



Application of DNA Molecular Model Printed by 3D Printing Technology in Biology Class of Senior High School

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Abstract. Under the background of the new era, in order to improve the quality of senior high school biology curriculum education, biology teachers need to explore more effective teaching strategies of senior high school. 3D printing technology, which has been given a “Digital Revolution” background, has entered an era of rapid development. When 3D printing comes into the classroom, it will also bring many surprises to the classroom. In biology class, the teacher instructs students to design the DNA molecular biological model with SolidWorks software, then uses Simplify 3D software to slice the model, finally uses FDM 3d printer to print the DNA molecular model. The model is much more intuitive than the floor plan in the textbook, making it easier for the students to grasp the knowledge. At the same time, 3D printing is a rapid prototyping technology, so there is no pressure on teaching time. After students learn how to operate the instrument and are granted teacher's permission, they can print out the expected personalized items. In this way, students can also greatly develop students' hands-on and brain-on abilities, so as to achieve the transformation of the school teaching mode.

Keywords: 3D printing · Secondary education · Biology · Modeling · Hands on skills · Classroom teaching

1 Introduction

With the increasing attention to senior high school biology curriculum education, how to innovate senior high school biology curriculum education methods has become one of the concerns of many teachers. However, in the actual high school biology curriculum education, many teachers use the educational method is not innovative enough to attract students' classroom attention, lack of interest. Therefore, it is helpful to strengthen the new space of biology education in senior high school to constantly improve the teaching strategy of biology education.

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American educationist Kline once said, “the best way to learn is to do it first and then recognize it, or to recognize it as you do it.”. The former Soviet educator Vasily Sukhomlynsky also said, “it is an important condition to arouse the special interest of the youth to let the students experience an emotion of being personally involved in the acquisition of knowledge.” In the study of biology, we should realize the consistency of structure and function. DNA is the genetic material of the organism, which stores the genetic information of the organism. So how does it store an organism’s genetic information, and how does it make that information work? To answer a series of questions about DNA, one must first understand the structure of DNA. Help students understand the molecular structure of DNA by using biological models. 3D printing is a fast and affordable technology that can be used in the classroom, so it is now possible to print biological models at a lower cost, turning boring book knowledge into an engaging 3D entity. And with the deepening of the educational reform, classroom teaching has become more and more important, therefore, the study of high school biology classroom teaching strategy under the background of the new era has bright practical significance.

2 Current Teaching Situation of Biology in Senior High School

2.1 Lacks the Thick Study Atmosphere, the Teaching Form is Unitary

China’s education has been influenced by the traditional examination-oriented education, which emphasizes practice and theory over innovation and foundation. Therefore, in the current biology teaching process, teachers still adopt the traditional teaching method of teaching materials plus oral instruction, the control of the discourse right in the classroom makes students have no choice in learning, which leads to the inversion of the status between teachers and students, resulting in students’ subjective status is not obvious. In this case, the student seems to be an outsider in the classroom. In this way, students can’t be stimulated to think in the classroom and the thinking ability of biological learning, which leads to their inability to concentrate in the course, thus affecting the efficiency of lectures, as a result, students are unable to build up confidence and motivation in the subject of biology, which leads to a decline in their grades [9].

2.2 Lack of Novel Teaching Methods

In teaching, most of the teaching materials are mainly teaching materials, which have not been expanded properly, and multimedia teaching equipment has not been effectively used in the teaching process [6]. The teaching is not creative and can’t arouse students’ interest, the whole classroom teaching atmosphere is more boring and lifeless. Although the teaching content in this way conforms to the arrangement of the teaching syllabus and can complete the teaching task more quickly, it is easy to cause the students to be too rigid and passive study, and can’t inspire them to further explore and think about biology study, and students in learning ability, personality and other aspects of the differences, such a model is not suitable for every student, resulting in students between the grade division is serious, not conducive to student learning growth and progress [10].

3 Teaching Process

3.1 New Lessons for Zhongguancun Science Park Sculpture

In the late 1980s, the fast-growing region of Zhongguancun Science Park was transformed into China's Silicon Valley. In the early 1990s, the government of Haidian District, in a bid to improve its image, built the first DNA city sculpture on the central roundabout at the Huangzhuang junction in Haidian District, giving it a double helix of "Life", the symbol Zhongguancun Science Park unceasing innovation spirit [4].

A dozen years later, the statue rusted and cracked. At this time, the rise of the Zhongguancun Science Park Business Park, Zhongguancun Science Park has become the city's vanguard. Road expansion, demolition of the roadside office building has become the image of the district government projects, road central island has also seriously hindered urban traffic. In 2009, around the island, the double-helix sculpture removed, while a taller "Double Helix" New Tuhao gold sculpture stands in the original site on the west side of Zhongguancun Science Park Square. The sculpture is framed by steel pipes and the outer layers of shiny steel plates are riveted.

