THE BENEFITS OF ARTBOTS ACTIVITIES IN EDUCATION & SOCIETY

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Abstract

The aim of this research is to present the benefits of working with artbots in education and to investigate further benefits for society. The methods which are implemented in order to reach this aim are related to children's and other audiences' participation in contemporary art practices as well as educational activities which involve artbots. These practices and activities are rich and diverse ranging from drawing with artbots (with or without coding) to producing small-scale theatrical pieces, happenings and films. However, all the activities presented in this paper are interdisciplinary and involve or connect the STEAM (Science, Technology, Engineering, Arts and Mathematics) fields. Another common characteristic of all the activities is that they communicate human values through messages of love and peace as well as through references to beauty, harmony, festivity, mobility, interconnectedness and other qualities of the contemporary living conditions. Which are the learning outcomes and what impact do these practices and activities have on the audiences? In order to give an answer to these questions it is important to take into consideration the different age and social groups as well as the contexts where these activities take place. It is also interesting to see these activities through and beyond STEAM education by highlighting the implementation of the Arts as a way to blaze new trails for fostering creative and innovative thinking. The artbots activities presented in this paper can be easily carried out in various intercultural, intergenerational and interdisciplinary contexts and they can bring together people by bridging many kinds of gaps. This means that artbots activities are a promising field of research and creation in education with multiple opportunities for original activities which benefit education and society

Keywords: artbots, art, technology, STEAM education, theatre, interdisciplinary practices

1 INTRODUCTION

The aim of this research is to explore the benefits of working with artbots in education and to investigate further benefits for society. It presents a series of activities –artistic or otherwise– which involve artbots' integration and reach out different publics.

Artbots (art + robots) are, by definition, a product of combination of art with science and technology, as they are robots which produce drawings and, thus, they are associated with art. However, it is important to indicate the three axes which should be taken into careful consideration when implicating artbots in activities:

- The **technology**, i.e. the artbots' *modus operandi*, the way they move and function as well as the materials and mechanisms which enable their functioning,
- Their **aesthetic appearance**, i.e. the materials used for their decoration, elaboration or embellishment,
- Their **drawings** on paper or any other drawing or painting surface.

The activities presented in the frame of this research constitute examples of integration and utilization of artbots at all levels of education in formal, non-formal and informal learning environments. These activities are rich and diverse ranging from drawing with artbots to producing small-scale theatrical pieces, happenings and films. The aforementioned three axes of artbots' integration are used as a tool for better understanding and analyzing the benefits of artbots' implication.

Artbots activities are interdisciplinary and can be associated with the STEAM trend (Science, Technology, Engineering, Arts and Mathematics) especially when artbots' creations and use result from a fertile synthesis of artistic with scientific and technological thinking.

Artbots can be separated in two categories based on their mode of operation:

1. artbots that work without coding and usually operate with motorized mechanisms or electricity;

2. artbots that work with coding.

The artbots that work without coding create mostly random shapes, while programmable artbots are characterized by apollonian precision in drawing.

More precisely, drawings by artbots which function without coding are characterized by randomness, unpredictability and free drawing. The drawings they produce are without (pre)defined rules or commands. The shapes that appear in the drawing can be geometric, semi-geometric, organic or random. On the contrary, artbots that work with coding draw on the basis of (pre)determined rules given *a priori* by the user and consequently produce pre-designed and therefore predictable shapes which are mainly geometric.

For the purposes of this paper we will focus on artbots that work without coding. Except for the beebot (Figure 1. Artbot G), all other artbots, which were used (Figure 1, artbots A to F) for the activities presented in this paper, are self-fabricated with daily low-cost materials. The cost of every self-fabricated artbot does not exceed 15 € or 20 €.

