ARTICLE

CREATE in 3D

Building a Maker Mindset One Print at a Time

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Seeing the Power of Making

I began thinking about 3-D printing in 2014 when I learned that the Mississippi Library Commission would loan school libraries a printer for programming. At the time, I was a brand new school librarian who had recently transitioned from being an English teacher, so I was learning about the maker movement in libraries and all the different ways that looked. 3-D printing stood out to me as innovative and awe-inspiring. I was curious about the technology and wanted to share with my school community the sense of wonder I felt. When I brought the printer to our school library for the first time, it mesmerized the students, teachers, and me. We spent hours watching the printer build robots, dragons, and other trinkets. The possibilities that exist in desktop manufacturing are exciting not only for those watching the printer build something but also for those who think about what it *could* build.

Unfortunately, we had to return the loaner printer and couldn't afford to buy one for our school. However, earlier this year, I had the opportunity to partner with the Lafayette County and Oxford Public Library to bring a loaner 3-D printer to my school library. Although I am in a different school setting than before, the printer did not fail to captivate the attention of high school students, teachers, and administrators.

This was the "ah-ha" moment for me when I knew I needed to purchase a 3-D printer for the school library's makerspace. It was exciting to think about how 3-D printing could really shift the culture of my library from a "sit and get" to a "make and take" environment.

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This was a major turning point in how I am now shaping the makerspace at Oxford High School. Until this moment, I struggled with developing makerspace programming that could capture the attention and spark the curiosity of my school community.

Meeting Standards through 3-D Printing

I decided on the spot, as I watched the engagement with the borrowed technology ignite wonder among my patrons, to submit a grant to the Oxford School District Foundation, a group with the mission of funding innovative projects in the district, to request support for the purchase of a Makerbot Replicator+. Using the *AASL Standards Framework for Learners* as a foundation, I focused my grant proposal on Common Belief 6 and its summary description that states:

> Information technologies must be appropriately integrated and equitably available. Although information technology is woven into almost every aspect of learning and life, not every learner and educator has equitable access to up-to-date, appropriate technology and connectivity. An effective school library bridges digital and socioeconomic divides to affect information technology access and skill. (AASL 2018, 3)

I argued that the printer's placement in the school library would promote

the "democratization of technology," which Jim Reitz has defined as "the process by which access to technology rapidly and readily becomes accessible to more people" (2018). Furthermore, the school library is a place that, "help[s] individuals of all ages harness this technology to build cutting-edge digital skills and unlock new opportunities for learning, entrepreneurship, scientific advancement and personal creative expression …. Libraries are leading the charge toward a 'democracy of creation' " (Wapner 2015).

Another crux of my argument focused on the *National School Library Standards for Learners, School Librarians, and School Libraries* Shared Foundation of Explore and its Key Commitment: "Discover and innovate in a growth mindset developed through experience and reflection" (AASL 2018, 4). Specifically, I focused on the Create Domain and the expectations that "Learners construct new knowledge by: Problem solving through cycles of design, implementation, and reflection" (V.B.1) and "Persisting through self-directed pursuits by tinkering and making" (V.B.2). These learner competencies were important for shaping how to implement the printer in library programming. I argued that access to the 3-D printer would further STEAM initiatives across the curriculum because makerspaces are "natural, and accessible, venues" for "engineering, technology, and the application of science" (Meyer 2018). Andy Plemmons has stated, "The library [is] much more than a place to consume information. In fact, with more and more devices in students' hands in their classrooms, there is less need to consume information in the library and instead use that knowledge and curiosity to create something new.… The focus will be on a culture of creation that incorporates the curriculum standards and interests of the library" (2014).

Like Plemmons, I do not have a special room called a makerspace. I simply made the decision to "invest in … technology that supports a culture of creation" (Plemmons 2014).

Supporting Curriculum through Making

I was awarded a $6,000 grant in April 2018 to purchase the printer. To date, the project that fully realizes the goals set forth in the learner competencies cited above involved 3-D printed "gingerbread" houses. I collaborated with Brittany Franks, an English II teacher, to use the printer to help students in her classes create houses to display at the annual Gingerbread Village at the Gertrude C. Ford Center for the Performing Arts in Oxford. We worked from the idea that the tradition of making gingerbread houses at Christmas began with the Brothers Grimm tale of "Hansel and Gretel." The story of two children stumbling into a house made of treats sparked a centuries-old Christmas tradition. The gingerbread house, in essence, is a symbol of the power of storytelling and its ability to ignite curiosity in the hearts and minds of its audience.