Now a similar double-helix sculpture has been recreated not far from the centre of the Huangzhuang Road in Haidian District, as opposed to the double-helix sculpture in the square. It resembles a second child and highlights Zhongguancun Science Park's love for the double-helix sculpture.

Teacher questions, this leads to the learning content of this lesson: what is the structure of DNA and what are the characteristics of DNA? [1].

3.2 Explaining the Basics of DNA, Printing Models

3.2.1 Teaching Analysis to Determine the Model Structure

DNA is the genetic material of organism, and its double helix structure is a difficult point in teaching. It is difficult for students to understand the characteristics of double helix structure and base complementary pairing of DNA molecules. DNA molecular formula and structure are more complex, as shown in Fig. 1. DNA molecular structure is modeled as pentagon, sphere and rectangle by analogy of similar shape, and then the physiological process is simulated by image model [3].

3.2.2 3D Model Construction

SolidWorks software is the first 3D CAD system based on Windows in the world. It follows the three principles of ease of use, stability and innovation. Using it, designers greatly shorten the design time, the product quickly and efficiently to the market. According to the famous talent website, compared with other 3D CAD systems, there are more job advertisements related to SolidWorks than all other software combined. This objectively shows that more and more engineers use SolidWorks software, and more and more enterprises employ SolidWorks talents. The software is used to build this model.

The first step, build the model in the computer. According to Fig. 2, using SolidWorks software, mainly through the basic geometry construction to design the DNA model, Firstly, we should build a deoxyribonucleotide model, then select the forward-looking

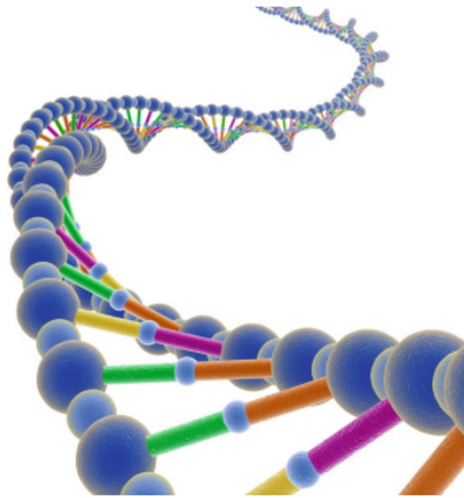


Fig. 1. DNA structure

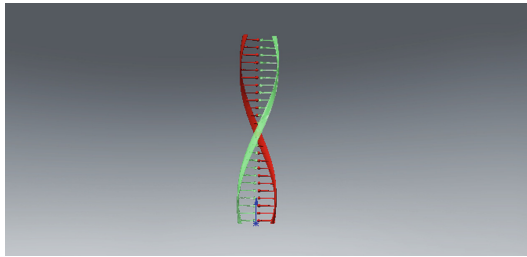


Fig. 2. DNA model in the computer

datum, edit the sketch, and stretch the boss as long and as deep as 500 mm, as shown in Fig. 3. Editing the sketch again, and stretching the boss as wide and as deep as 10 mm, as shown in Fig. 4. DNA make up of two basic skeletons. As the midline of the base, adding a dome to the sketch and drawing a linear array as shown in Fig. 5. Figure 6 is for representing the base. And mirroring the array as the base of the two strands, as shown in Fig. 7. At last, bending the two strands of DNA as shown in Fig. 8.

The second step, slicing through 3D software. The software used here is Simplify 3D, which imports the files to be printed, as shown in Fig. 9. After importing the file, clicking twice on the model to change the model's position and size parameters, as shown in Fig. 10. When the parameters are set, clicking edit print process settings to change the fill rate, support, instrument temperature, extrusion head, etc. After setting all the parameters, clicking ready to print.

