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Design and Implementation of a Makerspace for Learning Programming Logic

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Abstract

This research article designs and implements a makerspace focused on the possibility that students can program in a real way, innovating and creating devices through learning didactics. The implementation process is carried out following 5 components: makerspace needs, location and space, tools, products and equipment, courses and usage policies. The importance of a makerspace in education is known, that is why the first step to investigate is to have all the implementation to start the pedagogical processes, it is vital to be clear about its functionality.

Keywords: Makerspaces, learning, programming logic, research spaces.

1. INTRODUCTION

Makerspaces are the new building spaces focused on innovation and creation to enhance the teaching and learning of different areas in science, technology, engineering and mathematics (STEM). These spaces are created in libraries and special areas within institutions or in the framework of smart cities.

The creation and design is composed of multiple stages which must be organized in the best way to ensure a successful workspace, the makerspace playbook allows to know part of the needs and requirements to be taken into account, such as knowing the maker movement to not incur in a normal classroom of the traditional, the space must be according to bring together a community of innovators, the budget, tools and an inventory of all of them, security, policies and roles, as well as the type of projects that may arise and become innovation companies, all this allows an organized and functional makerspace, which should be taken into account before starting [1].

Within the most searched topics of makerspaces in education stand out: engineering training, technologies such as digital printing, related processes such as learning and teacher; within the indicators by countries, the United States and Finland stand out among the 10 institutions that publish the most on related topics [2].

Makerspaces have been implemented in universities to the point that some countries have facilities that make them unique, starting by creating pilot makerspaces, where the innovation rate and impacts on education are measured, one of these countries is Norway where multidisciplinary spaces are created [3]. There are several approaches to participation such as letting people enter freely or must be part of the university and its workers, but in common they are funded by the department or faculty where they are implemented.

Makerspaces can be classified from the point of their accessibility as fixed or mobile and sometimes distributed, but the purpose is one of the most discussed and reviewed features by students, there are works where this purpose is discussed more rigorously by the teachers themselves who are going to use them to improve the confidence of students in STEM education, drawing particular attention to the incorporation of other women in the makerspace and its different methods of implementation and teaching [4]. They have also been analyzed from the multimodal point of view where the results show that new pedagogical solutions must be developed, and it is not enough to have a makerspace to carry out good teaching [5].

The European Union is one of the most studied and explored for education and training, highlighting three aspects, one is the possibility of combining different areas of knowledge, which were previously done separately due to the nature of the classes, secondly the exploration and solution of real world problems through the formulation and design of devices or parts made physically, thirdly the participation and social interaction that is created in a flexible way between peers and teachers [6].

Within the research that has analyzed makerspaces, they recommend that universities integrate the activities of the makers within the curricula, which are part of the curriculum in such a way that help the development of skills and thus contribute to the development of new engineers [7]. It also highlights the importance of using makerspaces to create functional prototypes that although they are not highly reliable if they are highly functional and can lead to the creation of innovative products and to perform tests that would not achieve them in a traditional classroom ultimately limiting their learning and product development [8].

In Latin America, makerspaces are analyzed as spaces for innovation and entrepreneurship development, where they highlight that training can be given outside the classroom through places where they interact with objects to develop ideas, training new students with digital tools [9]. A maker space can be interpreted as a home away from home because of its comfort, the relationships formed with other students, and the relevance they form with the space [10].

This article investigates all the processes and requirements for the design and implementation of makerspace that allows students to develop research skills and programming logic using different tools and software. The process goes from the solution of obtaining a physical space, the implementation, materials and tools to the policies of use, focused on the implementation at the Universidad Francisco de Paula Santander Ocaña and the subject of fundamentals of programming and development of mobile devices.

2. METHODOLOGY

The creation of the Makerspaces followed the following phases:

- Why a makerspaces to investigate.
- Makerspaces Location
- Design and location of tools and work areas.
- Selection of products and equipment for work areas
- Definition and acquisition of specialized software and courses to be offered according to the program or subject.
- Policies and hours of use.

2.1. Why a Makerspace for research?

A building space was necessary to change the traditional form of computer centers, where classes are usually taught from start to programming, arranged in columns and rows with computers, where classes are taught facing the front where the blackboard is located. The previous form does not allow an active participation of the student, which prevents the creation, innovation and collaboration of all students participating in the class, which brings consequences of demotivation and possible low performance, not being able to implement the student's skills in a more didactic and realistic way. The course of beginning to programming is generally composed of 2 groups of 20 students each, and the topics cover the resolution of problems using control structures through software in Spanish.