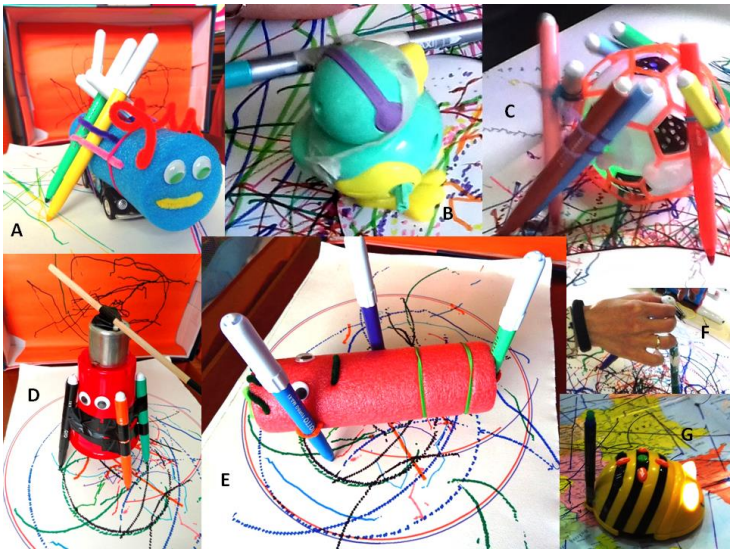

Figure 1. Anastasia Zoi Souliotou, (from A to F) These artbots function with motorized movement or electricity, without coding. A, D, E and F are DIY constructions with simple and low-cost everyday materials. A, B and C use children's toys. D and E are constructions made by following instructions of online tutorials likehttps://www.youtube.com/watch?v=B80RWRIL4wQandhttps://www.youtube.com/watch?v=daWU2Oh_xlg 1.A. The artbot of this image works with a common car with a motorized mechanism. By placing markers right, left and on the back of the construction we can draw straight lines. 1.B. This artbot works with a simple wind-up duck toy with a marker tied upon it, 1.C. This artbot consists of a bouncing ball with a bunch of markers tied on it, 1.D. The artbot of this image works with a motor placed on the top of a plastic cup. It makes drawings with markers taking advantage of the rotation of the stick which results the movement of the whole construction, 1E. This Artbot function with an electric toothbrush and makes drawings with markers. 1.F. This artbot works by holding manually a motor which turns around an helix made of a plastic bottle with markers tied on the helix. The markers draw at the moment of their approach on the drawing surface. (G) Beebot. 1.G. The artbot of this image is a Beebot with a marker tied on it. It is the only artbot of the image which works with an elementary form of coding and is a commercial product.

The presentation of the activities with artbots in this paper highlights the possibilities that arise from the

integration and exploitation of this kind of artbots in education and their benefits for society.

2 ACTIVITIES WITH ARTBOTS

2.1 Methodology of Activities with Artbots

The general methodology for planning and conducting activities with artbots in education consist of the following steps:

- Introduction with artbots through demonstration of how they function and *ad hoc* drawings on paper.
- Discussion on the way artbots are made and operate and on their painting effect on paper. It should be noted that at this stage there are also interdisciplinary discussions on art, physics and geometry.
- Experiments with artbots by participants, who are usually divided into groups and each group paints with one or more artbots. At this stage, it is encouraged to exchange different types of artbots among the groups so that all participants get to know the potential of all types of artbots.
- Creation, in order to explore the potential of artbots giving targeted themes
- Discussion and reflection on the whole experience of artbots' drawing or painting during the activities. In several cases, discussion and reflection are related to the comparison of artbots' paintings with the participants' paintings. Other discussion topics that are being developed at this stage relate to the possibilities of utilizing artbots in other fields and applications beyond the classroom or exhibition space.

The evaluation is done in the course of the activities, but also at the end of each activity by examining the produced drawings or other creations.