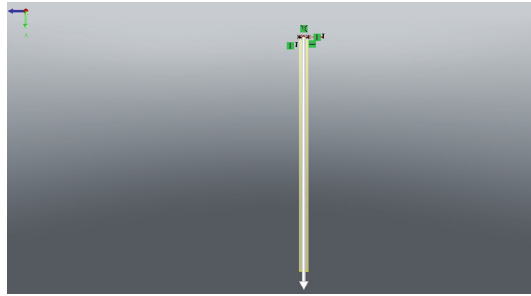


Fig. 3. Create a long strip and stretch

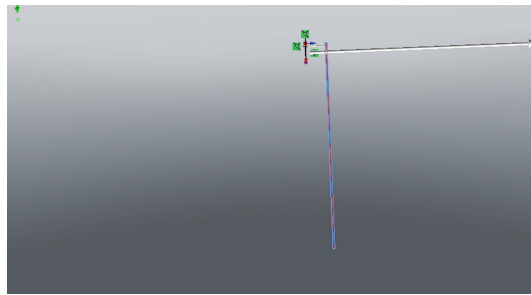


Fig. 4. Given a certain thickness

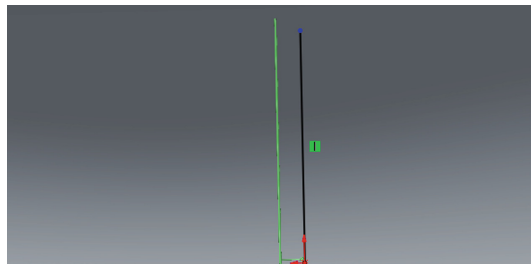


Fig. 5. As the midline of the base, adding a dome to the sketch

3.2.3 Model Printing

FDM 3D printer melts the molten material at high temperatures and extrudes it through a nozzle with a precision nozzle. The material is extruded from the nozzle, cooled, solidified and stacked one layer at a time. This technology is best suited for students. It is safe, fast, low cost, and can choose a variety of materials [7].

Instructing the students to set the parameters and printing the DNA molecular model using the FDM 3D printer, as shown in Fig. 11 [5]. In Fig. 12, DNA model is printed.

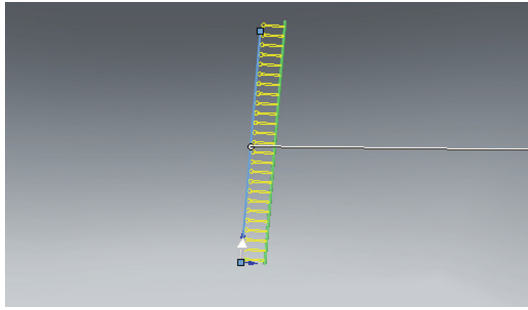


Fig. 6. Draw a linear array

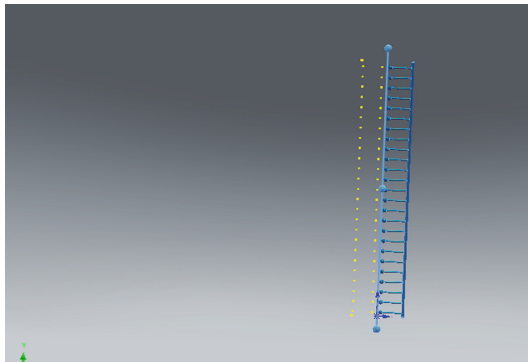


Fig. 7. Mirroring the array as the base of the two strands

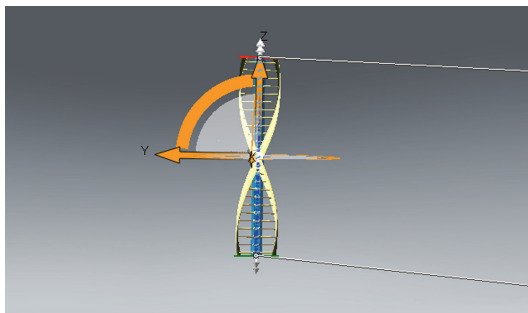


Fig. 8. Bending the two strands of DNA

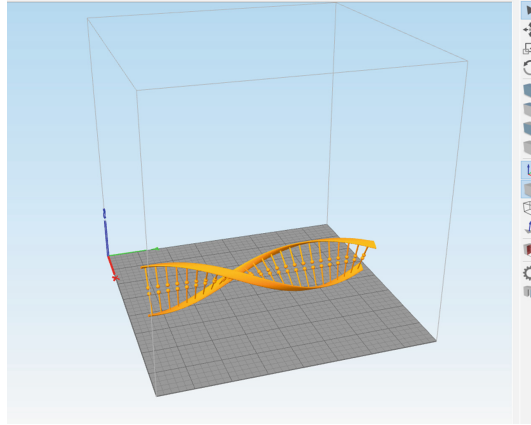


Fig. 9. Import the files to be printed model into Simplify 3D

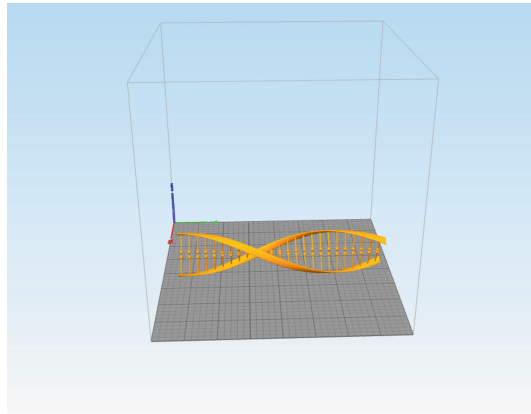


Fig. 10. Changing the model's position and size parameters by clicking twice on the model

