BIOIMAGES IN ARTISTIC EDUCATION: ACTION-RESEARCH OF THE PRODUCTION OF IMAGES AND THEIR DEVICES FROM ECOLOGICAL PROCESSES

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Abstract

The present Project developed from an action that took place at the Junior University (*U. Junior*) at University of Porto, edition 2018. More specifically in a course, as part of a summer Project named "Model your ideas in 3D (*Modela as tuas ideias em 3D*)". In this course, students from the 9th to the 11th grade, aged between 14 and 17 years old, explored the potentialities of the 3D Software open source Blender. Each course had the duration of a week and was organized by two monitors, who enable the students' deeper and broader understanding of the subjects.

Furthermore, the course was divided into 3 main phases: "introduction to the program", "consolidation of knowledge" and "project". In the introduction, the students had their first contact with the interface software as well as the inputs behind the 3D modulation. The consolidation phase was organized by several exercises, ranging from the simple creation of a house from two cubes to the creation of a table and a chair. In the last phase, the students consolidated the knowledge received during the week. In this edition there was also the possibility of introducing 3D printing technology, allowing the students to see their digital creations gaining shape.

In this edition, it was proposed that the theme of the final Project be modified. Thus, the students were challenged to jointly create images that demonstrate the contemporary problem of ocean pollution by plastics due to human action. Throughout the week, the students created various 3D models of bottles, marine life, characters, and coastline houses. At the end of the activity, all the elements were gathered, and a final scene was assembled, which resulted in images that intend to sensitize the viewer to the problem.

By the end of each course week, and from the obtained results, it was possible to state that the students had gained awareness of the problem of sustainability and the power of images. From this experience, we could ask ourselves: how can we produce ecologically sustainable analog images? From the educational point of view, that allowed an interdisciplinarity and awareness for the emancipation of the student.

This 3D course will be combined with other past courses such as "Plants and seeds for alternative images: researching biodegradable processes in developing photosensitive film". Therefore, an action-research project was designed in order to cross the printing of 3D devices for the capture of images with aspects of image development from biodegradable processes. The intention is to develop an open source ecological kit to capture analog images. Such kit consists of a vertical garden and a Pinhole photographic device made from recycled plastics. For this, the circularity of the materials is a fundamental point in the whole process. The process must be the most ecological possible, from the construction of the device to the development of latent images through ecological solutions (e.g. Developer made from Mint).

This kit will be printed with 3D printers, allowing the transformation of three-dimensional computer-developed models into physical objects. Future interdisciplinary courses will be designed, where the applicability of the kit will be tested. The project will have 3 cycles. The first one – "Awareness" –, will take place in January, at Soares School; the second – "Interconnected courses on device production and image development" – will take place in July at *U. Junior*; the third – "Production of the pedagogical kit for secondary students and reflection" –, will occur between September and December 2019.

Keywords: Art Education, Education, Technology, 3D Printing, Ecologic, Sustainability, Analog Images.

1 INTRODUCTION

The work translated in this presentation, is part of a pedagogical and action-research project named Bioimages. This project focuses on the research of biodegradable alternative processes in the

development of photosensitive film, in various formats of photography and cinema. As well as in the application of these processes, as pedagogical practice in artistic teaching. Such research will focus on innovative processes and technologies that drastically reduce the use of toxic chemicals present in the methods commonly used in conventional laboratories. The design and construction of these innovative and accessible technologies will serve to assist the biodegradable processes of photosensitive film development, moreover, their applications may be multiple. More specifically, this presentation focuses on the contribution of 3D modeling and printing technology to this Project.

Concentrating on the intersection of chemistry with art and art education, this project shows a political link. Such interaction is made by using ecological issues and environmental sustainability. Therefore, it is aligned with the Sustainable Development Goals (SDG) set by the United Nations. This political bond emerges as a conscious gesture of resistance to processes stemming from an era of heavy industry. An era of harboring practices and technologies, that are highly toxic and harmful to a planet that is increasingly overloaded and incapable of regeneration. In this way, art and artistic work is linked to a relationship of intervention and development of society. Resulting in a positioning and practices with important impact and in the same direction of the major societal challenges, that have been posed by the main international agencies and organizations.

