Chapter 3
Using 3D Printers to Engage Students in Research

Jim Flowers
Ball State University, USA

ABSTRACT

Is the primary purpose of a 3D printer to manufacture a product? Yes, but students and teachers can also use 3D printers to learn about and engage in research and experimentation. This could begin with product research and development, then expand to technical areas based on additive manufacturing technologies, the physical and mechanical properties of additive manufacturing materials, and the properties of 3D printed products. Student inquiry can take the form of formal or informal experimentation and observational studies. Although dedicated testing equipment can facilitate more demanding investigations, it is possible for quite a bit of experimentation to be done with little or no dedicated testing equipment. It is hoped that the reader will identify different educational experiences with experimentation that might fit their learners’ needs and see 3D printers as tools for conducting and teaching about research, including product research and development and research into process engineering and materials.

INTRODUCTION

The purpose of this chapter is to highlight how 3D printers in classrooms and academic labs can be used to engage students from primary school to graduate school in research. In many instances, this can serve as an introduction to research methods, engaging students in designing and executing formal or informal research related to using 3D printers. Such research can focus on the design of products, understanding and comparing additive manufacturing processes, determining the effect of modifying additive manufacturing parameters, and a host of other areas specific to the student’s or teacher’s area of interest. An area of special interest here is materials science research as this seems to be only rarely described in the context of primary and secondary education using 3D printers. While some graduate students may work with professors and companies in research and development for new commercial additive manufacturing systems, the purpose of this chapter is instead to highlight how 3D printers can facilitate student research.

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Chapter Plan

The chapter begins looking by mentioning the use of 3D printers for creating solid products based on designs others have created. To illustrate how 3D printers can be an aid in teaching and learning about research, this simple use of 3D printers is compared to product design research and development, where students use 3D printing and simulation as feedback tools to provide information they use in iterative design. These 3D products may also be the subject of usability tests conducted by students. Because 3D printers and associated software allow for so many changes to build parameters, students will likely engage in a host of informal micro-experiments as they work with 3D printers. They may also test the limits of the technology and the materials. Helpful instrumentation will be recommended to support the use of 3D printers to teach and learn about research. This is followed by a host of ideas and inspiration for classroom research that stem from researchers, manufacturers, specific academic fields, teachers, and students. The chapter ends with cautions regarding safety and a recommendation for teachers to focus on student learning outcomes, rather than on model production.

3D PRINTING FOR MODEL CREATION

Some important uses of 3D printers may seem to require neither creativity nor design on the part of the user. A foremost purpose of today’s relatively low-cost 3D printers commonly used by hobbyists or in schools may be the creation of physical models, often using designs downloaded from online repositories. In classrooms, 3D printers can be used to fabricate manipulatives used for teaching and learning within a particular field, such as materials science (Rodenbough, Vanti, & Chan, 2015), anatomy (AbouHashem, Dayal, Savanah, & Strkalj, 2015), biology (Meyer, 2015), and geosciences (Horowitz & Schultz, 2014). In some of these instances the teacher or student may not be the one who originally designed the virtual object.

When students do engage in the design of physical objects, they can use 3D printers to fabricate models that “would be too difficult to sculpt in conventional model making foam” (Joy, 2014, p. 111) or by other methods given the students’ expertise and the tools available. Again, the chief purpose of the tool may be seen as building the model, but here there would be accompanying learning outcomes related to design. Kwon (2017) found that with sample of high school students in the US who engaged in a 3D printing and design summer camp class, there was a “positive influence on students’ motivation, interests, mathematical skills, and real-life skills” (p. 40).

Product Design Research and Development

Additive manufacturing may be just one step in 3D product research and development (R&D). Students who use 3D printers may first spend many hours using 3D object design software. Software now used to design 3D objects portrays the virtual object on the screen where it can be rotated, enlarged, and examined by other means (e.g., determining volume, center of mass). In designing objects, the designer makes a host of decisions, and may try out different design alternatives. In this way, engaging in the design of a 3D object can be inquiry-based learning for students as they experiment both with design features of the object and with the software, which may be new to them. Before using a 3D printer, the
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