Scaffolding Digital Literacies for Disciplinary Learning: Adolescents Collaboratively Composing Multimodal Science Fictions

Blaine E. Smith, Ji Shen

Integrating digital literacies in the classroom can create impactful opportunities for students to engage in disciplinary and collaborative inquiry. As researchers interested in exploring intersections between digital literacies and disciplinary learning (see Jiang, Shen, & Smith, 2016), we designed Project Imagine the Future (Project IF) to support middle school students in developing disciplinary expertise and identities while working with their peers to create multimodal science fictions. These products (see Figure 1) are sci-fi narratives—a literary genre that incorporates imaginative content including futuristic technology and scientific discoveries—constructed through multiple modes (text, visuals, sound, and animation) and digital formats (e.g., hyperlinked text, Scratch animations, Pixton comics, infographics).

Through a design-based approach (Cobb, Confrey, diSessa, Lehrer, & Schauble, 2003) that has included three iterations of Project IF—twice as an after-school program and recently as a sixth-grade elective course—we have continually refined our curriculum, which aligns with many of the key synergies between disciplinary and digital literacies (Manderino & Castek, 2016). Project IF, involves students in collaboratively creating digital sci-fis with multimedia that propose creative solutions for climate change. In the process, students engaged in disciplinary inquiry by taking on specific roles (e.g., scientist, designer, writer) and shared their work with multiple audiences.

This column details specific ways that Project IF introduces various scaffolds to support middle school students' digital literacies for disciplinary learning. These scaffolds were adapted from an after-school setting for use in a sixth-grade STEAM (science, technology, engineering, arts, and mathematics) elective. The elective class originated out of a middle school–university partnership; we were approached to collaborate with the middle school teacher to develop the STEAM class in its inaugural year. Comprised of 32 students, the 18-week class met for two hours twice a week: once at the university and once at the middle school. The course had multiple goals, including helping students participate in integrated STEAM practices, nurturing their collaborative and critical mind-sets, and exposing students to possible STEAM careers. The Project IF curriculum reflected our specialties as researchers and teacher educators: Blaine's work focuses on adolescents' digital literacies, and Ji specializes in technology-enhanced STEM education. We led some of the class sessions and researched students' learning experiences with the assistance of graduate students.

In the following sections, we present various scaffolds developed for Project IF. These examples are intended to spark design ideas and strategies for creating projects that support digital literacies for disciplinary learning more widely.