2.2 Activities with Artbots

In March 2018, an educational and artistic activity took place with participating students from the Department of Early Childhood Education at the University of Thessaly, as part of the 'Puppet and Puppetry' module. Students constructed *ex nihilo* artbots that are powered by an electric toothbrush. For the construction they used various types of sponges and other foam materials where they incorporated a cheap electric toothbrush. Then they put their artbots in operation and created a large collective drawing in the form of a floor installation at the Dome in Papastratou Building of the University of Thessaly.

The purpose of this activity was that the students –who are the future pre-school teachers– get in touch with how to construct and set in motion a low-cost artbot so that they can use it in activities in their forthcoming stage programme as well as in their subsequent careers. From the beginning of this activity, students paid close attention and took care of the aesthetic appearance of their artbots, as it happens with mechanical dolls (Magouliotis, 2017: 182-185). Thus, artbots of different sizes, colors, and textures were constructed and their common feature was that they moved through the vibration of an electric toothbrush.

At this point, it is important to point out that within the process of constructing this kind of artbots the students were well-trained to problem-solving (Wyffels et al., 2016), since at each stage of the construction they needed to take into account the properties of the materials they used and then to face various challenges. The latter relate primarily to the achievement of setting the artbot in motion which links this activity with engineering and other STEAM fields (Traggianese, 2016).

Figure 2. Educational and artistic activity at the Dome of the University of Thessaly. The students put into operation their artbots which are powered by an electric toothbrush. Artbots move and paint together on a

large paper placed on the floor. The action took place in the framework of the module "Puppets and Puppetry", Tutor: Anastasia Zoi Souliotou, Department of Early Childhood Education, University of Thessaly, Volos, Greece.

Thereafter, the students set up the artbots and made drawings all together on the floor of the Dome at the University of Thessaly. The drawings which were created remind us of Jackson Pollock's abstract expressionist dripping technique, as for example the drawing in Figure 3. The relation of these drawings with Pollock's Abstract Expressionism can be used in the context of educational activities which include presentation or reference to his work. These drawings could also be seen as random networks and be integrated into graph and network theory activities which link art with mathematics.

Figure 3. Student's drawing with the use of an artbot powered with an electric toothbrush. The construction of artbots and the subsequent creation of drawings took place in the frame of the module "Puppets and Puppetry", Tutor: Anastasia Zoi Souliotou, Department of Early Childhood Education, University of Thessaly, Volos, Greece.

The artbot in Figure 4, which moves with an electric toothbrush, at the time of the drawing creates repetitive curvilinear, circular and helical shapes. We also see the attention given to its aesthetics as well as the way in which functionality determines its structure and its aesthetic appearance: blue sponges tightened with rubber on the toothbrush, the head of the toothbrush, which rotates while touching the drawing surface, is visible.

Figure 4. The artbot that moves with an electric toothbrush at the time of the drawing creates repetitive curvilinear, circular and helical shapes. The construction of the artbot and the subsequent creation of drawings took place in the frame of the module "Puppets and Puppetry", Tutor: Anastasia Zoi Souliotou, Department of Early Childhood Education, University of Thessaly, Volos, Greece. The artbot of the image was created and set in motion by the student Vivi Oikonomou.

The following activities relate to artbots drawing and its influence to participants of different age and from diverse social and cultural backgrounds. Some of these activities took place in the form of workshops in the frame of several educational programmes: TALOS-ed-UTH-robotix programme at the University of Thessaly; *Come with us! 2019* programme by Onassis Scholars Association; STEAM Festival 2019 at Argyri-Laimou Schools in Athens. There were also other festivals where artbots were presented and then participants made

drawings, like Athens Science Festival 2018 and 2019, Thessaly Science Festival 2018, Nea Genia Ziridi IT Festival 2018 and 2019 and other occasions. Notably during the Thessaly Science Festival 2018 children refugees came in touch with artbots and produced drawings. Children refugees were very much impressed by artbots drawing, found a lot of interest in artbots as simple constructions and enjoyed drawing.

