THE POWER OF DIGITAL STORYTELLING TO COMMUNICATE COMPLEX STEM INFORMATION ACROSS CULTURES

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The growing internationality of science and technology suggests the need to teach STEM students to communicate successfully across intercultural environments. This article argues that digital storytelling, which combines visuals and narrative to convey a message through story, can be a useful tool to do that. That health and other industries have already adopted this communication tool is further evidence of its potential for usefulness to STEM professional writing students. After defining digital storytelling, this article presents an analysis of the value of narrative (story) in professional communication and also specifically in communicating the complex information of STEM. It also examines the role of narrative in intercultural communication, connecting the multimodal form of digital storytelling to the multifaceted construct that is "culture." This article further analyzes visual communication and the role visuals play in successful digital storytelling. Finally, the article provides two examples of the use of digital storytelling in the classroom.

Keywords. Intercultural, STEM, Professional writing**,** Digital storytelling.

The Story

(Coyne, 2013)

We know this story. It is one of action and intensity. We see the swiftness of the chase—the mouse's ears and tongue blown back, the cat's claw extended. We feel the terror of the surging mouse; catch determination in the eye of the cat. The story is full of suspense, too. We don't know how it will end.
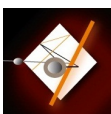
This image speaks to not only the power of a picture to tell a story but also why understanding science and technology across cultures is important. It is a classic illustration of the dynamics of ecosystems, significant today as international environmental agreements around the globe are threatened. It illustrates nature's food chain and the innate proclivity of living things to survive. Here, too, is a story not only of survival of the fittest among animals, but also a metaphor of the race among humans (cultures and nations) for dominance as well as survival. It illustrates attempts at dominance in the animal kingdom (again, we don't know how the story will end), suggestive of hegemonies and dominant cultures within human society that influence intercultural communication. Significantly, the image demonstrates the ability of a message to be told through a picture that can be understood across multiple cultures. While it may be "read" in different ways, the concept can be interculturally comprehendible. The digital story, incorporating images such as this one along with language, sound and video, holds promise for creating understanding of science and technology (STEM) across multiple cultures so important in our 21st century.

Introduction

Storytelling has been used throughout the ages and across cultures to help make sense of our worlds and their workings. It has included pictures (such as ancient cave drawings) as well as sound (such as Native American dance ceremonies). Digital storytelling also is not new. It began in Berkeley, California in the late 1980s with the Center for Digital Storytelling established by Joe Lambert and the late Dana Atchley. This narrative concept has been described as "combining the art of telling stories with a variety of digital multimedia, such as images, audio, and video" (Robin, n.d). It uses the technology tools of our digital age, particularly the use-and-share tools of Web 2.0 (social media, such as Flickr, Pinterest, Reddit and others), and can utilize such authoring tools as Microsoft's Photo Story 3, Apple's iMovie and PowerPoint. With that, often all that is necessary to create a digital story is a digital camera or smart phone, some audio tools and the Internet, thus it is easily accomplished with limited technology. Digital storytelling has

been used in schools to teach everything from history to math to writing, and it is now being embraced by business and industry.

Digital stories have the capacity to simplify, amplify and explicate the topic at hand using multiple modalities (visuals, sound, and language). They appeal to the senses and can create effective rhetorical appeal. In particular, they present images and create metaphors (such as the cat and mouse picture) that can explain complex technical data or situations in comprehendible and meaningful ways. But these are just a couple of reasons why digital storytelling can be effective. It is clear that 21st century technical communication is a global enterprise. Teaching students about intercultural communication has been a facet of technical communication instruction for a number of years now, as can be seen in technical communication (TC) textbooks. Further, educators in the field recognize that STEM students need skills not only in technology, communication, collaboration, and writing but also in communication of highly technical data to diverse audiences across cultural divides. In order to equip student with these skills, technical communication instructors should consider all the ways they might teach communication in this environment.

This article addresses why and how digital storytelling can be an effective communication tool in STEM subjects, areas in which data is not only often complex, layered and hard to explain, but also more and more directed to intercultural audiences in the global fields of science and technology. It discusses the value of narrative in communication and the potential of digital storytelling to create compelling, persuasive narrative. It also discusses the value of visual communication, including visual narratives (such as the opening image of this article), and the ability of digital storytelling to utilize creative visuals, including infographics, to aid reader comprehension. The latter, which combine visuals with text, can be especially significant to intercultural communication because of the combined use of language and graphic (thus no reliance on either domain on its own to create understanding but rather a coming together of both to aid comprehension). This article shows how digital storytelling is a powerful technical communication experience through integration of narrative (story) and graphics, one that can prove especially significant to STEM education across intercultural

audiences. This pedagogical tool has the potential to enhance communication of technical content by helping TC students build skills in creativity, thinking in the abstract, visualization and intertextuality, all essential for intercultural communication. Two examples of how it has been used in the classroom are presented here as well. While more thorough field study of its application in professional communication needs to be done, this article presents a theoretical rationale for its potential for effectiveness in the classroom along with examples of practical application. Evidence of its use currently in business and technology fields further supports the need to consider implementing it in the classroom

Rationale for Digital Storytelling in STEM Communication

Researchers have discussed how this pedagogy can be a powerful learning tool in math and computer science teaching. Schiro (2004) has engaged digital storytelling in teaching algorithms and mathematics problems. We can all probably remember the "word problems" in elementary school math classes that told mini stories (if Jane has two apples and Tom has one orange, how much fruit do the two of them have?). With digital storytelling, math problems have a context, and from that can be made to be interesting and compelling. Papadimitrou (2003) has suggested that this pedagogy can be useful in teaching computer science to help make it more compelling. While there is still more research to be done, testimony is available as to its efficacy in the classroom.

In regard to professional communication in STEM industries, some businesses are already practicing digital storytelling. Notable is the Mayo Clinic's use of social media and storytelling to improve communication with patients. One instance involves Mayo's Chair of Dental Surgeries, Dr. Sreenivas Koka, who created a video for his patients in which he introduces himself (tells his story) and conveys information about the dental clinic (tells the "clinic's story"). His story gives a personal touch while telling what the patients can expect when they come in for treatment. The clinic is studying the effectiveness of the video in increasing efficacy of treatments and reducing anxiety (Justice, 2013). Meanwhile, the Clinic

has partnered with the Rochester Healthy Community Partnership (RHCP) and Storycenter to produce digital stories from Somali and Latinos members of the community in their own languages. The goal is to see if their culturally-focused personal stories about their healthcare can be an effective intervention for advancing both health literacy and health behavior among these populations in relation to type II diabetes (Paulos, 2015). The Clinic not only uses social media tools to communicate between its own patients and doctors, but also works with other hospitals and health care professionals to help them use social media to promote health education and literacy (Justice 2013). The Mayo Clinic Center for Social Media (MCCSM) provides tools and resources for digital communication, including storytelling. Mayo's Social Media Network includes 140 organizations and their staff. Notable here also is use of digital storytelling in journalism. As far back as 2012, *Forbes* was one of 30 agencies using Narrative Science software to create stories. With this technology, narratives are created from data sources and can be customized for voice and style to fit the journal (Boog, 2012, Feb. 17).