Scaffolding Digital Literacies for Disciplinary Learning

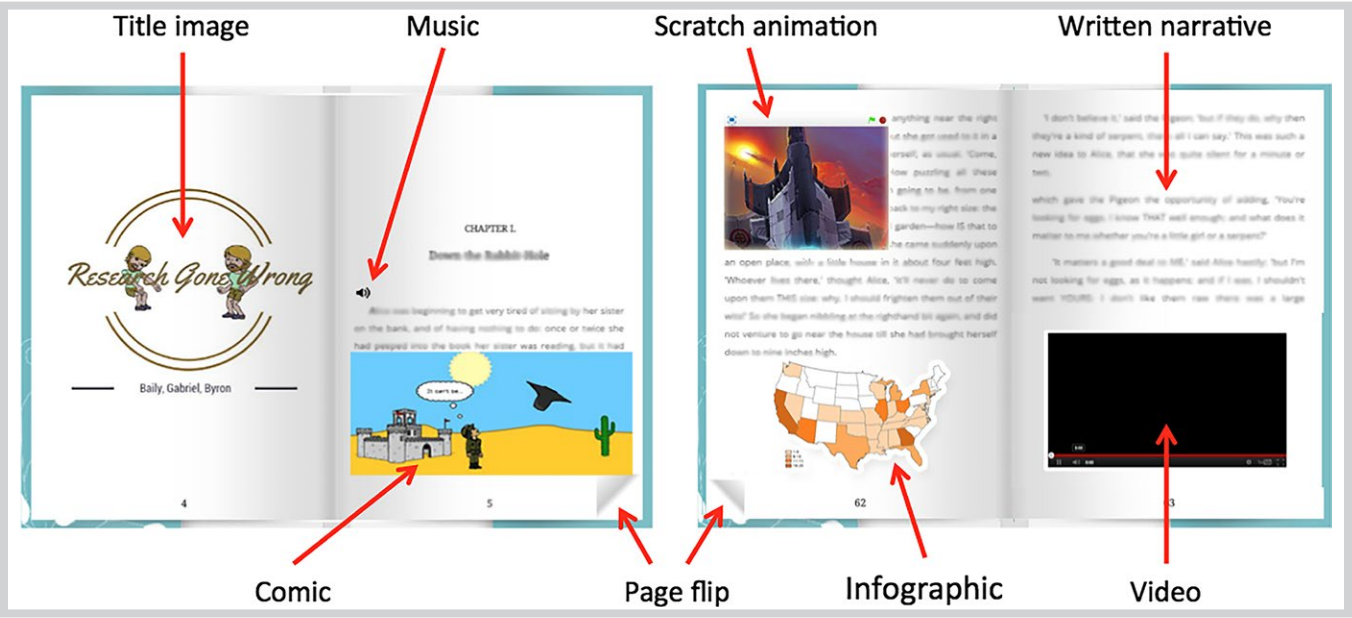
Individualized and Flexible Roles

Students developed individualized roles within their collaborative teams throughout the elective course. On the first day, three main roles were presented for

BLAINE E. SMITH is an assistant professor in the Department of Teaching, Learning, and Sociocultural Studies at the University of Arizona, Tucson, USA; e-mail blainesmith@email.arizona.edu.

JI SHEN is an associate professor in the Department of Teaching and Learning at the University of Miami, Coral Gables, FL, USA; e-mail j.shen@miami.edu.

Figure 1
Example of a Multimodal Sci-Fi Focused on Climate Change



Note. The color figure can be viewed in the online version of this article at http://ila.onlinelibrary.wiley.com.

students to potentially embody: The scientist could contribute by integrating all scientific content into the sci-fi, the writer could contribute by developing the narrative, and the designer could contribute by creating the multimedia that drive and enhance the story.

After reflecting on the roles, students formed groups ranging from three to five members. They selected roles that highlighted their interests, skills, and past experiences. We facilitated this process by having each student wear a color-coded name tag that ranked his or her preference for enacting the roles in order of interest. The majority of groups developed their own unique role structures. Some groups had greater participation from particular roles (e.g., three designers, one writer, one scientist), others designed hybrid roles (e.g., scientist/designer), and still others created new roles altogether (e.g., manager, engineer). The goal was to approximate the negotiations and self-marketing tactics that many experts utilize when working on interdisciplinary teams. With the teacher and researchers serving as facilitators, students collaboratively completed a graphic organizer that helped them brainstorm different aspects of their sci-fi narratives (e.g., plot, context, characters). During this time, student conversations productively centered on what group members needed to do to effectively create an engaging final product while simultaneously leveraging each team member's unique interests and skills.

An obvious concern with students taking specific roles is the possible imbalance in their exposure to science, literacy, and technical learning. Our research (Jiang et al., 2016) found that students regularly traversed different roles and collaborate on all aspects. Flexible collaboration and shared responsibilities were the norm, as students constantly shared what they learned with their peers. In addition to project work, everyone participated in the curriculum that included science content, genre-specific writing instruction, and tech tutorials.

Structured Workshop Sequence

Adapted from Dalton's (2012) digital writer's workshop model, we followed a structured workshop sequence (see Table 1) aimed at simultaneously supporting the disciplinary learning and multimodal composing aspects of the curriculum, along with balancing individual and collaborative learning. First, each session began with a quick meeting within groups to reflect on their progress and set role-specific goals for the day. Second, students engaged with discipline-specific content through participating in expert-led sessions, reading model sci-fi texts (Pytash, 2012), or completing self-paced science units in Web-based Inquiry Science Environment, a digital platform that fosters students' scientific exploration and knowledge integration

Table 1
Structured Workshop Sequence

Workshop sequence	Description
Group planning	■ Groups reflect on their progress and set role-specific goals. ■ Goals are recorded in an online blog or graphic organizer.
Disciplinary session	Range of disciplinary sessions: ■ "Expert" sessions (6): Sci-fi movie directors, sci-fi author, marine biologist, geophysicist, medical scientist, and professional game designer ■ Field trips (2): A tour of the sustainability initiative around the university campus and a visit to a biology lab that studies insects ■ Web-based Inquiry Science Environment: Self-paced science units (https://wise.berkeley.edu/) ■ Read mentor texts: Excerpts of sci-fis by an author who presented and other students' work ■ Sessions taught by the teacher, university professors, or graduate students (e.g., writing, multimodal composing, science lessons)

Short tech tutorial	■ Led by a university professor or graduate student
	■ Range of skills for different digital tools:
	  ■ Scratch: Animations and games (https://scratch.mit.edu/)
	  ■ iKOS: Online platform (http://ikos.miami.edu/TKSS/)
	  ■ Pixton: Digital comics (https://www.pixton.com/)
	  ■ Venngage: Infographics (https://venngage.com/)