Also the space was necessary to strengthen the research lines of the group in Science and Technology (GRUCITE), attached to the Systems Engineering program of the Faculty of Engineering, which can be used by different groups across the university to conduct joint projects. GRUCITE is divided into groups to give students the opportunity to carry out their research. Strictly speaking, a research group is composed of students who carry out research focused on a specific line that is related to the lines of the program and the University. The lines of the group are:

- Design and development of video games and interactive systems.
- Development of applications for mobile devices (app`s).
- Free software and hardware.
- Development and implementation of computer platforms and computer vision systems.
- Transport and mobility.

In addition the group works in articulated form with some lines of research of the group GIMUP attached to the University of Pamplona in the areas of mechanical engineering. As it was a space for the group and the subject it was not necessary a space so big but comfortable to be able to carry out most of the research, which had its equipment and research tools.

2.2 Location of the Makerspace

The main question is where to locate it, which could be accessible to the teacher, who had to continue with his academic work in different classrooms and that students were close to be able to go to the makerspace, so they would not have to change venue and could use the free hours to work on their research and ideas. Among these problems were size, location and availability. So we opted for a location of administrative areas, laboratories, classrooms and parking, which can be easily accessible for teachers and students. After several proposals it was finally conditioned with the following divisions:

- 6x6 makerspace room.
- Shelving room of 1.90x6.30.
- 3x2 storage room
- Bathroom.

2.3 Design and location of tools and work areas.

To make the most of the space we demarcated a Fab Lab area, an augmented reality area, a meeting room with workstations, a video curtain for projection, two workstations with metal partitions and shelves.

2.4 Selection of products and equipment for work areas

According to the areas of work, the acquisition of the products in table 1 was projected.

Table. 1. Working tools.

Products	Quantity
Laptop table and/or video beam	4
Multifunctional printer	2
Laptop Computer	3
3d printer	6
Tablets	5
Folding tables	2
Videobeam	2
Video beam curtain	1
Football Robot	8
Robofighter	6
Fingerprint readers	5
Robot davinc	8
Programmable robot bigtrak	8
Surround sound speakers	3

2.5. Training to be offered

The trainings are focused on improving the level of learning in programming logic, as well as those oriented according to the research lines of the group (Table 2).

Table 2. Initial courses to be offered.

Drone Handling
3D printer assembly
Scratch
Makey Makey
Graphic design and 3D printing
Electronic vehicle programming
Design and development of gamification tools
Mobile device programming
Machine Vision Course
Virtual Reality Course
Augmented Reality Course

Finally, the policies of use are adapted to those of the university and the schedules of each teacher and student.

3. RESULT

The purpose in the design and implementation of the makerspace is to encourage participation, innovation, creation and understanding of the different themes in the programming logic, being important an environment that can motivate the student, where they do not only have rows with computers as the normal learning rooms. In figure 1 you can see the different zones destined to each learning area, where students can generate work cycles which vary according to the days of work, they are also used in the schedules of the subjects framed within the curriculum.