One of the problems with communication within STEM fields is the disconnection between audience and writer partly due to the plethora of complex information to be conveyed. As we know, these audiences range from experts in the field to mildly knowledgeable board members to lay people. This issue is also particularly telling when the audiences for such communication cross international as well as cultural divides, as in the case of the Somali and Latino patients at the Mayo Clinic. These are the additional issues beyond mere writing, designing and collaboration with which STEM professionals grapple. As such, the challenge for technical communication education is how to teach future scientists, engineers, technicians and professional writers in such fields to make the data they convey interesting, compelling and comprehendible to their multicultural and multi-level audiences. Digital storytelling can play a part.

Digital Storytelling Defined

Digital storytelling is an amalgamation of narrative (story) with multimedia production. Like a written or orally delivered story, digital stories focus on a topic

and emanate from a particular point of view (About Digital Storytelling, 2013). Like all stories, through a series of events generally conveyed through "characters" (human or non-human, such as a cell or electron for example), a digital story unfolds that impacts the audience, persuading them to believe, accept or do something. Digital stories also make use of images to help tell the story and employ digital devices, including Web 2.0 tools, to add compelling components such as sound, music, enhanced photos and video.

The Center for Digital Storytelling established seven major elements of the digital story (Scandola & Fiornini, 2012):

1. Point of view – the author's stance

2. A dramatic question – the unknown that holds the audience's attention

3. Emotional content – issues that connect to the audience in a personal way

4. Voice – the author's voice personalizes the concept and explains context

5. Sound – music and sound embellish the story

6. Economy – just enough information conveyed to hold the audience's attention, create meaning

7. Pacing – the story has a rhythm and moves at a pace that creates that rhythm

These elements are intimately bound to rhetorical theory and Aristotelian concepts of logos (sufficient information), pathos (emotional appeal) and ethos (having a point, answering a question, and being believable). The narrator's voice and its pacing of the events and information embody the tradition of storytelling. With digital storytelling, music, images and video can also be embedded into the story line to create emotion, add interest or help make a point. The power of sound, voice and graphic art connect to video and film production and are a significant part of digital storytelling.

Digital storytelling also has a democratizing effect in communication of information in that it can be used by anyone who has access to basic technologies

and the Internet. It can enhance communication at the local as well as global level, which is significant to intercultural communication where the local and the global often intersect (see upcoming section on intercultural communication). The University of Houston (About Digital Storytelling, 2013), where extensive research has been done on this concept, notes that "digital storytelling is being practiced in neighborhood community centers, schools, libraries and businesses, by novice technology users and those with advanced skills." One example provided by Swartz (2013) below is a digital storytelling initiative by Mass Mentoring Partnership (MMP). Figure 1 (p. 8) shows MMP's advertisement before they worked on crafting a story for their message.

This information piece is data heavy and difficult as well as time-consuming to read through. While the agency is justified in trying to educate its audience about its purpose and goals, the audience is lost in the plethora of text. Figure 2 (p. 9) shows the advertisement revised as a story with appealing graphics and, significantly, with a personal story about a real person whom the agency has helped.

Figure 2 illustrates a story that is intimate and personal. The visualization of Christina is a major part of that rhetoric. In the photo she looks directly out at her audience. Her eyes as well as her textual story create relationship with the viewer. In the testimonial the narrator speaks directly to the audience to tell the story of the character Christina. As Schwartz (2013) notes, crafting stories to convey information is about ensuring that listeners connect to your information because if they can do that then you are more likely to build rapport and trust. With that rapport and trust comes persuasion to get the audience to do what you request of them, whether it is simply understanding a complex idea, buying a product, or getting on board with a concept or process.

Figure 1

MMP's text-focused advertisement

More than
11,000 Massachusetts youth
drop out of high school
each year.[1]

United Way works to ensure that all youth graduate from high school with healthy options for the future.

THE CHALLENGE

More high school seniors drop out of school than any other grade level in Massachusetts, and 65 percent of them had already passed the MCAS.[2] The Massachusetts high school drop out rate is of critical concern, especially among lower-income communities. A student's reasons for leaving school can be complex, and include exposure to violence, poverty, teen pregnancy, and substance abuse.

More than 4,500 Massachusetts youth are waiting to be paired with a mentor.[1] When at-risk youth have access to a supportive adult and engaging after-school opportunities, they are less likely to engage in risky behavior, and are more likely to stay in school.

THE UNITED WAY SOLUTION

United Way has the unique ability to connect the efforts of parents, schools, and out-of-school staff to address gaps in youth service, and support innovative, engaging youth programming. Quality programs and nurturing relationships help school age youth successfully navigate the challenges of growing up, and help them reach their full potential.

Our goals:
• Increase the number of at-risk youth participating in quality out-of-school programs

Source: How Story Trumps Description: Non-profit Storytelling #9. Retrieved from http://gettingattention.org/2013/05/nonprofit-storytelling-9/

Figure 2

Narrative description with graphics

Source: How Story Trumps Description: Non-profit Storytelling #9. Retrieved on Sept. 1, 2013, from http://gettingattention.org/2013/05/nonprofit-storytelling-9/

The Value of Narrative (Story) in Professional Communication

History tells us that people relate to story. From the petroglyphs to parables, stories and visual narratives communicate ideas across time to create learning and understanding. It is a powerful communication tool and has been deemed one of the fundamental ways humans think (Schank & Abelson, 1995). Story is the place where understanding is created explicitly through a subjective voice. As such, it

has particular significance to professional communication as a subjective conveyance of information.

Blyer's (1996) study of ethnographies, through a postmodern lens, can help us understand the value of subjective storytelling in professional communication. What she found in her study were the many voices that ethnographies contain (both the scientist and the subject(s) observed), suggesting that a text is a multi-voiced discursive lending itself to story. The narrator/author of ethnographies is always and already informed by the subject he or she is researching and writing about. Blyer's work thus serves to debunk the myth of objectivity in research and scientific reporting.