Group work time	■ Students collaboratively work on their multimodal sci-fis. ■ Two peer-workshops ■ Two conferences with instructors
Reflection and sharing	■ Students revisit their goals for the day and plan for the next class. ■ Four whole-group presentations of in-process work ■ Individual and multimodal reflections

(Linn, Gerard, Ryoo, McElhaney, & Rafferty, 2014). Third, many sessions included a short tech tutorial led by the researchers where students learned how to use a new digital tool or program. Ample time was provided for students to apply what they learned while composing their multimodal sci-fis. This gave students time to collaborate or work independently, choose their tasks and composing tools, and give one another feedback. At the end of each session, students shared their in-process work and revisited their goals for the day to monitor their progress and plan for the next class.

Freedom in the Composing Process and Use of Digital Tools

The goal for structuring class sessions was to strike a productive balance between learning new content and digital skills while also allowing students the freedom to forge individualized composing paths and pursue their own interests. Previous research has suggested that adolescents' multimodal composing processes are complex and vary based on the convergence of multiple factors. Adolescents often exhibit unique modal preferences (Smith, 2016; Smith & Dalton, 2016), relying on modes in different ways to make meaning. For example, some students might prefer to initiate their multimodal composing process by focusing on visuals first, whereas other students might want to lay a written foundation before attuning to nonprint modes (Smith, 2016). By providing choices in the multimodal composition process, students learn how different modes possess unique affordances for communicating their message (Smith & Dalton, 2016).

Students had the latitude to select which digital tools and online programs to use for creating their projects. The final sci-fis revealed variation in both content and how different modalities were leveraged. The science topics in the stories included natural disasters (e.g., tsunami, hurricane), nature exploration (e.g., sea trench, sink holes), infectious disease, and space colony and time travel. Students relied on different modes and media to represent scientific phenomena. Some groups foregrounded text to drive their narrative and used visual and aural components as supplemental content (e.g., "Our comics were like the Cliff Notes for the writing"). Conversely, other groups relied primarily on comics, infographics, and animations to communicate their sci-fis and minimally employed text. This freedom allowed for multiple points of entry and interest-driven composing (Ito et al., 2010) and may have supported students in considering the affordances of different modalities and digital tools when conveying scientific content.

Multidirectional Flows of Expertise

Several of the workshops included an interactional session where guest speakers shared knowledge and skills that would aid students in creating their multimodal sci-fis (see Table 1). These experts ranged from practicing scientists (e.g., marine biologist, geophysicist, medical scientist) to sci-fi authors and filmmakers and professional game designers. Guest speakers were enlisted by searching for expertise at the university, using existing contacts, and reaching out to experts in the community.

Expertise flowed in a less traditional, bidirectional manner (Manderino & Castek, 2016) when students learned from one another during Project IF. Students were encouraged to teach others their digital skills, which were often developed on their own or outside of school. For example, Alejandro (all student names are pseudonyms) showed the class how to use Pixton to create representations of hurricanes, and Becca demonstrated how she built an interactive game in Scratch that used a computer's webcam to allow readers to combat germs. Many times, students embodied the role of expert by teaching the instructors. The collaborative nature of the projects also fostered the exchange of role-specific expertise within groups.

Multimodal Reflection

Students developed meta-awareness of their collaborations, role identities, and composing and learning processes through completing a range of multimodal reflections at different stages of their work. Along with daily reflections in which students tracked their progress, additional reflections were made up of online surveys with open-ended questions. Students also created multimodal reflections (Smith & Dalton, 2016) by choosing a digital format based on the tools they learned. Reflections ranged from written blogs to infographics, Scratch animations, and Pixton comics. Maria, for example, created a comic that reflected on her science learning and how her role as designer changed to writer based on the needs of her group (see Figure 2). Her comic also illustrated key examples of how she collaborated with peers in and out of class.

Multimodal reflections allowed students to leverage the digital tools that they learned in workshops and opened up a unique introspective space to uncover their collaborative processes and views on their experiences. The reflections also provided a low-stakes opportunity for students to continue learning the new tools and gain experience with multimodal composing. Along with fostering a meta-awareness of their disciplinary roles and science learning, these reflections served as insightful formative assessments for the teacher.

