USE OF 3D-PRINTED MODELS IN MEDICAL EDUCATION

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ABSTRACT
This study aimed to evaluate the efficiency of using 3D-printed bone parts in Human Anatomy classes in the first semester of the Medicine course at the Evangelical University of Goiás. The parts were produced on a 3D printer and used in an activity to identify the bones and muscles of the left human foot. A questionnaire about the structures studied in class was administered before and after the activity. There were 130 responses to the first questionnaire and 105 responses to the second, with varying rates of correct answers as the difficulty of the questions increased. As a result, it was observed that the success rates in the questionnaires increased substantially after the activity with the 3D pieces, which reinforces the thesis that there is space, application, and usefulness in the production of the pieces in the medical educational context. It was concluded that the bone pieces are efficient in assisting the teaching process of the Human Anatomy discipline.

Keywords: 3D printing, Education, Medicine, Medical Materials.

INTRODUCTION

Problem-Based Learning (PBL) encourages students to increase their ability to actively seek information, managing their own learning. In addition, this methodology provides an opportunity to work on communication skills and critical and argumentative competence (Ronn, 2019).

3D printing in the study of medicine emerged after the revolution in medical education, whose ultimate goal was to develop a pedagogical model in which the student was the protagonist, placing more emphasis on practical activities and using technology to further stimulate student contact with active learning. The relevance and innovation of 3D printing technology are directly related to the fact that it provides active and didactic methods for academics, focused on touch and the visualization of details (Garcia et al., 2022). The printing of 3D models also opens up opportunities for scientific research, helping to understand the functional processes of the organism more clearly.

The discipline of Human Anatomy is one of the areas that can benefit from the use of 3D parts to optimize studies. The use of interactive multimedia stimulates knowledge of surface anatomy, clinical anatomy, procedure-oriented anatomy etc. (Sugand; Abrahams; Khurana, 2010; Barreto, 2018).

Given the experience reported in the literature, the production of 3D parts and their use in anatomy teaching is a fact. UniEVANGÉLICA already has the LabIn 3D technology park, with an educational printer, type CL2 Edu from Cliever Studio. The medical course follows the PBL methodology, and anatomy classes taught at the institution can benefit from the use of these 3D-printed pieces.

Thus, this study evaluated the efficiency of using 3D-printed bone parts in Human Anatomy classes in the first semester of the Medicine course at the Evangelical University of Goiás. One of the possible benefits of using these printers is the reduction in the cost of acquiring industrial prototypes of anatomical parts, since such parts are expensive to purchase, while the production of parts at CL2 would only involve the costs of PLA or ABS filaments.

METHODOLOGY

The study began with learning how to use the hardware and software of the CL2 Edu 3D printer (Cliever Studio) located at UniEVANGÉLICA's LabIn 3D. During this process, the operation of the 3D printer, its assembly mechanism, software, and compatible files were studied. In the second stage, life-size anatomical models of the bones of a human left foot were produced. Free files available on the internet were used, and each bone was printed separately. During this stage, numerous prints of different models were made, with different errors during printing. It was identified that PLA material was not the most suitable for the production of the parts; the ideal material was ABS (Figure 1).

Before the activities began, the objectives were explained, and the students signed a free and informed consent form. A pre-activity electronic questionnaire was administered to assess prior knowledge. The parts produced were used in an educational activity in the human anatomy laboratory. The class was divided into two groups, each with the bones of the left foot. The students had to assemble the parts that form the structure of the foot. To simulate the role of the muscles, modeling clay was provided, and the students numbered the structures (bones and muscles). At the end of the assembly of the foot structures, the students answered the post-test questionnaire.

Figure 1. Parts printed in white ABS and complete prototype.

Source: image by the author.

The questionnaire responses were analyzed, including both the observations made by students and teachers regarding their experience with using 3D models during class and the students' accuracy rate, which was compared with the responses from the first questionnaire to determine whether there was an increase in the accuracy rate after the activity.

RESULTS

The first form was completed by 130 students, while the second was completed by 105. A large discrepancy in the accuracy rates was observed in some questions, while others remained within a small margin of error. The accuracy rate decreased dramatically as the questions became more difficult, as expected. Overall, the accuracy rate increased in the final questionnaire (after the activity) compared to the initial questionnaire (before the activity).

It is believed that other factors influenced this result, as the activity came to an end, some students were eager to finish and did not answer the second questionnaire with the same commitment as the first. The class was the last of the day, which also did not help students engage with the activity; in many groups, only a few students made an effort to finish the foot structure (Figure 2).

Figure 2. Activity in progress.

Source: image by the author.

In the final evaluation questions, most of the responses were positive, stating that the activity did help in visualizing 3D structures and learning anatomy. The most common criticism was related to the difficulty of keeping the pieces connected, since the adhesive tape and modeling clay were not sufficient to keep the bones connected. They suggested printing the piece with a fitting, placing magnets, or even using hot glue for fixation.

The tactic of creating a competition and rewarding a group was also praised, and most responses regarding the possibility of using the pieces in the classroom were well received. Some students expressed frustration at not being able to assemble the pieces within the time limit, stating that they spent more time assembling than naming the bone and muscle structures.

CONCLUSION

Through this analysis, it was possible to conclude that there is openness and optimization of learning with activities using 3D models, as predicted in the literature, although the pieces themselves need adaptation.

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