Chapter 11
Using OpenSCAD for Teaching Mathematics: Building an Educational Model for 3D Printing

André Rafael Liziero
State University of Paraná – União da Vitória, Brazil

Maria Ivete Basniak
https://orcid.org/0000-0001-5172-981X
State University of Paraná – União da Vitória, Brazil

ABSTRACT

Three-dimensional representations have been used in teaching for several decades. However, these representations were made primarily using materials available in the market. The use of 3D printers has extended the possibility of creating and printing these objects, enabling the printing of three-dimensional models using computer designs. These computational designs or 3D computational modeling are built employing various software programs, which require reflections and strategies during their production. In this chapter, the authors discuss the possibilities of using the OpenSCAD software 3D models for teaching mathematics.

INTRODUCTION

The use of three-dimensional (3D) objects in teaching and learning offers more possibilities for the understanding and exploration of concepts than the use of two-dimensional representations, simulations or written texts. Nevertheless, despite the availability of a wide range of 3D objects available for teaching and learning, there are situations where the real objectives of these materials do not meet the teacher's planning, as Santos (2007, p. 2) wrote:

DOI: 10.4018/978-1-6684-6295-9.ch011

Teachers in the process of obtaining their professional qualification usually complain about the rigidity of the available teaching materials, which makes it difficult to use them in certain teaching strategies. At times, the teacher declines to faithfully adopt the textbooks from the market and makes adaptations trying to mold them to their school reality and pedagogical convictions.

Moreover, as they are objects from the market, their acquisition requires financial resources, a lack of which may become a hindrance to their use, such difficulties are often circumvented by the creation and reproduction of materials by students and teachers themselves who use alternative materials to produce the desired objects. However, individual manufacture of objects takes time, and when identical copies of the same object are required, differences between the manually produced objects can occur and depending on the purpose for which the teaching material is intended can hamper the teaching and learning process.

An alternative to these situations is the production of teaching materials through 3D printers, where the presence of this technology in educational institutions can provide the production of specific materials and adapted to the teacher's planning. In addition, it facilitates the production of the same material more than once, avoiding imperfections and ensuring uniformity and a standard quality. That is, the 3D printer allows the educational institution, teachers or students to create materials particularly designed for situations in that study environment. However, as with all technology, to use a 3D printer it is necessary to understand its operation, its possibilities and its limitations to reduce the likelihood of difficulty; for example, printers whose printing method is FDM (Fused Deposition Modeling) require regular calibration and cleaning. The purpose of understanding the printer operation and doing regular maintenance preserves the print quality of the object, enabling better results when used by teachers and students in the classroom.

The use of printed objects can enable new approaches to teaching, i.e., how objects created by the 3D printer in the educational institution are designed according to the teacher's or student's planning, the object allows for innovative approaches to related content. These new approaches can provide new perspectives and new learning opportunities (Basniak & Liziero, 2017), as stated by Aguiar (2016, p. 47), the 3D printer:

[…] can help the student think differently and see the world differently. Together with other ICTs, it helps create environments that offer adequate stimulus to students who are indifferent in the school, because it enables them to learn on their own through exploration.

Consequently, one can understand that using printed teaching materials in 3D has the distinction of providing the creation of models that were previously only found as virtual objects or two-dimensional illustrations, and in turn the physical manipulation of such objects may enable new opportunities for learning. However, it is also important to point out that teachers need to think about innovative situations while planning to create innovative 3D objects (Basniak & Liziero, 2017). As suggested by the authors' research (Liziero & Basniak, 2016), innovative situations and innovative 3D objects hardly happened, and the models created were already available in the market with characteristics superior to those built.

Another interesting factor related to the production of objects through 3D printing is that, as already mentioned, such materials depart from virtual models. These virtual models can become didactic objects and their transformation to a 3D object can also help in the process of teaching and learning, both to