Engaging Various Audiences

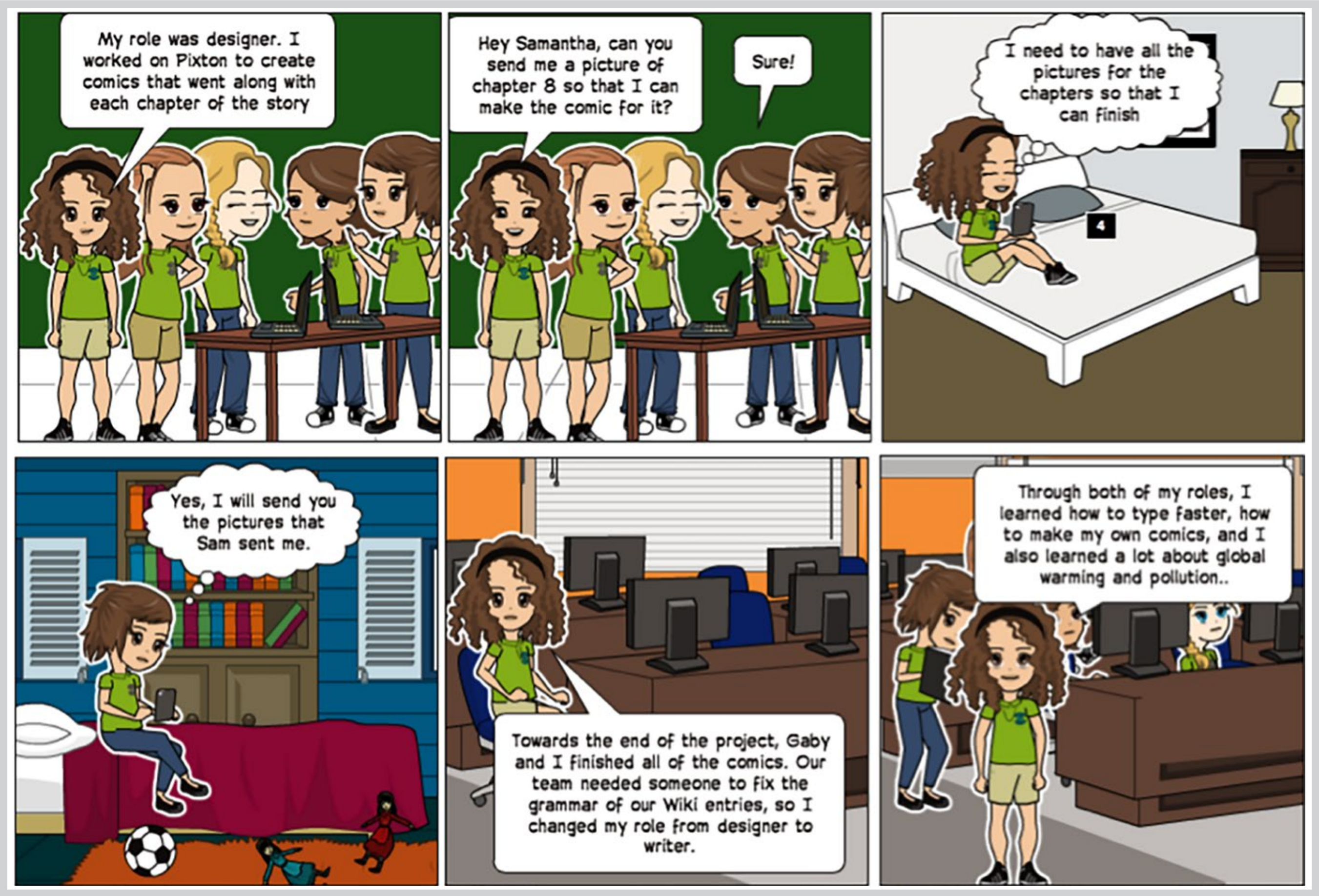
In accord with digital literacies research emphasizing the importance of authentic audiences (Curwood, Magnifico, & Lammers, 2013; Dalton, 2012), students shared their sci-fis in multiple venues. They participated in two peer workshops, two in-process conferences, and four in-process presentations to gain feedback on their work at different stages. They also shared their sci-fis online through platforms such as iKOS and Pixton, where they could receive ratings and feedback from peers. These low-risk opportunities to share in the classroom over time helped students become more comfortable asking for, applying, and giving feedback to one another, a process that scientists themselves use to seek input from others.

Students also shared their sci-fis with larger authentic audiences. Their final work was posted online and shared widely, which encouraged students to take ownership of the content and their choices by explaining the decisions that they had made through their individual roles. An international sci-fi film festival took place annually in the local community, and we arranged for students to present their work there. Engaging multiple audiences allowed students to see their work in a professional light and experience how science learning takes multiple forms.