3.3 The Main Characteristics of DNA Molecular Structure Were Summarized by 3D Model Analysis

Through the observation of the model, summarizing the main characteristics of DNA molecular structure:

- (1) The two chains are spiraled in opposite directions parallel to each other;
- (2) The outer side is alternately connected with deoxyribose and phosphoric acid to form the basic skeleton;
- (3) The inner side is the base pair formed by hydrogen bond, which is matched by base complementary pairing principle.

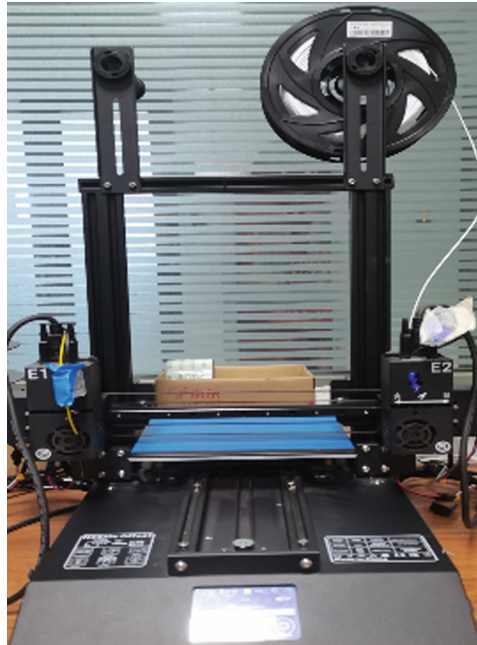


Fig. 11. Using the FDM 3D printer to print the DNA molecular model

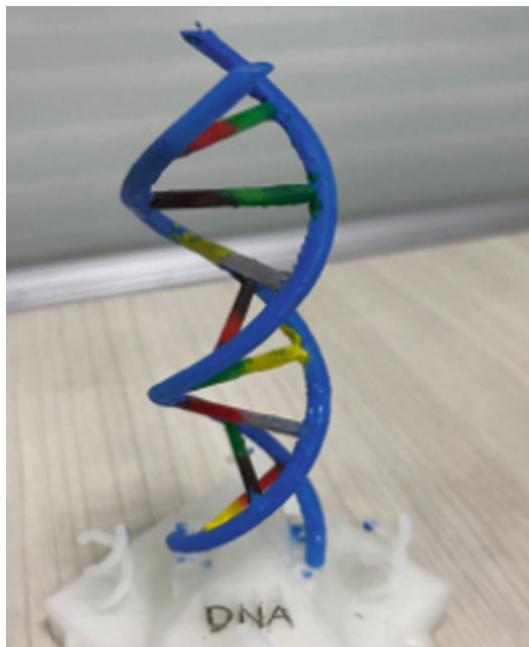


Fig. 12. A print-out model

4 Emotional Attitude

Biology as a basic scientific subject, not only carries on the teaching of biological knowledge, but also hopes that through the knowledge teaching of this subject from the perspective of subject setting. Therefore, it lets students have a deeper understanding and cognition of biology and life.

In a sense, the study of the process of life development is also one of the goals of biology teaching in senior high school. For this reason, it also requires teachers to pay attention to the education and guidance of students' rational biological thinking. In this way, cultivating students' outstanding biological spirit, maintaining a rigorous and rational attitude to knowledge learning. On the other hand, this way can train students outstanding biological thinking [8].

Human being is the starting point and the end point of education. Emotion reflects the most essential relationship between human life activities and the reality around. The internal process of emotional education is composed of "Emotion-feeling, experience-understanding, and value systematization-personification" [2]. It is necessary to giving a good education for the students. Good education includes optimism education, perseverance education, frustration education and so on. Only in this way can create a positive and healthy emotional environment and cultivate their healthy psychological quality.

5 Conclusion

Youth is the future of the motherland, the hope of the nation. 3D printing is a rapid prototyping technology that turns imagination into reality, based on digital models that use layers of powder metal, plastic and the like to construct real objects. When it is applied to the classroom, it will certainly bring surprising changes to the classroom. In the classroom, the process of 3D printing can promote cooperation between teachers and students, increase student participation, and improve the ability of teachers and students together.

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