Chapter 33
Makerspaces and 3D Printing: A Learning-by-Doing Professional Development Model for Preservice and Inservice Teachers

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ABSTRACT

This chapter presents a professional development model for introducing preservice and inservice teachers to makerspaces and 3D printing. The model is based on a 3D Printing 4 Teaching & Learning project, a school/university partnership focused on maker and 3D learning. In the project, 13 inservice teachers were paired with 10 preservice teacher candidates and charged with integrating hands-on physical makerspaces and 3D modeling and printing activities into existing elementary, middle, or high school curricula. Two day-long workshops introduced participants to makerspace experiences. Teachers then completed projects with students organized around history/social studies or science/mathematics topics. Three primary recommendations emerged for integrating maker-based and 3D technologies into preservice and inservice teacher learning: 1) a growth-in-practice model, 2) preservice/inservice teams, 3) multiple approaches to the adoption of new technologies.

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INTRODUCTION

Education has joined the makerspace/3D printing revolution. K-12 schools are repurposing existing physical spaces as maker places and equipping them with 3D printers and multiple design and building tools. Administrators are urging teachers to use those spaces and tools for academic learning while students are wondering what they can create in these new settings. At the center of this wave of educational change are classroom teachers, many of whom have only vague ideas about makerspaces or 3D learning, but who are expected to seamlessly include making, modeling, and printing into existing curriculums while still ensuring student learning gains as shown by improved test scores.

BACKGROUND

A makerspace has been defined as "creative, DIY [do it yourself] spaces where people can gather to create, invent, and learn" (Kroski, 2013, para. 1). Makerspaces are places for individuals to "imagine, envision, create, innovate, play, learn in a formative manner, simulate, experiment, collaborate, think critically, communicate, share, synthesize, invent, evaluate, and most of all dream of new possibilities" (Gorman, 2017, para.1). Makerspaces can range "from a repurposed bookcart filled with arts and crafts supplies to a table in a corner set out with LEGOs to a full blown fab lab with 3D printers, laser cutters, and hand tools" (Rendina, 2015). In education, they have "the potential to revolutionize the way we approach teaching and learning. The maker movement in education is built upon the foundation of constructionism, which is the philosophy of hands-on learning through building things" (Kurti, Kurti, & Fleming, 2014, p. 8).

As a place to design and create—what the Educause Learning Initiative (2013) called a "zone of self-directed learning" (p. 1) —a makerspace has many applications for education. Used with students as part of the academic curriculum, a makerspace can be a "space for individuals to learn by doing," a setting that generates a "highly collaborative learning dynamic that is excellent for team efforts," and a process that allows "students to take control of their own learning" (Educause Learning Initiative, 2013, p. 2).

Teacher Laura Fleming (2015) sees makerspaces as a continuation of John Dewey's vision of education as experiences where children "participate actively in their own learning, with the teacher taking the role of a partner, a guiding influence, in the process" (p. 3). It is essential in education, said Dewey (1916) to "give the pupils something to do, not something to learn and the doing is of such a nature as to demand thinking; learning naturally results" (p. 154).

Riding the wave of increasing popularity and declining costs, many schools are buying 3D printers for their classrooms, libraries, and makerspaces. 3D printers have generated a resurgence of interest in making in the 21st century. As MakerBot CEO Jonathan Jaglom remarked after visiting a school in Connecticut where students are using 3D technology as a regular part of the curriculum: It is "incredible to see 12-year-olds sketch in 3D, print in 3D...the idea is that, 10 years down the line, that becomes natural, and that will move into the household space" (Zaleski, 2015, para. 12).

3D printers take a three-dimensional digital model from a computer and create a physical model. The 3D digital model is designed using 3D modeling software, such as Tinkercad, Google Sketchup, Autodesk 123D Catch, or Maya. Students and teachers can use free 3D modeling software programs to create original models or import 3D models found online and modify them. There are many websites and databases where educators can find pre-designed 3D models for their students to remix, including the