Rather than students creating gingerbread houses in the tradition of decorative baked goods, we used 3-D printed houses to teach students how setting is an essential element of narrative writing. The students used the concept of the gingerbread house to learn how authors use setting to tell a story and how attention to detail is crucial in this process. The overarching curriculum connection is to teach learners how to use details and setting to develop their narrative writing. This lesson connects to the *2016 Mississippi College- and Career-Readiness Standards for English Language Arts* for English II Writing 10.3, "Write narratives to develop real or imagined

Figure 1. 3-D printed "gingerbread" houses.

experiences or events using effective technique, well-chosen details, and well-structured event sequences"; Writing 10.3b, "Use narrative techniques, such as dialogue, pacing, description, reflection, and multiple plot lines, to develop experiences, events, and/or characters"; Writing 10.3d, "Use precise words and phrases, telling details, and sensory language to convey a vivid picture of the experiences, events, setting, and/or characters"; and Writing 10.6, "Use technology … to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically" (Mississippi Dept. of Ed. 2016, 120).

For this assignment, students were asked to write an original Christmas story, making the setting the most important part. Since they would be recreating the story's setting in a 3-D model, the directions stated, "The story must contain very detailed information about the setting. Specifically, your story must include a house or other specific building that is described in great detail. You should also be sure to include classic story elements like a protagonist and antagonist, basic plot structure, and dialogue." After students had written an initial draft, Brittany grouped students based on their strengths and weaknesses as writers. Each of the eleven groups contained three to five students who shared their narratives within the group and selected one story to collaboratively revise and edit.

After the revision process, students created a sketch plan. They were instructed to choose a scene from their story to recreate in 3-D and draw a detailed plan for the "gingerbread" model. Each group of students generated a list of materials needed to create the planned

Figures 2–4. Finished houses on display.

Figure 5. Finished houses on display.

> *Investing in technology for the school library ensures that all students, regardless of their achievement on standardized tests, will have access to innovative tools to learn digital skills necessary to thrive in 21st-century college and career environments.*

structure and assigned each group member a job to complete for the final model. Their ELA teacher emphasized that learners should check their sketch against their story to make sure everything in the model was in the story.

Next, each group of students met with me in the school library to learn how to use 3-D printing technology to create the setting of their story. Students either created their own original 3-D designs using SketchUp or downloaded an open-source design from Thingiverse to bring to life the settings of their stories. Because I am not a design expert, I enlisted a few student "experts" to teach other students to design using SketchUp. All groups, then, met with me individually to select and scale projects in Makerbot Print software. This process took several weeks as most designs required four or more hours to print with some jobs including multiple pieces. I even took the printer home one weekend in the beginning because learning to print large designs was challenging while working with a deadline.

After all the houses had been printed, I invited local artist Lee Harper to share with students her artistic process for bringing scenes to life. She is a self-proclaimed "maker of things." Harper's works, History Bones, are dioramas depicting historical scenes and created with found objects (Harper 2018a). From her, students learned how to use the details of the setting to recreate the story. Harper explained to the students how the story is in the details. From her perspective, the setting actually *is* the story (2018b). She brought a few of her pieces to show students her process for creating dioramas by using things she finds in nature and around her home. The students went to work decorating their houses to depict the settings of their written stories. Using materials from the library's makerspace, the students began decorating their houses and incorporating the details into the scenes. Students solved design problems by

making parts of their design with the materials available. A few items were store bought, but the majority of the designs were created by the students' inventive use of the materials on hand. What we presented to the public was the culmination of this process.

Bridging the Digital Divide

It is important to note that the students who created these designs are categorized as being in the bottom 25 percent of achievement in English language arts based on their end-of-year test scores. This fact is significant because access to 3-D printing technology is usually available only to students enrolled in STEM classes. Students who fall in the bottom 25 percent of ELA achievement typically are not enrolled in these technology-enriched courses because these learners don't have time available. Instead, they must devote significant amounts of their time to remediation. To meet graduation requirements, these learners must improve their performance on high-stakes tests. Therefore, without access to 3-D printing through the school library, projects employing emerging technologies to produce, publish, or share student learning would not be possible for most of Brittany's students.

Investing in technology for the school library ensures that all students, regardless of their achievement on standardized tests, will have access to innovative tools to learn digital skills necessary to thrive in 21st-century college and career environments.

At the conclusion of the project, English teacher Brittany Franks stated:

> The possibilities opened to them [students] through the design/3-D printer process pushed them to develop their stories further so that they could use those designs or details in the dioramas. I think being able to bring the story settings "to life" with all of the options on SketchUp and/or Thingiverse really pushed the creativity in their writing, and the whole process definitely pushed them to add more detail to their narrative writing than I saw in their initial drafts. (2018)

With the adoption of the conviction that the school library "bridges digital and socioeconomic divides to affect information technology access and skill," my job as school librarian is to facilitate learning equitably for all student and teacher populations (AASL 2018, 3).

Cherie P. Pandora and Kathy Fredrick wrote, "... technology integration isn't about the 'stuff,' but about the use and manipulation of tools and resources to build understanding and facilitate creation" (2017, 83). Creating in 3-D is extending students' learning with opportunities to use technology through innovative lessons that capture the imagination and build a maker mindset.

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