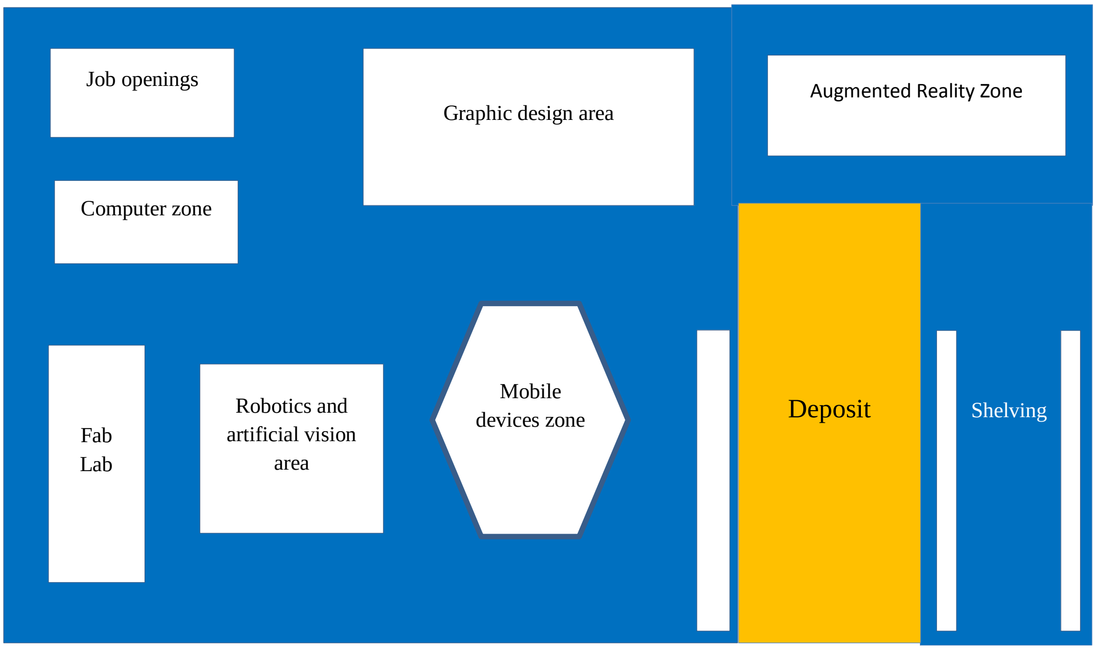

Fig. 1. Makerspace zones.

The Fab Lab area was implemented with the 6 3D printers, where students can build new printers, follow courses or print their prototypes (Figure 2).

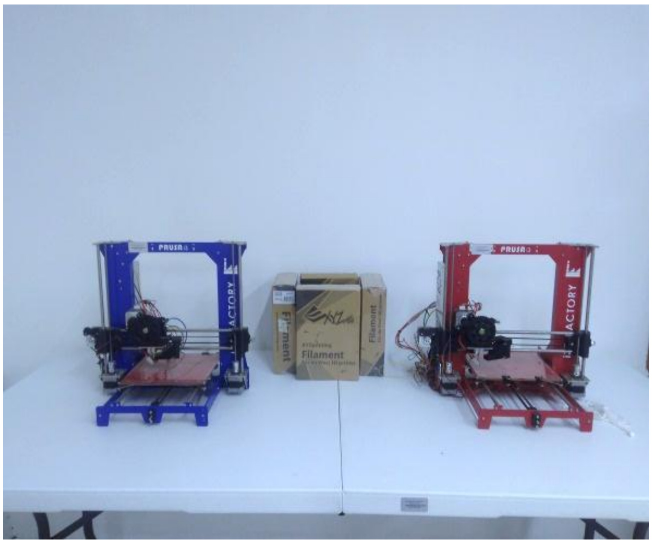

Fig. 2. 3D printer assembly prototypes.

The prototypes that they can print help them to better understand the theoretical and practical classes in the laboratory, because a physical object is easier to remember than using some kind of software. One design they can use is the creation of flowchart symbols, the design and printing of each one allows the student to retain the shape of the object longer than using the symbols directly from the software (Figure 3).

Fig. 3. Printing and design.

The workstation and computer area has equipment on movable tables, which can be moved to any place where an activity is required, this allows freedom of work and easy coupling in the Makerspace training. This was one of the ideas where nothing was fixed, which prevented movement according to the learning cycle or stage of each student (Figure 4).

Fig. 4. Programming area.

The development area of mobile devices (Apps) maintains a process where there are no hierarchies, using an octagonal shaped table, as there is no visible head in the form, allows the student to feel committed in a work group where they have the same possibilities of growth and their ideas are important and have the same value as the other students and the teacher or instructor (Figure 5).

Fig. 5. Programming mobile devices.

The movement through any area of the makerspace, not only involves people, it also involves carrying tools in and out of the makerspace to participate in competitions, conferences or simply take them to a class, so it is of vital importance something as simple as material transport carts, which allows to be prepared to move to such events (Figure 6).

Fig. 6. Warehouse and logistics.

Among the tools that can help programming using gamification are programmable vehicles (Figure 7), software such as Kodu and devices created with design tools. That is why once implemented the makerspace is left free to use and creative student, giving ideas that can serve for learning, improving the innovation of products that may arise and become didactic games. Within the software such as DFD, Pseint, Java, php, etc... We try to create didactic alternatives that are from the real world and allow a more concrete connection with programming.

Fig. 7. Didactic tools.

4. CONCLUSION

The benefits of building on top of teaching are innumerable by having makerspaces, but the sole purpose of having a workspace according to the needs is a very complex task. Having a workspace and having a strategic location in the university is vital to continue with innovation and teaching. After several years designing a maker space, where even had the tools and a mobile maker, which finally ended with deteriorating the implements, it ended with a physical space composed with innovation areas, which had comfort and could be used by students within the subject or that are part of the research group or the university. That is why it becomes a very difficult task to be able to start with the tests and results according to the teaching. That is why each of the advantages and disadvantages that allowed the design and implementation of makerspace, as a reference dl research group and innovation and understanding of programming logic were analyzed.

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