Furthermore, the Project was born of sustainable and environmental awareness, along with a willingness to explore new processes of producing images. These processes, today, must be critical of the force that the flow and proliferation of images has hit with the digital age [7]. Therefore, the creation of biological images and technology, created from 3D printing at the pedagogical level [5], is important to encourage students to think of images as means for new possibilities and new future realities.

The concern over the imaging processes was launched during the "Model Your Ideas in 3D" Project at Junior University (*U. Junior*). *U. Junior* is an Educational Program created and launched by the University of Porto with the purpose of providing the experience of Higher Education to young students of the Middle and High School. *U. Junior* allows students of getting to know some of the Faculties included at University of Porto through the involvement in activities. Simultaneously challenging and promoting reflection and learning, involving laboratory practice, fieldwork, study visits, group works, discussions, etc. [1] In this direction, the Bioimages Project took the first steps in *U. Junior* with courses developed for the creation of 'photographic gardens' and alternative processes for the development of photosensitive film.

This course was part of the 14th edition of *U. Junior* and during the course of the project, students were confronted with the creation of digital images from the open source software *Blender 3D* [2]. Also, for the sustainability, there is a concern of using open source software in this project. The main objectives of this experiment were to raise awareness of the ecological problems derived from plastic in the oceans, as a result of our heavy consumer society and mass industrial processes [3]. As well as to provide a certain awareness about the power of images, and how this influence the society of consumption, using the Education as instrument capable of counteracting this power [4].

After the first experiences with the "photographic garden", its alternative with ecological processes of revelation and the course held at *U. Junior*, it is intended to initiate an interdisciplinarity that facilitates an action for the creation of more sustainable analog images, drawing new possibilities of 3D printing. In this direction, it is tried that devices that go from the capture to the impression of the images can be produced from the technology of 3D impression, with biodegradable substances. As an example: Polylactic Acid (PLA). In our Bioimages ecosystem can be printed in 3D, what we call ecobjects: pinhole cameras; pots for plants (vertical garden); revelation tanks etc.

2 METHODOLOGY

The methodology applied in the present study was an action-research methodology, where students, professors and researchers integrate the research dynamics. This research is composed by experimentation and qualitative data collection, both, on the ecobjects and images produces (on a technical and aesthetic side). Moreover, on a pedagogical and relational processes developed.

For this study, a pedagogical course in the *U. Junior* program, 14º edition (2018), as part of a summer Project named “Model your ideas in 3D” was developed and applied.

The course took place at the Fine arts Faculty of Porto University and it was applied in two different moments. Each application had the duration of a week, from July 2nd to July 6th and from 9th to 13th July, starting at 9 am to 1 pm and again from 2 pm to 6 pm (8 hours a day).

The total number of participants was 31 (n=31), 16 in the first week (2nd to 6th July), and 15 in the second week (9th to 13th July). The participants were students from the 9th to 11th grade, between the ages of 14 to 17 years old.

The tool used during the course was *Blender 3D software, version 2.79 for macOS*. This software (*Blender 3D©) was used* for the modulation of virtual objects and creation of images and 3D print to print.

From the pedagogical point of view, there was the concern to start the apprenticeship from the simplest to the most complex. In digital 3D modelling, one must begin the construction of a new model from a simple form. The direction of the tasks and exercises always began with Lowpoly models and only in a later phase was applied retopology methods, to transform the Lowpoly models into Highpoly models.

In this edition there was also the possibility of introducing 3D printing technology, allowing students to see their digital creations gaining shape.

The course was divided into 3 main phases: “introduction to the program”, “consolidation of knowledge” and “project”. Nonetheless, each day had specific objectives, activities and strategies.

From the action taken at the U. Junior, the obtained results allowed a discussion about the future of the project. This discussion led to the creation of a 2nd cycle of action-research, in which the Bioimages project was redesigned and the Ecobojects design started.