Her ideas impact professional communication if we think of scientific reports, data collections and the like as ethnographies of sorts, politically (and personally) situated in institutional discourses (i.e., laws, policies, cultural norms, scientific norms). Blyer suggests that narratives be created that connect the researcher/writer with the co-narrators within the subject area to create cohesion and a place (narrative space) for understanding rather than creating binary systems of power (the writer who knows and the audience who doesn't know). Looking back at the opening image of this article, we see co-narrators, the cat and mouse. Whose story is it? Clearly the narration is multiplicitous. It is the mouse's story of terror and attempts to escape a threat. It is also the cat's story of the hunt and pursuit. Finally, it is the reader's story as she or he situates herself or himself in various narrative relationships with either the poor little mouse or with the natural predator cat or perhaps with both at the same time. What comes to mind in intercultural STEM communications is the collaborative narrative of the professional writer and translator working together to stitch understanding across cultural broadcloths from the text of a research report, proposal or set of instructions.

Global communication in STEM industries and research is just such an area in which a multifaceted, collaborative communication effort is needed in order to create understanding and rhetorical appeal across cultural divides. International STEM communication must consider the scientist, her or his subjects, the cultural circumstances of the subjects and the research agenda

(including the time, place and purpose), the professional (co)writer, the translator, and the audiences as well as other entities such as owners, investors, costs and restrictions. The professional writer must draw together the distinctly subjective voices of these participants in order to create a message that clearly communicates the scientific research across cultural boundaries. The communication must also create compelling rhetoric to be effective. Telling a data-rich story with rhetorical appeal, as in the case of Christina's story in Figure 2, can be done. One model can be gleaned from journalists, particularly embedded war journalists, who create understanding and appeal in international communication through language (including audio of the native language of the subjects involved), candid images (including shots of landscapes and cultural iconographies) and sound (what more effective narrative of war than sounds of machine guns and mortar).

The rhetorical value of digital storytelling, as it is applied to data-heavy fields of science and industry, is explained by Stikeleather (2013). He shows how one can tell a story with data to help the audience gain insight. He notes that adding effective visualizations to the narrative can not only express complex ideas with clarity and simplicity but also is "a dynamic form of persuasion." Stikeleather (2013) reveals how storytelling with visualization utilizes the same techniques that journalists use to tell a story. These include:

- *Create a compelling narrative.* In competing for the audience's attention and time, the narrative must have "a hook, momentum, or a captivating purpose."

- *Consider the audience.* As rhetorical theory teaches, the writer must first and foremost consider what his or her audience knows, needs to know, and is capable of understanding. Consideration of the needs of the novice, managerial, expert and executive audience has relevance for any digital story.

- *Be objective and balanced.* Here "objectivity" combined with "balanced" suggests being unbiased in one's presentation. Being consistent in presentation and using standard and acceptable measures help maintain an ethical and balanced presentation of information.

- *Don't censor*. When choosing what information to put in and what to leave out, being careful not to censor what you do not particularly want known is important. For example, in presenting data on a clinical drug trial, it is essential that the communicator not leave out any data that suggests problems with the drug. People's lives depend on this openness and accuracy.

- *Edit thoroughly*. As with all communication, the editing process is the place where clarity, accuracy and effectiveness are checked and confirmed.

The Value of Narrative (Story) in Communicating Science and Technology

Narrative seems naturally in sync with science. A scientific experiment includes agents reacting together over time to create effects, all "narrated" by the scientist and communicated by the science writer. In the same way, narrative by definition includes agents, events that happen over time to produce an outcome(s), a narrator and agency. Avraamidou and Osborne (2009) reviewed the literature on the forms of scientific texts and found these four: expository, argumentative, narrative, and a mix of narrative and expository (p. 1685). Of these they found that the "most common in everyday discourse is narrative, not expository" (p. 1686). Citing Ogborn, Kress, Martins and McGillicuddy (1996), they concur that scientific explanations mirror the construct of story in creating a cast of characters who engage in actions that produce consequences (p. 1691). They further cite Williams (2000) who stated that narrative text is easier for audiences to understand than expository text, which is supported by other researchers as well according to Avraamidou and Osborne (p. 1694).

Avraamidou and Osborne (2009) found pedagogical purpose in teaching science through narrative. So too did Dahlstrom (2014) a few years later, citing research that suggests that audiences find science narratives easier to understand and more engaging than traditional logical-scientific texts (p. 13614). Science narratives, he found, lend themselves to better recall of information and shorter

reading times (p. 13615). Health communication, he also notes, is an area investigating the value of narrative (see earlier discussion of the Mayo Clinic initiatives). Indeed, Green's (2006) research on narratives and cancer communication found engaging stories especially effective in relating cancer information for these reasons: reduces counterarguments (which helps patients overcome resistance to treatment), helps mental stimulation to deal with the unknown and unfamiliar, and provides role models for changing behaviors and facilitating strong attitudes based on both cognition and emotion (p. S163).

A direct study of the effect of health narratives vs. health statistics on audience reveals supporting results. Betsch, Ulshofer, Renkewitz and Betsch (2011) conducted research on communication of health information, specifically, communication of the potential for adverse events from vaccination. They compared communication of these risks through narrative discourse versus communication of the risks through statistical data. They measured perception of perceived risk according to frequency of narratives posted on a "constructed" internet bulletin board. Thus the two modes of adverse event information delivery were: 1) firsthand, experiential stories with details about adverse events related to a particular vaccine and 2) statistical information about the same adverse events. Their study showed that "a greater relative number of narratives reporting the occurrence of adverse events raised the perception of vaccination risk" and "had a stronger influence on perceived risk than the statistical information" (p. 9). Although they noted that statistical data was not ignored, the researchers concluded that "the relative amount of narratives reporting adverse events is the critical variable affecting risk judgments (and as a consequence, intentions [to get vaccinated]" (p. 9). They further found that "highly emotional narratives had a greater impact on perceived risk" (p. 9). Pathos appears alive and well as a rhetorical appeal.

This is of course only one study, and there are risks and considerations in using solely narrative communications. As the study authors note, the fact that the more emotional narratives incited more perception of risk might be influenced by psychological factors in which "affect and emotions directly translate into risk judgments." (p. 9). In addition, the difficulty of deciphering data may be different

among ages and education levels of consumers and influence reliance on narrative. The researchers themselves suggest that future studies might assess whether greater understanding of statistical data impacts the influence of narrative. Another issue is that narratives can be embellished, manipulated, and carry many socio-cultural preconceptions and prejudices. Some consumers may distrust narratives that they believe come from unreliable sources and prefer data from what they deem "reliable" sources. The researchers note the limitations of their study and suggest that long-term effects of narrative be studied to continue to understand the usefulness of narrative in health science communication.