Figure 5. Drawing of a child of the 2nd Grade, Elementary School in which the hand-made drawing (human figure) coexists with the artbot's drawing in the background. The drawing was created during the ARTBOTS workshops, Responsible: Anastasia Zoi Souliotou, summer programme of TALOS-ed-UTH-robotix programme at the University of Thessaly, website: https://talos.uth.gr

Antonis (2nd Grade, Elementary School) creates the human figure (Figure 5) and puts it in a space that is defined, activated and filled with dots created by the artbot. We feel that the human figure is an extension of the dotty background, as the shape of the face and its features (eyes, nose) have the same round shape as dots. At the same time the degree of abstraction renders this figure a symbol of the whole humanity, as its gender is not entirely clear and seems to be possessed by an existential or metaphysical anxiety that is so close to human nature, especially when humans need to confront the conditions that surround them.

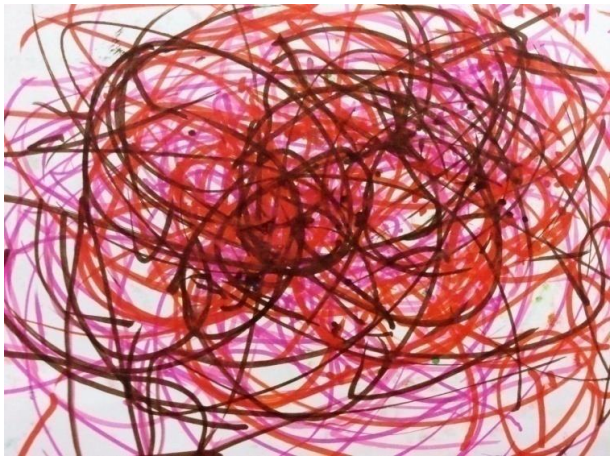

Figure 6. Drawing of a child from the 3rd Grade Primary School in which a smear is made across the whole surface of the paper. The painting was created during the summer workshops TALOS-ed-UTH-robotix programme at the University of Thessaly, website: https://talos.uth.gr

Another particularly interesting characteristic observed during the artbots drawing workshops is that children were very much influenced by artbots and created abstract art and expressionistic drawings by using points and lines, as for example in Figure 6 where the child made a hand-free drawing full of lines. Another characteristic of children's drawing under artbots' influence was that children were feeling safer when their drawing covered the whole surface of the paper, just like the technique *all-over* which was implied by Pollock and many other abstract expressionists.

In this procedure of filling their whole paper with their lines or dots children always stopped at that critical point, just before they reach levels of high density and saturation, since more density or saturation would be

intolerable for the human eye. This happens, for example, in the child's drawing in figure 6. This attitude of children confirms Richard Taylor's analysis of how the works of American painter Jackson Pollock are linked to the structure of fractals we find in nature and how ultimately the thickening of Pollock's works could have reached that very critical point, after which they seemed unnatural and unacceptable to the human eye. (Taylor 2002: 117, 121)

Artbots, as already mentioned, create primarily abstract shapes, which may be geometric, semi-geometric, irregular or organic. Participants –especially children– are initially impressed when they see artbots being put into operation and then move and make abstract drawings on paper. However, what happens next? In what ways can artbots drawing open up to other possibilities so that they maintain participants' interest?

"Artbots make abstract art,

while we do perfect art. "

Pupil of 3rd Grade in Primary School

The following activities expand artbots drawing paving, thus, the way for drawings that can be related to other styles –apart from abstract expressionism– as well as with other fields and sciences.

When using stencil in artbot drawing, the participants come up with recognizable objects and popular symbols which, however, include in their inner shape random, abstract and expressionistic artbots' drawing. At the same time artbots' drawing is also created on the surface of the stencils which have a positive-negative relationship with the drawing surface. For example, in Figure 7 we see two drawings that came out using a stencil to design a star: a) on the left we see the stencil, in which the artbots drawing develops around the shape of the star and b) on the right we see the artbots drawing inside the star.