3 FIRST CYCLE OF ACTION-RESEARCH

3.1 Introduction to the program

Each course had a total of 5 days and in this subsection, it’s shown the course management.

3.1.1 Day 1

The introduction to the program was done in the first day, were students had the first contact with *Blender 3D©* software.
The main objective of this day was getting to know to software and its potentialities. It started with the introduction to the interface and tools of the Blender software, as well as showing examples created by Blender software.
Expected outcome: In this way, this first day had primary objectives done.

3.1.2 Day 2

The day 2 was used to define the shape of a 3D object.
For that, 3D modulation was used. Including introduction to the modulation tools and creation of a three-dimensional (step to step) object.
Expected outcome: In this day the modulation of complex was made.

3.1.3 Day 3

This day had the goal to apply the texture and raw material in the modulated/created object, lights manipulation and cameras.
Tools experimentation that allow the application of modulated objects.
Expected outcome: creation of complex scenes, composed by several 3D models.

3.1.4 Day 4

Experimentation of animated tools with basic notions about animation. Initiation of 3D models of bottles, marine life, characters and coastline houses, cars, wheels and trees.
Expected outcome: Creation of a basic animation.

3.1.5 Day 5

Objective: Realization of a personal or group project
Development and presentation of the final project developed
Expected outcome: including 3d models of objects or scenes, textures, illumination, materials and “render”.

3.2 Results and Discussion

In general, results were very positive. By the end of the week, students were able to work with *Blender 3D* in an autonomous way. More specifically, students got the basic knowledge for an individual search of new ways of doing.

Some of the results obtained during the course are shown in this section. Regarding the proposed exercises, there were some interesting extrapolations that are shown be in the subsection 3.1. The point 3.2 shows the final results obtained at the end of second week. Point 3.3 demonstrates the first prototypes of ecobjects for plants. In the point 3.4 it was drawn up a new cycle of research action, where it is explained in detail the bioimages project.

3.2.1 Plastic bottle models

All students completed these three digital models of plastic bottles.

From a reference image, bottles were modelled from a hexagonal prism. This exercise allowed to reinforce the knowledge about the software, due to the practice with commands, including some advanced ones.

Figure 1. 3D model of different types of plastic bottles.

In addition to the modelling bottles, some students decided to create compositions of elements, creating abstract images (figure 2, figure 3).

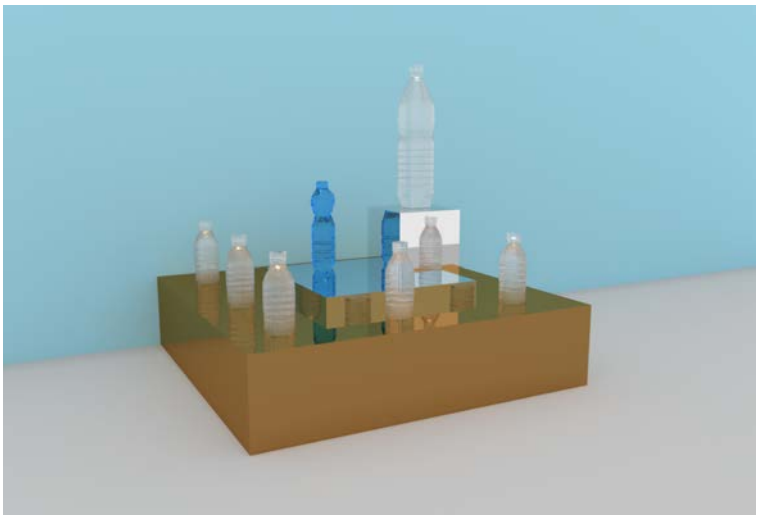

Figure 2. Composition of different 3D models of plastic bottles.