The Value of Narrative (Story) in Intercultural Communication

The multiplicitous form of digital storytelling, with various components such as story text, sound and video, concurs with the multivarious context of intercultural communication and thus could have potential as a salient mode of expression in intercultural communication. To argue this point, I address Hunsinger's (2006) critique of just what culture is and how it underpins intercultural technical communication. Hunsinger looked at how understanding of culture had been previously assessed from a heuristic and ethnographic approach. He noted, however, that working from strictly cultural heuristics and ethnographic descriptions of cultures can result in attempts to locate a definitive culture. This approach, he says, can ultimately lead to technical communications that focus on cultural "representations" rather than realities (p. 32). Such an approach oversimplifies and essentializes, says Hunsinger (p. 35), and effectively elicits stereotyping. Significantly, he notes "the heuristic approach [to culture and cultural identity] encourages cultural identity to be represented as effectively autonomous, independent of economic, political, and historical contexts" (p. 38). Following the theories of Appadurai, Hunsinger contends that culture is always and already a part of the manifestations of a region's economics, politics and history and cannot be reduced to a single representation. Thus "cultural" is writ large with intertextualities rooted in economics, politics, religion and such.

Further, according to Hunsinger crediting Appadurai, today's culture is affected by intensive media (e.g., immediately transferred cell phone photos of political and civil disturbance, Instagram, Twitter and other social-turned-quasi-professional media), as well as transnational migration (made more impactful in the moment by mass migrations from some Middle Eastern countries into Europe). As such, culture is impacted by imagination and creativity of many people as they both physically cross borders to settle and also as they digitally cross borders through the exchange of cell phone photos, instagrams, videos and through traditional news media. "Culture" becomes a construct affected by all of these things and manipulated artistically and digitally. Such an amalgamous nature of culture concurs with the multiplicities inherent in the communication form that is digital storytelling, that is, the digital narrative as text, visuals, colors, music, voice, even silence. In this way, digital storytelling seems a fitting form for the content and context of intercultural communication in this century.

Use of languages also impacts intercultural communication. Today, English as the "international" language is problematized. Block (2004) noted in his assessment of transnational communication that "even within the borders of nation-states where English is the official language, the Internet is not an exclusively English mediated phenomenon (p. 14). Rather, he sees the Internet, the highway of intercultural communication, as the place where more and more local languages and cultural practices take place. In his study a full 12 years ago, he saw a strengthening of Spanish language on the Internet. With the Hispanic population growth rate higher today in the U.S. than for other ethnic groups, we can likely see increases in Spanish on the Internet.

Iconic visuals have been used to facilitate intercultural communication for a good while. We are all familiar with symbols such as those for women's and men's restrooms and the no smoking visual found in airlines internationally. Of course not all visuals are themselves international or intercultural in scope and usage. An image in one culture can mean something different in another. It has been noted for example that the owl in U.S. culture can mean wisdom while in South American cultures it might represent death or witchcraft. Additionally, color, so important in visuals, also has varying meaning across cultures. Because of

these concerns with images and color in international communication, digital storytelling's ability to combine language with visuals and sound can help facilitate communication as it provides multiple platforms for comprehension. For example, in a digital story, an image that might be construed in multiple ways can be accompanied by a written text in the audience's native language to provide clarity. As Block (2004) above notes, the use of local languages is taking place more and more in intercultural communication across the Internet. Further, sounds such as music, can be added to the digital story to influence the tone of the message particularly if that message contains images or colors that could possibly be adversely interpreted by the intended audience.

Digital Storytelling as Narrative Tool in STEM Communication Pedagogy

Digital storytelling continues the practice of storytelling with not only multiple genres of communication but also the addition of digitally developed and enhanced components. It is a tool that STEM scientists and communicators, who deal with large amounts of complex information in particular, can find useful because creating story requires the writer to pay attention to the information at hand and manipulate it effectively for the audience. As Coyne (2013) notes, storytelling is all about information; creating story helps "master the way you parcel out information in your work." Crafting a story is about choosing what information to put in and what to leave out. In that way the writer is able to manipulate the relationship between herself or himself, the message and the audience. This is an important skill for STEM subject communicators, who must choose from a plethora of often-complex data only that information which is pertinent to convey to a particular audience. Further, story gives the writer the ability to surprise the audience, to entertain, to tantalize and to create suspense, drama and interest. In communicating complex science to the lay as well as to the expert audience, writers need all of these attributes.

It has been shown that digital storytelling has value for 21st century pedagogy (Robin, 2008; Barrett; 2005; Scandola and Fiorini, 2012; Sadik, 2008).

It integrates technology into the age-old communication motif of storytelling and in that way continues the adaptation of storytelling to successive media (radio, television, internet) across time (Scandola & Fiorini, 2012). It has particular value to the pedagogy of communication (Barrett, 2005; Robin, nd; Sadik, 2008) and is pertinent as a technology tool of the 21st century communication classroom. Because digital storytelling employs readily available, and often free, use-and-share tools of social media, it gives students practice with technology to research and compose content; edit text, graphics, video and sound; as well as share their work with wider audiences than just their peers in the classroom. Working in this digital space enables students to build communities across cultural, language and physical divides. Technology is embedded in digital storytelling in all phases of the production/learning process.

Many of our students are already casual technical communicators on their Facebook pages, Snapchat, Pinterest, YouTube and other social media sites. Using digital storytelling in the classroom can help students apply those kinds of production methods to their coursework in a more professional way. In fact, as they work to produce information artifacts they are practicing many literacy skills that are especially important to professional communication. Robin (n.d.) describes some of these skills.

- Research – gathering and analyzing relevant information (i.e., being selective)

- Writing – creating a point of view and writing the script

- Organization – managing the materials and the time-to-task

- Technology – learning to use the digital tools needed to create the story

- Presentation – considering audience and presenting the story effectively

- Interview- gathering information from sources through conversations with others

- Interpersonal skills – working within a group and negotiating roles

- Problem-solving skills – making decisions and working through obstacles

- Assessment – editing and critiquing one's own work and that of others

Practicing all of these skills is particularly significant for STEM students. While the technology skills may come easy, the writing, interview, organization and presentation skills may not. Indeed, working to solve problems, researching the most accurate and current data, and developing interpersonal skills that involve nuanced cultures, languages, and ways of knowing, while necessary in all disciplines, are crucial for STEM communicators working more and more in global contexts.