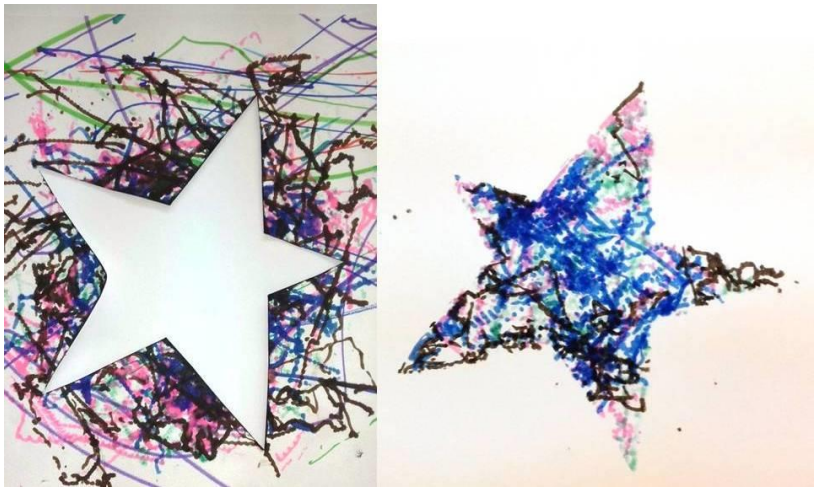

Figure 7.a. Stencil used for making star-shaped drawings with artbots and 7.b. a star formed with artbots' drawing with the use of the stencil of Figure 7.a.

The use of stencils in this activity has been observed to excite children and teen-agers, obviously because this time they create drawings that represent recognizable forms. Looking at the stages of children's drawing, it becomes clear that recognizing forms and patterns is very important from the age of about 2.5 years old, when children start representing objects in their drawings. This effort to recreate objects continues in childhood, but also in adolescence, when the so-called "visual realism" is predominant, with a necessity for a more and more close representation of the visible reality. (Thomas & Silk, 1997: 54-60) Thus, the use of stencils in artbots drawing ensures the creation of recognizable forms in the right proportions, satisfying children and teen-agers who feel that their drawings are successful.

In the frame of the educational programme *Come with us! 2019* by Onassis Scholars Association the person who writes this paper visited three different secondary schools in different areas around Athens and carried out workshops which involved drawing with artbots. The aim of *Come with us! 2019* programme is to offer the opportunity to pupils from different urban areas to participate in innovative activities and to obtain cutting-edge knowledge and skills by participating in activities which are proposed and realized by members of the Onassis Scholars Association and are the fruit of many years of research and high-level studies. Drawing with artbots very much inspired participants of *Come with us! 2019,* especially when they used stencils, like the one in Figure 7.

The following activity is connected with astronomy and took place in the frame of TALOS-ed-UTH-robotix programme at the University of Thessaly at the end of 2018. The participants were primary school children. Children were initially given drawings which had been made with artbots. All these drawings had numbered dots and the children were invited to connect them. By connecting the dots they made various recognisable forms, as for example the fish in the Figures 8.a. and 8.b. Afterwards the writer had a discussion with the children, pointing out that although the original artbot's drawing was abstract, the connect-the-dots puzzle led to the emergence of a recognisable form.