Implications

Whereas many models of interest-driven youth learning are situated outside of schools (e.g., Ito et al., 2010), these types of rich learning opportunities were possible in the classroom through careful scaffolding. In closing, we

Figure 2
Excerpts From a Student's Reflection Focused on Her Collaborations, Science Learning, and Roles for Creating Her Multimodal Sci-Fi



Note. The color figure can be viewed in the online version of this article at http://ila.onlinelibrary.wiley.com.

offer insights for developing a multimodal curriculum that supports disciplinary learning.

First, strike a balance between supporting students' processes and providing them with creative and collaborative freedom. In particular, give students latitude in constructing their collaborative groups and disciplinary roles, developing creative solutions to real-world problems, and choosing effective modes and tools for communicating creative visions.

Second, leverage the personal, institutional, and community resources around you to find disciplinary experts who can work with students, as well as authentic spaces for students to share their work. Also, gauge the existing expertise in your classroom and allow students to step forward to share their strengths with the class.

Third, gain a multidimensional understanding of students' products, processes, and perspectives when assessing. Along with looking for evidence of disciplinary learning and digital proficiency in students' final products, track their collaborative processes over time and through examining their reflections. Together, these practices provide a more complete picture of student learning.

Finally, embrace the moments of ambiguity and discomfort that are often necessary for student-led collaborative projects. Students' struggles ranged from negotiating their own groups and roles and deciding how to productively allocate their time to learning new digital tools and creatively addressing open, real-world problems. Through careful scaffolding, we believe these new and uncomfortable experiences of collaboratively problem solving are where engaged learning can be most transformative—at the intersections of disciplinary and digital literacies.

REFERENCES

Cobb, P., Confrey, J., diSessa, A., Lehrer, R., & Schauble, L. (2003). Design experiments in educational research. *Educational Researcher*, *32*(1), 9–13. doi:10.3102/0013189X032001009

Curwood, J.S., Magnifico, A.M., & Lammers, J.C. (2013). Writing in the wild: Writers' motivation in fan-based affinity spaces. *Journal of Adolescent & Adult Literacy*, *56*(8), 677–685. doi:10.1002/JAAL.192

Dalton, B. (2012). Multimodal composition and the Common Core Standards. *The Reading Teacher*, *66*(4), 333–339. doi:10.1002/TRTR.01129

Ito, M., Baumer, S., Bittanti, M., boyd, d., Cody, R., Herr-Stephenson, B., ... Tripp, L. (2010). *Hanging out, messing around, and geeking out: Kids learning and living with new media*. Cambridge, MA: MIT Press.

Jiang, S., Shen, J., & Smith, B.E. (2016). Integrating science and writing in multimedia science fictions: Investigating student interactions in role-taking. In C.-K. Looi, J. Polman, U. Cress, & P. Reimann (Eds.), *Transforming learning, Empowering learners: The International Conference of the Learning Sciences (ICLS) 2016* (Vol. 2). Singapore: International Society of the Learning Sciences.

Linn, M.C., Gerard, L.F., Ryoo, K., McElhaney, K., & Rafferty, A.N. (2014). Computer-guided inquiry to improve science learning. *Science*, *344*(6180), 155–156. doi:10.1126/science.1245980

Manderino, M., & Castek, J. (2016). Digital literacies for disciplinary learning: A call to action. *Journal of Adolescent & Adult Literacy*, *60*(1), 79–81. doi:10.1002/jaal.565

Pytash, K.E. (2012). Engaging preservice teachers in disciplinary literacy learning through writing. *Journal of Adolescent & Adult Literacy*, *55*(6), 527–538. doi:10.1002/JAAL.00062

Smith, B.E. (2016). Composing across modes: A comparative analysis of adolescents' multimodal composing processes. *Learning, Media & Technology*. Advance online publication. doi:10.1080/17439884.2016.1182924

Smith, B.E., & Dalton, B. (2016). "Seeing it from a different light": Students' video reflections about their multimodal compositions. *Journal of Adolescent & Adult Literacy*, *59*(6), 719–729. doi:10.1002/jaal.503

The department editors welcome reader comments.

JILL CASTEK is an associate professor of technology for bi/multilingual learners and STEM education at the University of Arizona, Tucson, USA; e-mail jill.castek@gmail.com. You can contact her on Twitter using @jillcastek.

MICHAEL MANDERINO is an assistant professor of literacy education at Northern Illinois University, DeKalb, USA; e-mail manderino@niu.edu. You can contact Michael on Twitter using @mmanderino.