Barrett (2005) finds digital storytelling a "tool for deep learning," suggesting its implications for complex studies in the sciences. She illustrates the convergence of four student learning strategies that digital storytelling enables (see Figure 3, p. 19).

Engagement is a major component of digital storytelling, as shown in Figure 3, and a crucial skill for STEM communicators who practice within international teams in many science and technology industries. In a digital storytelling project, students can work together to create a product of their learning; they are not passive or solitary receivers of information. Second, students not only embrace and utilize technology, but also make it a part of the learning product itself. That is, they don't just *use* the computer and technologies to put the story together, but rather the technology *is* the story. The video, the graphics, the music are all part of the product that comprises the story. Third, the project-based aspect of this pedagogy means that students must work with others to make the story happen. They must learn to work out the complexities that arise from teamwork. This is a valuable skill for scientists and engineers who must work with others to make the experiment come together or the building come to fruition. Fourth, this pedagogy enables reflection that is the hallmark of deep learning. Once the story is composed there must be reflection on its usage, on its contribution to the field of study. Finally there is the presentation (not noted on

Figure 3

Four student-centered learning features of digital storytelling

the diagram above), which returns full circle to student engagement, only this time it involves engagement with others outside of the production process. Presentation requires the students to become deeply invested in what they have created and learned and to present it knowledgeably to others.

Additionally, this pedagogy addresses multiple learning styles. Visual learners have a high stake in digital storytelling because of the dominance of graphics in telling the story (more will be discussed on this in the upcoming section). Beyond that, creative learners benefit from the imaginative component involved in putting together a story. In fact, the creative aspect of digital storytelling (also not noted in Figure 3) is an important aspect of learning for STEM students who traffic in proofs and data but rely on creativity and imagination at the root of science.

The importance of learning to work as a team to create a knowledge product cannot be overstressed in STEM professional writing. As noted above, science is historically team driven and STEM communication follows suit in partnering scientists, writers and subjects. Digital storytelling contributes a valuable skill in this area linked to constructivist ideas about participation in learning. Nelson Spivey (1997), literacy pedagogist and scholar of intercultural dialogue, notes the constructivist idea that knowledge is built not passively received. Constructivist strategies play into project-based assignments such as digital storytelling because such assignments include hands-on production along with collaboration and cooperation. Further, the use of technology in experiential production of knowledge plays significantly into digital storytelling. Sadik (2008) cites the work of Jonassen and Carr (2000); they believe that students can be actively involved in learning with the help of Information and Communication Technology (ICT) tools. Sadik (2008, p. 487) reports on a study done in Egypt on the use of digital storytelling to assist teachers in developing teaching and learning through application of digital technology. Despite some ups and down with the technology, the consensus of the teachers was that digital storytelling projects "could increase students' understanding of curricular content" and that they "were willing to transform their pedagogy and curriculum to include digital storytelling."

Visuals and Narrative in Storytelling

In 1986, a 3M-sponsored study at the University of Minnesota School of Management found that presenters who use visual aids are 43% more effective in persuading audience members to take a desired course of action than presenters who do not use visuals (Hanke, 1998). Graphic communication is more ubiquitous than ever before because research has shown that graphics do what text alone cannot do. They affect us both cognitively and emotionally. Pictures can enhance or affect emotions and attitudes (Levie & Lentz, 1982), engage our imagination and heighten creative thinking by stimulating certain areas of the brain (Bobrow & Norman, 1975, Rumelhart, 1980).

Because emotions influence decision-making, business communicators and marketers strive to find the right images to communicate or sell a product, service or idea. Getty Images is one company supplying images for business and industry and thus making it their business, literally, to discover what makes a powerful image. In its online publication Curve (2016), the company suggests four factors that affect that: 1) authenticity – audiences want to see real people in images 2) cultural relevancy – images that display what is really happening in the cultural moment, hence images of mixed race and gay couples are prevalent today 3) sensory currency – audiences' desire to see real human contact, hands-on activity and creativity, such as a craftsperson at work, and finally 4) classical story archetypes – audiences desire, still, to see images of archetypal heroes, caregivers (the latter, if serving cultural relevancy, might be fathering instead of mothering for instance) (Curve 2016).

Pimenta and Poovaiah (2010) discuss the power of the visual narrative (VN), which they define as visuals that tell stories (formerly also called visual storytelling). The term as they define it encompasses narrative art (e.g., sculpture, painted artifacts), films, pictorial stories, illustrated stories, comics, animation, history painting and others (p. 25). I would add that "before and after" pictures also create a visual narrative. For example, Figure 4 shows two visuals that were part of a digital story created by students in one of my professional writing classes

Figure 4

Dolly Before, Dolly After

Source: Humane Society of Monroe

for their community writing project for the local Humane Society animal shelter. They presented an image of a distressed animal, Dolly, when she first arrived at the shelter and another visual after she had been cared for at the shelter. Both factual and emotional content is carried by the visual while the textual narrative adds context, clarity and purpose.

Pimenta and Poovaiah (2010) note that what is distinctive about VN "is the presence of a story" (p. 29). Thus VN includes something, which is seen (an image), a series of events linked to produce an outcome (story movement) and a signified narrative (an act of telling, a narration) (p.30). A VN can have several functions, they assert (p. 33). For example, it can explain how an event took (or takes) place. In science and industry communication, such a visual might be effective in explaining a scientific process or a business procedure. The authors note that VNs can also show what a company looks like using pictures of the people who comprise the company story. It is not uncommon today for company websites to feature photos of employees and particularly company executives. A VN, say Pimenta and Poovaiah, can also show in visual form a historical process. One might find such a visual portraying the history of destruction caused by

cancer cells from Stage I through Stage 4. Or it may convey a visual social message. The visual narrative of Dolly in Figure 4 is one such example.

Pimenta and Poovaiah (2010) categorize visual narratives into three categories: 1) static narratives, in which the visual is fixed but the viewer's eye moves across the static images (Figure 4 is one example) 2) dynamic visual narratives, in which images constantly change and the story unfolds through the changing images (a film is one example) and 3) interactive visual narratives, which involve interaction with the viewer. The later, begun with invention of virtual space and the tools to navigate it, is significant in that it allows the viewer to control and participate in the action of the narrative. The interactive book 'Alice in Wonderland for the iPad' is one example they cite (pp. 35-41). The interactive visual narrative in particular holds promise for effective communication using digital storytelling for the level of technology that it can provide to digitally create communications with which the audience can actually engage, somewhat control, and enter into on a personal level.