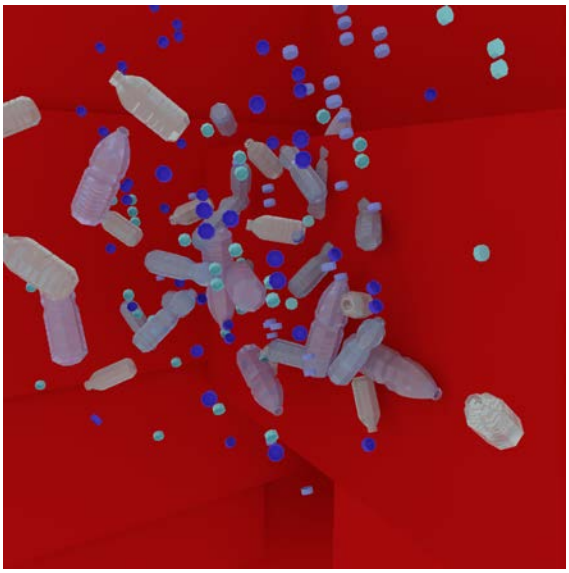

Figure 3. Composition of different 3D models of plastic bottles.

3.2.2 Sea life models

In addition to the plastic bottles modelling, students modelled a series of sea animals (figure 4).

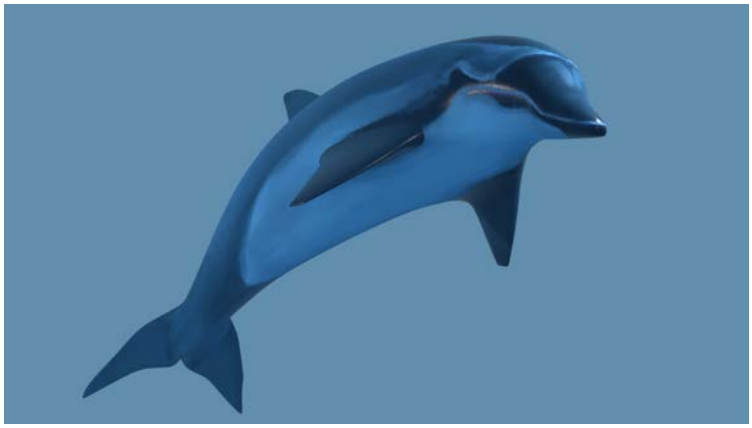

Figure 4. 3D model of a Dolphin made by a student.

3.3 Final Rendered Scenes

These are some of the results obtained at the end of the course. As a group, objects were putted together, composing final scenes.

In this example, it can be seen that individual learning contributed to a collective outcome. Team spirit, in this laboratory environment, is important to strengthen and assist individual learning, where failure is seen as an educational benefit [5].

Figure 5. Final Scene, week 1 – Typical sea village from Portugal, but the water is full of plastics.

Figure 6. Final Scene, week 2 – A diving whale in an ocean full of plastics.

Figure 7. Final Scene, week – A Saturn like ring on earth made of plastic cups.

3.4 Second cycle - Redesigning Bioimages action-research project

3.4.1 From Plants and Seeds to Bioimages

Due to the understanding of the possibilities of joining 3D modelling and printing technology to the Bioimages Project, it will be organized a new project based on 2 Points: i) field intervention, constituting research teams from the practice; ii) systematization of research and development of innovative pedagogical practices in art education.

i. Field intervention

The development and implementation of “Photographic gardens”, courses for the production and development of images and courses for the design and 3D printing of ecobjects, will be used to understand the possible applications of alternative processes for biodegradable development in the field of artistic education. The 'photographic garden' will be composed by plants, fruits, flowers and seeds, which may be used in the process of developing photosensitive film (e.g. coffee, beetroot, mint, thyme).

Once again, the methodology of action-research is assumed. Where students, teachers and researchers integrate the dynamics of the research. Nonetheless, this research is made by experimentation and a collection of qualitative data for tested formulas, on the ecobjects and images produced (on the technical and aesthetic level), and on the pedagogical and relational processes developed.

ii. Research systematization and development of innovative pedagogical practices:

The students' involvement in their own research is in itself a pedagogical act. However, another objective will be the systematization of research and pedagogical practices, in order to be integrated into the artistic teaching. More specifically, from the developed work and the data gathered in the field, we will look for:

- To develop alternative biodegradable processes in the development of photosensitive film;
- To develop pedagogical practices in artistic teaching using biodegradable alternative processes in the development of photosensitive film;
- To develop and produce devices for capturing and aiding the production and development of images using biodegradable materials in 3D printing;
- To improve and adapt spaces, lab equipment and technologies for sustainable and ecological pedagogical practices;
- To integrate sustainable and ecological pedagogical practices in art education courses;
- To develop a pedagogical kit of sustainable and ecological practices in the scope of the image, in order to disseminate these practices in the artistic teaching.

