $t = -0.758$, $p = .468$, but this may be due to a ceiling effect.

Limitations

In terms of the quantitative results, we recognize the small number of college students in this study, and we are not using these results to make broad claims regarding the impact of particular instructional approaches. Rather, we use the quantitative results to support our qualitative findings regarding the positive impact of a technology-mediated approach combined with a university/high school collaboration.

In terms of the qualitative results, it is important to note that these findings emerged from a partnership between a college-level neuroscience course and an upper-level high school anatomy course in a suburban district. It is not clear whether similar results would have been achieved in other contexts.

Discussion

In this study, we examined how a course structure that integrates student-directed research, digital storytelling, social networking, and a university/high school partnership facilitated the construction of an emergent authenticity in a college behavioural neuroscience class. Results of the modifications to this course included a view of science that prioritized the social and participatory aspects. The *authentic science* that emerged in this course differed in some important ways from how participants may have perceived the work of professional scientists based on their prior exposure through textbooks and the media. While science is sometimes portrayed in classrooms as only for special people (Barton and Yang 2000), science in this class was more accessible, as digital storytelling rendered visible the backstage of initial uncertainty, fear, attempts, learning processes, and eventual successes. While science is often portrayed in classrooms as objective and devoid of emotion (Lemke 1990), the authentic science in this project was rich in emotional expression. Overall, the use of technology and networking provided a space where students could create products that incorporated humour and emotional colouring, leading to hybrid practices that allowed for a more accessible science.

The high school visits to the lab also supported a sense of group membership between participants, thereby enhancing emotional energy associated with science learning. Further, the results of this study suggest that emotional connections may be possible through virtual communication, as indicated by the types of language that both the college and high school students used in their posts when discussing the projects. However, it is unclear whether social networking would have been sufficient as a vehicle for building a sense of community, as in this case, it was supported by experiences of emotional entrainment during visits.

While some science educators have investigated the potential for an authenticity that emerges from students' life worlds, in this study, the *authentic science* that emerged did not tie to high school students' community concerns. However, the high school students still were able to be involved as peripheral participants as they visited the university and communicated with the college students through the blog. Given that relevance is multifaceted and can also involve the exploration of "an intellectual pursuit that holds intrigue, challenge and utility" (Darby-Hobbs 2013, p. 93), the result of this course redesign can still be considered an emergent authenticity that supports relevance. The experience inspired students' curiosity and opened up a world of neuroscience to high school students who may not have considered it before. The strong positive response of the high school students to the experience suggests the potential for digital storytelling to transform science from "objective and distant" to "emotional and close". In addition, this study supports the potential for the creation of science-centred educational communities within social networking sites.

Conclusions

As social networking, iPads, and other forms of communication-related technology take hold in some classrooms, it is important to understand the implications for science learning. This study offers some insights into how these technologies can be used within the context of a university/high school partnership in order to improve science engagement and learning for participants. Technology can enable college students to communicate about their research to a variety of audiences, thereby instilling their work with a greater sense of purpose and enabling them to co-construct authentic science through hybrid presentation practices. For high school students, the use of technology within the context of a partnership with a university can provide virtual communities that increase the accessibility of original research and scientific practices. Further, the social networking aspect has the potential to facilitate the interaction and emotional experience that can provide an incentive for learning.

The findings of this study suggest several areas for future research. While all students may be alienated by narrow views of authenticity that ignore students' interests, experiences, values, and language use, the alienation is particularly problematic for students from non-dominant backgrounds (cf. Barton and Yang 2000; Moore 2007; Parsons 2003). In this exploratory study, the high school was located in a suburban area. In 2000, the township's residents were 86.0% non-Hispanic white, 7.7% Hispanic or Latino, 3.1% black or African American, 0.2% Native American, 1.9% Asian, 0.1% Native Hawaiian, and 1.8% multiracial. Around 33% of the students qualify for free lunch. Students in this district may be more likely to see science as "for them" than students in districts with fewer resources and/or students who come from non-dominant groups. An area for future research would be the ways in which digital storytelling and social networking could be used to support co-constructed authenticity and student-centred science for students from non-dominant backgrounds. In addition, research could investigate whether the hybrid presentation practices and the social learning that technology can afford could be applied towards making college-level science more inclusive.

Future studies could also investigate the processes and outcomes of involving high school students to a greater degree in collaborations. In this particular study, the college students conducted the research, created digital stories, and blogged on a social networking site, while the high school students observed, questioned, and participated when they visited the university. The behavioural neuroscience course was recently revised again to increase the involvement of high school students by scheduling more visits, allowing time for the high school students to interview the college students, and having the high school students develop their own video projects focused on the collaboration. Future studies could investigate the outcomes of this structure, as well as explore others and their implications for co-constructed authenticity. For example, one possible approach could be a longer-term partnership in which the high school students learn from the university students, but the university students also learn from high school students who develop and document their own science research project that stems from community concerns. In this type of partnership, there may be more opportunities for the co-construction of authenticity because of the possibilities for mutual learning. Overall, future studies could explore the impact of different approaches to high school students' involvement in K-20 partnerships involving digital storytelling and social networking, and the implications for perceptions of authenticity in science.

In addition, research could be conducted to explore whether emotional engagement and sense of membership are possible if a collaboration is entirely technology-mediated, rather than combined with in-person visits. In this study, the high school students' experiences of being present at the surgery, watching in anticipation, and collectively responding when the surgery was successful had all of the elements of a successful interaction ritual characterized by mutual focus and rhythmic entrainment. These types of collective experiences can lead to emotional investment in the symbols and a sense of membership (Collins 2004). However, it is unknown whether without these visits, the interactions between the high school and college students on the social networking site would have been sufficient for building a sense of community. If the emotional engagement that contributes to a sense of shared purpose and incentive for learning could emerge in online interactions, such collaborations could be particularly beneficial for high schools that are not located near universities.

There have been calls to reform undergraduate science education to include more student-directed research, partly because it better approximates science as practiced by scientists. This study suggests that it is important to consider that authenticity emerges from context and the actions of all participants, and therefore, replicating science as practiced by professional scientists needs to be one among many other approaches to increase authenticity within a college science classroom. For these college students, formal presentations that simulated professional science communities were less authentic than the hybrid practices that tapped into methods of communication in which many students already participated.

Overall, this study suggests that authenticity is not just tied to knowledge of science, but is also tied to a sense of purpose. For college classrooms to be more authentic, they not only have to enable students to develop skills such as the ability to conduct original research, but they also need to be structured in ways that allow students to find meaning beyond achieving high grades. The outcomes of this study show the possibilities of employing digital storytelling and social networking to enhance the accessibility of research to different audiences, the perceived relevance of the research, and therefore the incentive for being and becoming scientists.

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