Pimenta (2012) noted on the blog thevisualnarratologist that "visual narratives are a universally occurring phenomenon. They exist across media, history, genre and culture." While this may be true, visual narratives are read and understood differently, if at all, by different cultures. Pimenta notes herself that a non-Hindu may not understand the story behind a Hindu sculpture or image. Thus images alone, even visual narratives that seem to evoke a clear narrative story, will not necessarily be understood in the same way across cultures. Even the opening image of this article, which clearly conveys "the hunt" may not be interpreted or appreciated in the same way by all audiences. For example, Tucker (2016) reports on the troubles for ecologists produced by the common housecat on an island off the coast of Florida where domestic cats are killing off an endangered wood rat found on the island. Brumberger (2014) notes in her evaluation of intercultural visual communication that the idea of the visual as a universal language, while still common, is problematic and that a "one size fits all model is no more appropriate for visual communication than it is for verbal communication" (p. 91). Brumberger's assessment of a framework for understanding and creating intercultural visual communication, drawn from her

research of current theory and practice, includes a call for consideration of all the factors that affect visual communication design including not just the cultural, but also organizational standards and guidelines as well as accessibility and restrictions of technology on the part of the audience. She calls for more research, particularly in the area of user behavior, such as eye-tracking, to get a better idea of how visuals are received and read by various audiences. In light of the limitations of visual narrative for intercultural communication, one type of VN, the infographic, may offer more opportunities for intercultural communication.

Infographics

Infographics are defined simply as an "information-filled graphic." They are themselves a visual narrative that often includes language (text) along with the visual. They may hold promise for more effective visual communication through their ability to merge text and visual to convey a message. In an infographic, neither the text nor the visual alone bears the burden of conveying the message, but rather both work in tandem to create meaning and effect communication. With the technologies inherent in digital storytelling, infographics can be an important part of telling the digital story. Writes Caplan (2013), "[c]ommunicating effectively in our era of information overload means moving beyond static words and numbers. Images and graphics carry meaning in a way that cuts through verbal clutter."

It is this combination of graphics and words typical of the infographic that has a communicative power neither genre possesses on its own. Writes Levin (1989), "[p]ictures interact with text to produce levels of comprehension and memory that can exceed what is produced by text alone." And because humans are visually inclined, infographics can be effective in communication: "[t]hey help us see information in new ways, which gives us greater insight for understanding and problem solving" (*Infoposters*). "In an infographic, a mark, a symbol or visual element typically stands for quantitative information…Infographics use text as labels and short explanations to make the data useful. A viewer doesn't read an

abstract infographic, as much as study, analyze and explore it" (*Infoposters*). Their goal is to communicate information in a reader-friendly, engaging way.

As shown earlier in Figures 1 and 2, the difference between communicating a story with words only and communicating that same story with images and words is profound. Perhaps Figure 4, the "before" and "after" text and images of Dolly, shows most clearly the power of an infographic. Significantly, there "is no threshold at which something 'becomes' an infographic. It can be as simple as a road sign of a man with a shovel that lets you know there is construction ahead" (Lankow, Ritchie & Crooks, 2012, p. 20). Infographics can contain text and pictures, just pictures, or text that looks like graphics (e.g. Word Art). While the goal of infographics—to deliver information via visual cues—is not new, the

Figure 5

Infographic

Source: Wellness Media

current technology, design and use in online marketing specifically have carved new territory.

Use of the infographic in the health care industry is shown in Figure 5. The focal visual is the moving body depicted as water itself. Facts are included, but they are minimal. The color of the visual, blue, is appropriate to the subject matter – water. Color supports the message. The text is simple and minimal and the word "water" is repeated four times. The main message, drink more water, covers the top of the infographic. This infographic brings health information to light in a potentially more interesting way than mere statistics or charts alone can. Significantly, it shows the relationship between data and a human being. The study by Betsch, Ulshofer, Renkewitz and Betsch (2011) discussed earlier in this article suggests that audiences look for relationship in communication of data.

An infographic need only accommodate these three aspects to achieve the desired result – to meaningfully and efficiently inform (Roy, n.d.):

1. Visual—Color Coding, Graphics, Reference Icons

2. Content—Time Frames, Statistics, References

3. Knowledge—Facts, Deductions

The statistics, facts, deductions and graphics noted here are all elements common to science communication. Indeed, the scientific poster is an infographic (see Figure 6, p. 27).

Infographics can be formatted to include less language and more graphics depending on the needs of the audience (see Figure 7, p. 28). Additionally, infographics could include text in multiple languages as audience needs dictate.
Teaching students how to create these scientific and other technology industry infographics should be a part of technical communication for STEM students. Instructing students in cultural differences in reader relationship to specific images as well as interpretation of texts must also be a part of the pedagogy. Following are two examples of how a colleague and I incorporated digital storytelling into our technical communication classes for our domestic and international science students.
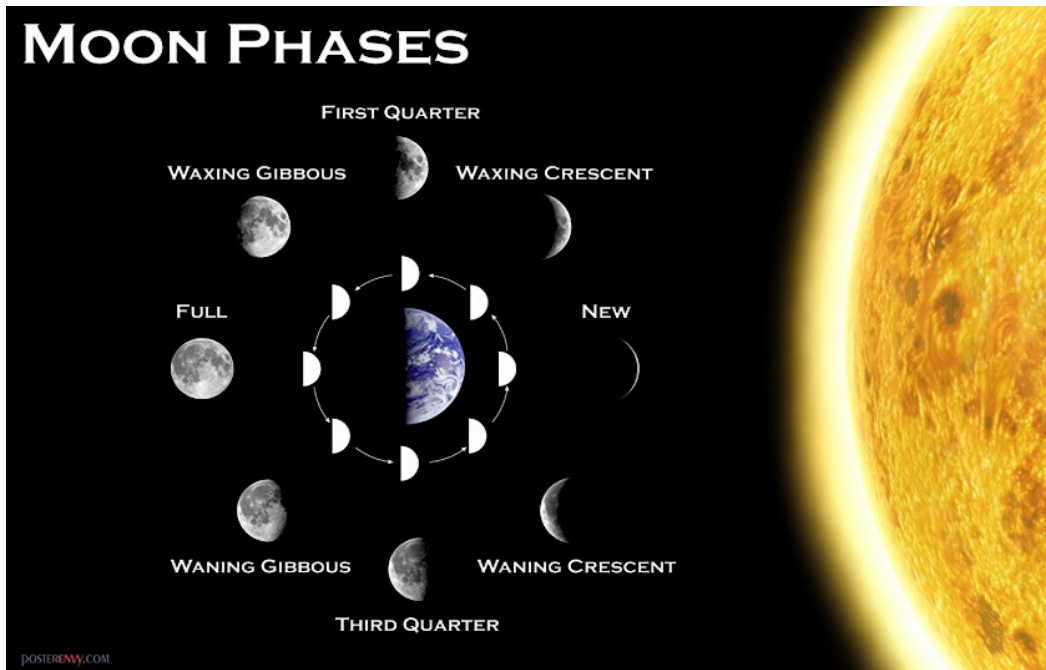
Figure 6