Processes / Procedures and products.

The project will be developed in 2019, at Soares dos Reis Art School, together with the Institute for Research in Art Design and Society of the Faculty of Fine Arts of Porto University (i2ADS / FBAUP). There will be 3 courses, applied to professors and students. Each course will be divides into 3 phases: design and 3D printing of ecobjects, testing procedures and developed formulas and reflection and development of pedagogical practices.

Phase 1 – 14th of January - lecture at “Viva a Soares”

Dedicated to professors and students to present the project and raise awareness about the problems and hypotheses. This general presentation of the project was carried out in a Product Design class. Students and teachers were present. This action allowed, besides presenting the general lines of the project and some of the past actions, to establish new institutional relations and future partnerships with companies that already work with the Soares dos Reis school, such as the plastics company Ernesto São Simão (ESS). Such partnerships will be important in shaping the project and research.

Phase 2 – in July (duration two days)

Dedicated to professors and will be made of a technical and pedagogical training, within the framework of photographic practice with sustainable and ecological alternative resources and methods. The course will also aim to create a pedagogical kit. The pedagogical kit will made of the necessary documentation for developing revelation processes and pedagogical exercises, as well as the production of ecobjects and other necessary resources and devices.

Phase 3 in September (duration three days)

Dedicated to professors and students to consolidate results in the process of revelation and pedagogical practices. This course will also test the educational kit.

At the end of the project a seminar will be held to discuss the results and a final report will also be produced.

3.4.2 Ecobjects: early prototypes

Here are presented the first sketches of the vertical garden ecobject, necessary for the plantation of mint and thyme, essential plants for the expansion of the ecological developer, in urban environments.

It started by thinking of a modeling way that would allow a construction, according to the needs of each user. Soon the idea came up to create a kind of hive with a hexagonal structure, as can be seen in figure 8. However, this possibility led to problems such as the impossibility of placing the pots in the water tanks when the vertical garden had two levels.

At this point, the importance of a more three-dimensional solution based on an octahedron was perceived. With this more volumetric shape, it is not only possible to stack several containers in height, it also gives space for the placement and removal of the pots (figure 9). The pots may contain balls of clay and land to support the cultivated plants. At the bottom of the pots there are seven holes with two purposes: i) to provide a correct flow of the water, ii) to enable the roots to capture the water that is in the tank. Each container may carry two or more pots depending on the brightness of the location.

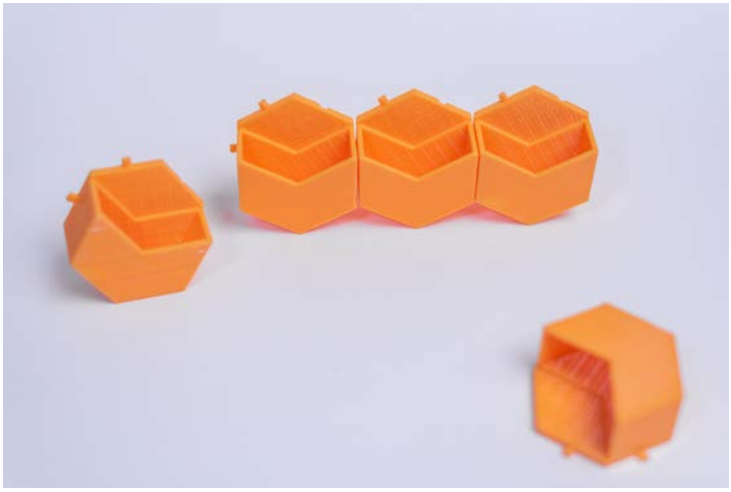

Figure 8. Early prototype with a hexagon base.

