Chapter 2
Re-Educating the Educators: Collaborative 3D Printing Education

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ABSTRACT
Given the rapid integration of 3D printing into schools and universities, educators must equip themselves with new skills, class structures, procedures, and thinking, many of which may be challenging for teachers with non-technical expertise. Training in 3D printing and computer-aided design traditionally requires extended instruction and experience, which is unlikely to be practical for school teachers. This chapter explores how effective up-skilling can occur through one-day professional development workshops, where educators from all areas of teaching work together during intensive hands-on sessions to understand the foundational principles of 3D printing, become aware of the opportunities and limitations, and develop strategies together for implementing it into their curriculums. Through examination of the literature around 3D printing adoption in Australian schools, and an analysis of peer-reviewed research into short-format professional development, this chapter will help inform researchers, teachers, and those developing higher-level curriculum directives around 3D printing in schools.

INTRODUCTION
3D printing presents numerous opportunities across disciplines and is fast being integrated within schools as part of broader technological shifts described by the fourth industrial revolution (Schwab, 2017), also known as Industry 4.0. Despite increasing pressure from Science, Technology, Engineering and Mathematics (STEM) policies, there is little support offered to schools and teachers to learn 3D printing and associated skills such as Computer-Aided Design (CAD) and 3D scanning. Such technologies have traditionally been the domain of designers and engineers, trained through years of university and commercial practice, and may be daunting for many teachers, particularly those in disciplines where computing and technical expertise is minimal. It is unrealistic to expect teachers to add lengthy training courses in these technologies to their already busy workload, so novel methods of training, driven by bottom-up engagement, must be implemented to ensure teachers and students benefit from the opportunities presented by 3D printing.

The aim of this chapter is to build new awareness of the challenges teachers face when integrating 3D printing into the classroom, and suggest how intensive workshops may be used to overcome many of the barriers when run in conjunction with local universities. This chapter begins by summarizing how 3D printing is currently being adopted within Australian schools as STEM agendas increasingly encourage teachers to embed new technologies into existing curricula. It then presents new research on the opportunity for short intensive courses to provide meaningful training to teachers in 3D printing, drawing upon peer-reviewed literature from a variety of disciplines to understand the opportunities and limitations of such short workshops. For 3D printing in particular, universities are suggested as vital partners for teachers to encourage ongoing learning, acting as hubs through which local schools may leverage knowledge and equipment free from many of the biases in existing 3D printing forums and education websites. The latter part of this chapter presents the structure of a one one-day Professional Development (PD) program run at Griffith University specifically for K-12 school teachers, which has been refined over four years with the aim of establishing a strong foundation in both theory and practice, driven by a “learning by making” (Loy, 2014) philosophy. These PD workshops in 3D printing have been found to be rich in collaboration, with teachers across disciplines and schools connecting and sharing new strategies to implement 3D printing into curricula, access equipment and funding, and create more enriching cross-disciplinary projects that suggest new possibilities for the future of education. The argument is that hands-on activities during PD courses can be used to encourage new flipped classroom teaching strategies that challenge conventional teaching models, and that one-day training can be effective for encouraging a bottom-up engagement with 3D printing. The chapter concludes with some recommendations for future research to measure the long-term effects of PD courses on teachers and their teaching, optimizing them as technologies like 3D printing increasingly permeate the classroom driven by the fourth industrial revolution.

BACKGROUND

To begin this chapter it is important to discuss the relevant context of this research, particularly around the adoption of 3D printing and associated technologies within Australia and its schools where this study is based. While there are many similarities globally, and this chapter is intended to benefit a broad range of readers, each country will vary depending on a number of factors including government policies around education, funding models, infrastructure and socio-economic factors. Within each country different states and regions may also have quite different educational policies, as is the case within Australia where education is predominantly guided by state policies rather than national policies. Peer reviewed data quantifying these differences related to 3D printing is limited, possibly due to the constant flux experienced by both 3D printing and educational institutions globally; however, clues for the rapid changes being experienced between states and countries can be found by looking at the quarterly reports from online 3D printing community, 3D Hubs. The most recent report at the time of writing for the fourth quarter (Q4) of 2017 lists Australia as the fourth most active country on 3D Hubs, with Melbourne (capital city of the state of Victoria) listed for the first time in the top ten cities (3D Hubs, 2017b), whereas only the previous quarter (Q3) it was the fifth most active country with no capital cities in the top ten (3D Hubs, 2017a). Similarly rapid shifts are seen globally, and while 3D Hubs is not reflective of total 3D printer uptake in each country, or related to 3D printers in schools, it does provide a regularly updated metric that shows global trends in a much more timely manner than many published works. Loy (2014, p. 113)