Polar Bears in Peril

Retrieved from https://www.pinterest.com/pin/168814686011506928/
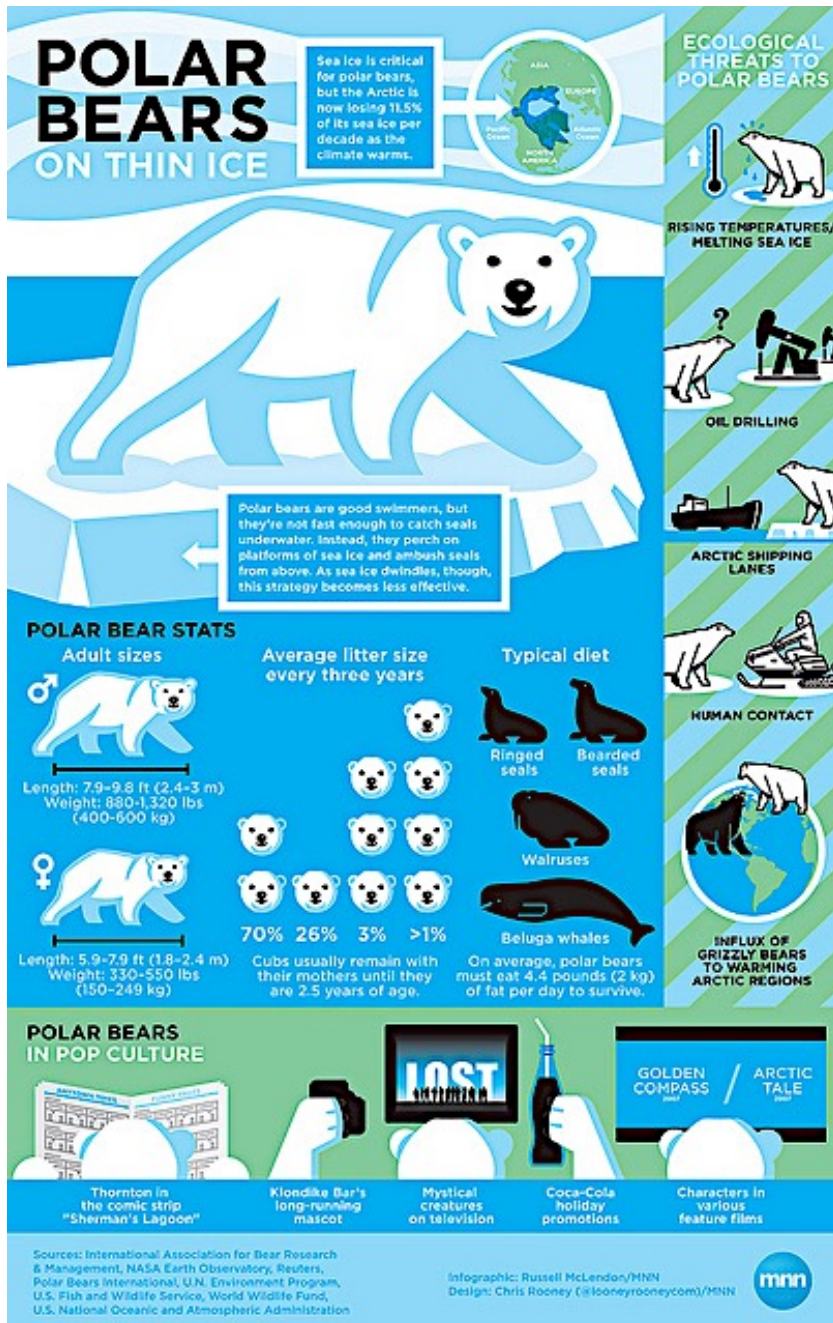
Figure 7

Moon Phases

Source: https://www.amazon.com/Moon-Phases-Classroom-Science-Poster/dp/B0088RLL28

Strategies for Teaching Digital Storytelling with Infographics in STEM Writing Courses

Background

Digital storytelling became a part of my and my colleague's teaching in introductory professional writing courses at our university a few years ago. Our particular professional writing program served a predominantly science- and technology-based group of majors, including biology, pharmacy, health studies, computer science, criminal justice and social work. Approximately six to eight predominantly major-specific sections of professional writing per semester were

devoted to these STEM majors (e.g., we offered sections for just pharmacy students and sections for just science and applied science majors). Social work students and liberal arts majors also had a section of professional writing designated just for them. These students worked with math and statistics (especially the social work majors) in their storytelling. The biology, pharmacy and computer science sections in particular often included international students or non-native English-speaking students from countries like Nepal, India, and Vietnam. We incorporated digital storytelling into assignments for which the base technology might already be familiar, such as PowerPoint, and for which the students might already have some familiarity, such as résumé writing. We wanted to spend less time on teaching genre and technology and more time on teaching digital narrative.

My colleague worked with digital storytelling in her introductory professional writing course for the health studies students, beginning with one of the most personally relevant documents that students produce in the course -- the résumé. My colleague transformed this assignment into a digital story assignment, including the creation of infographics. I transformed the PowerPoint assignment in my professional writing classes for the pharmacy and science majors, requiring that it be constructed as a digital story. The following discussion describes how we approached digital storytelling in these two assignments for our STEM students in these majors.

We began by providing a rationale for engaging digital storytelling in their coursework, noting that:

- Storytelling is central to human experience, as are the various genres and disciplines of art, which are, themselves, all different forms of storytelling.

- Education is changing to adapt to shifts in culture and technology.

- Competition is changing internationally.

- The workplace, jobs, and skill demands are changing, and have led to widespread adoption of digital storytelling in many fields.

We then explained the participatory culture that is part and parcel of Web 2.0 tools, thus introducing our students to the constructivist approach to learning (group learning that creates knowledge organically rather than hegemonically) using technology. Working in groups facilitated intercultural exchange as well. Although they had different backgrounds, many were already comfortable with Web 2.0 tools and the create-and-share culture of Web 2.0, thus technology brought them together. We explained that:

- Participatory culture shifts the focus of literacy from one of individual expression to community involvement. We emphasized the importance of global community involvement.

- New literacies involve social skills developed through collaboration and networking. Once again, we encouraged broadening their view of networking to include international exchange.