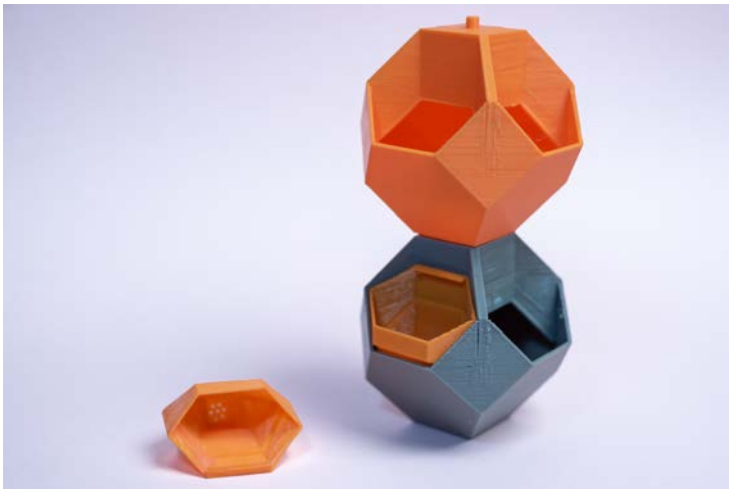

Figure 9. Early prototype with a truncated octahedron and a vase.

4 CONCLUSIONS

4.1 U. Junior Course

The course "model your ideas in 3D" was an important point in the Bioimages Project. It was used to understand and test new pedagogical practices focused on raising awareness of sustainability and environment. The use of the open source software Blender 3D represents an attitude and political

position [6] in line with the general concerns of the Bioimages Project, including the link between professors and students in the process of research and knowledge sharing.

From the obtained results it can be perceived that there is a positive learning of the digital tool *Blender 3D* ©, based on the topic of sustainability and environmental concern and reflection. The final results proved that the laboratory and collective environment of the course improved the learning and creation of constructive dynamics among students [5].

Therefore, this experience can be seen as something that can be repeated in the future as an integral part of the Bioimages Project, since reflection about environment and sustainability, and the power that images have over society is part of the problematic of the project [7].

4.2 The Power of Images

In the consumer and information society, images have a huge responsibility; they influence the opinions and desires of the masses. Consumer society uses the means of communication and, above all, the rapid and generalized communication of images, to induce Pavlovian reflexes useful to the market, and certainly not to civilized life [4]. How to break this vicious cycle? The school, as a privileged institution in the development of consciences, should provide a territory of reflection and confrontation before this reality. In the midst of this audio-visual abundance that takes place in contemporaneity, which alienates and displaces more than it informs, perhaps Education is the main instrument capable of counteracting this diffuse effect [4].

Starting from the role of Education as an instrument capable of counteracting these harmful effects, it was thought to produce images that appealed to non-consumerism. However, this is a utopian objective and at most we want to appeal to a sustainable consumerism.

This power of images is connected to the devices that create and reproduce them. The devices are inscribed in a relation of power [8]. They are complex structures constituted by grammars programmed for a certain purpose. To what extent are we not being carried by them instead of them being carried away by us? [9]

Perhaps from the construction of such devices, we can understand their structures, thus gaining greater control over them, in order to seek new solutions to the problems of communities and society. In this case, with the production of a pedagogical ecological kit to be used in artistic education as a device that enables new practices.

4.3 The importance of circularity

As we can verify, this action / research extends beyond the course applied at *U. Junior*, having previous roots in the project Photographic Garden. Its complexity – due, in part, to the present and intended interdisciplinarity –, can be given a common term: circularity.

It is in circularity that are found and established the various transforming connections of reality, promoting a sustainable vision of it. This circularity is present in the connection between disciplines (chemistry, drawing, photography or printing) and in the process of creating objects from the PLA, which can later be reused for new versions of it. It is also present in the students' awareness of environmental and sustainability issues, that can have an impact in the future, due to reinforcing and spreading this awareness and concern among them.

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