- New literacy skills build on the foundation of traditional literacy -- research, technical, and critical analysis skills still taught in the classroom.

The Digital Story Résumé

My colleague highlighted the changing nature of résumé writing and emphasized the need for students to have a presence on LinkedIn.com (a completed LinkedIn profile was required for the assignment). Before creating their digital story résumés, students first constructed a traditional résumé and cover letter. We wanted them to discover the drawbacks, limitations as well as advantages of both formats. Students had the opportunity to apply the theoretical knowledge of digital storytelling when critiquing traditional résumés. Interesting class discussions resulted from analyzing under what conditions a "story résumé" should be sent, including which employers might welcome them and which might reject them out of hand (applying lessons about audience analysis from earlier in the semester). Students were reminded of the lessons learned about reader engagement, story, and the importance of visual effect. They were shown that a

résumé, regardless of the medium in which it appears, shows potential employers how and why an applicant can meet specific job requirements; the document itself is a message (a story if you will) revealing an applicant's ability to communicate facts and information about herself/himself.

Plenty of examples of digital story resumes were provided including:

- 9 Dynamic Digital Résumés That Stand Out From the Crowd

- 10 Creative Social Media Résumés To Learn From

- Examples on Pinterest

- Examples on Scoop.it

Students were also asked to find examples of digital storytelling on their own and encouraged to explore the kind of digital storytelling they were already doing on their personal social web pages. Some took data from their Facebook pages to transform into professional presentation on their LinkedIn pages.

Students were put in diverse groups and asked to think about:

- How social media has evolved to become a highly visual and auditory medium and how to find examples (YouTube was recognized as an "international" venue for posting digital stories; examples were critiqued for differing cultural interpretation)

- What stories they would like to tell and/or hear about in their majors and how they would go about "visualizing" this story to a lay audience, to an expert audience, and to one composed of multicultural individuals

- How to find useful websites that show examples of digital storytelling

- How to find and curate digital stories and infographics associated with their majors

The story résumé allowed students to flex their creative muscles, learn about new platforms and applications, apply basic design principles, and develop a personal brand appreciation. We wanted to introduce our STEM students to the wider

applications available to them in the social media environment. One of the elements of the résumé assignment is the inclusion of social bookmarking tools. This technology offers knowledge sharing solutions and a social platform for interactions and discussions. Allowing a wide-ranging approach for completion lessened student apprehension about this assignment. Whenever possible, students completed this assignment in groups so that they could benefit from both peers who might have more experience in certain areas, such as video editing for example, and peers who might perceive things from a different cultural perspective.

The Digital Story with Infographics: PowerPoint Assignment

I taught digital storytelling using PowerPoint in my sections of introductory professional writing for science and applied science students as well as pharmacy majors. I began by presenting examples of what not to do. Googling "bad PowerPoint" resulted in a treasure trove of bad PowerPoints including some that were culturally insensitive. We also found examples of good PowerPoint presentations. The objectives for the assignment were simple: avoiding bad PowerPoint, using digital storytelling elements to communicate a given topic in an engaging manner, researching that topic thoroughly, being culturally aware of the message to intercultural audiences, and finally presenting the data in a reader-friendly fashion for a particular, named audience. Once again, audience analysis and narrative point were essential elements for the students to nail down in their story. Also included were study and practice of oral presentation itself, public speaking, and communication using visual aids.

Some of the specific expectations of the project were:

- Speak to the audience before launching the PPT and keep eye contact with the audience

- Create a narrative with images as much as possible and let the images tell the story, illustrating and dramatizing your points

- Put slide titles to work; they should help deliver the message, not merely name the slide

- Avoid bulleting data as much as possible

- Avoid delivering overly complex material for the first time via PowerPoint; that is best delivered in memo, report or discussion and can be elaborated on later

- Use a font style that is simple and large

- Remember that while content is very important (veracity, comprehendability) the PowerPoint will fall flat if you forget the one essential element -- the narrative/story. It is not enough to pull together 20 slides with cool images and text; the presentation must connect with the reader/viewer on an emotional level, draw the audience into the story.

- Find the" narrative hook" upon which to hang your story, one that will connect with your audience and keep them listening

- Think of your PPT as a little movie, one that has a beginning, a middle, and an end and leaves the audience thinking.

As with the résumé assignment, students researched and shared resources. Some very effective stories were created, including the one that featured the story of Dolly at the Humane Society shelter. I set up this assignment as a service-learning project, which engaged the students with community organizations. This component added an extra element of client and audience analysis. I also put the students into diverse work groups and asked them to discuss the intercultural implications of their choices of visuals, color, font style and presentation of material. But we went further, and I asked questions about interpretations of the story that might differ across cultures. We also viewed YouTube videos and discussed how certain images, sounds and story lines might be interpreted differently by different cultures. We looked for symbols of hegemony (where is the dominant cat chasing the little mouse?) in digital stories, both popular and

professional, and looked for cultural biases that might be implied. This exercise in intercultural interpretation was important particularly to the pharmacy students. We discussed the very international arena of drug manufacturing and dispensing, as well as the cultural implications of access to drugs, from over prescription of opioids among affluent white groups to access to birth control for certain groups of women to the imperative for inexpensive AIDS therapies for indigent populations.

How our STEM Students Responded

The students responded positively on their anonymous, end-of-semester course evaluations. What they appreciated most was the usefulness/applicability to both their academic work and their future careers. Several used the résumés created in their course to apply for and get jobs in their fields. They found the resources and the introduction of various new applications and platforms particularly useful for upcoming research. Many had never even thought of the questions concerning audience and culture that were raised in the class. Of course end-of-semester course evaluation forms provide only one generalized measure of student reaction. A more nuanced assessment is needed for future to more thoroughly evaluate the learning and reactions to this pedagogy.

Conclusion

While digital storytelling is not a panacea for all of the issues surrounding intercultural communication, it has the potential to be a useful tool in communicating across intercultural audiences. The multimedia effect of digital storytelling, merging a rhetorically moving narrative with impactful visuals, sounds, colors and creative components, brings together multiple approaches to create understanding through effective communication. It enables the story of the cat and mouse to be told and retold in different ways from different viewpoints. It holds promise for teaching STEM students how to communicate complex information in ways that can be effective across various cultures, especially with

the use of effective visuals, including infographics. Our students are already mostly savvy digital technologists. In order to help them succeed in the global STEM world they have inherited, professional communication pedagogy for intercultural audiences could be served by including instruction in digital storytelling so that students can perfect, professionalize and sensitize those skills. ■

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