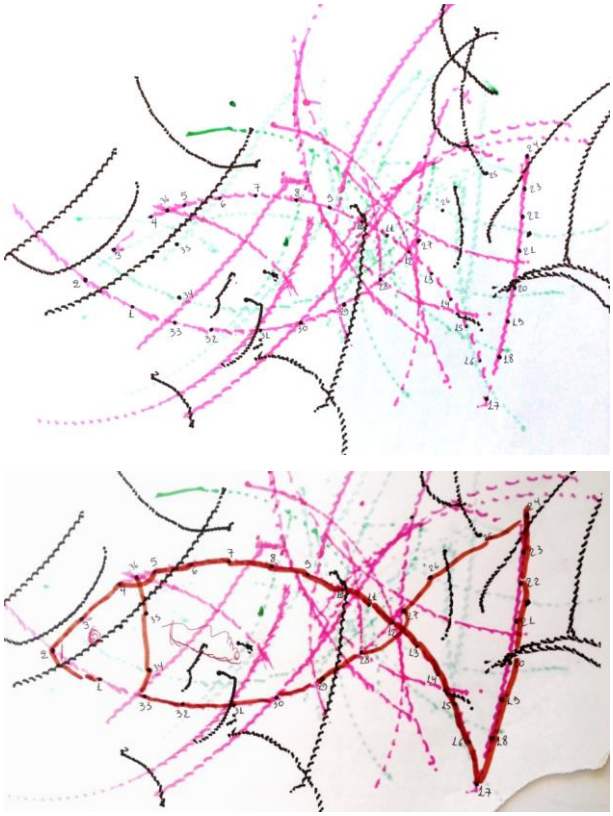

Figure 8.a. (above) and 8.b. (below) Activity by Anastasia Zoi Souliotou in the frame of TALOS-ed-UTH-robotix programme (website: https://talos.uth.gr) at the University of Thessaly in 2018. The child drew a fish on a pattern of artbots by joining the numbered dots

During the discussion with children, it was said that something like this happens in the night sky with the celestial bodies and the constellations. The children were given an astronomical chart in order to become familiar with the night sky and the constellations seen at specific dates and times of the year. Then a reference has been made to the history of the constellations and how people in ancient times, who lived in the open air and watched the night sky in a pure atmosphere, sought harmony and created connections among the stars forming, thus, constellations. These constellations were established shapes which took other dimensions in the human mind. Thus, humans created many kinds of stories and thrills about the constellations, as for example the ones related to the Greek mythology. (Siradakis and Avgoulopis, 2004: 9, 10)

Then the *Dots competition* was held where each child made as many dots as possible on A3 paper for 5 minutes and the winner would be the one who made the biggest number of dots. The artbot in Figure 1.D. participated in the competition and won! The words of the children during the competition are indicative and reveal their passion for the activity: "Hey, we are better than you, my poor artbot .. !!!", "Hurry up, my marker !!", "I beat the artbot .. !!!".

After the competition each child connected dots on the A3 paper and created their own constellations which they would name. There were some interesting constellations which have emerged from this process like the constellations "heart-like", "penguin" of Figure 9 which were created by Anna (2nd Grade, Elementary School).

Figure 9. Activity by Anastasia Zoi Souliotou in the frame of TALOS-ed-UTH-robotix programme (website: https://talos.uth.gr) at the University of Thessaly. Anna (2nd Grade, Elementary School) created her own constellations joining the signs and gave names such as "heart-like", "penguin", 2018

In *Beebot Eurotrip* project (Figure 10), which was realized during the Nea Genia Ziridi 7th IT Festival held in Athens (Greece) on 19th May 2019, kids were programming the Beebot to go from one country to another. Then the Beebot moved on the political map of Europe with a marker tied on its back enabling it to leave behind a trace of its route. The map was soon filled with a lot of routes and formed a network which extends from Pakistan to Portugal and from Iceland to Northern Africa. This activity helped the kids to count distances on the map and also to learn geography as well as basic principles of coding while drawing on the map. Thus, *Beebot Eurotrip* brings together art with science, technology, mathematics and geography.

Figure 10. Anastasia Zoi Souliotou, *Beebot Eurotrip,* a beebot is drawing routes on the political map of Europe and Near East, Nea Genia Ziridi 7th IT Festival, 2019

It is important to highlight that in *Beebot Eurotrip* the beebot becomes artbot in order to leave the trace of its routes, which represent the "trips" of the participants on the map. In this way it reveals the choices of all participants and forms a collective network of connections among different countries. This increases the sense of the community among participants.

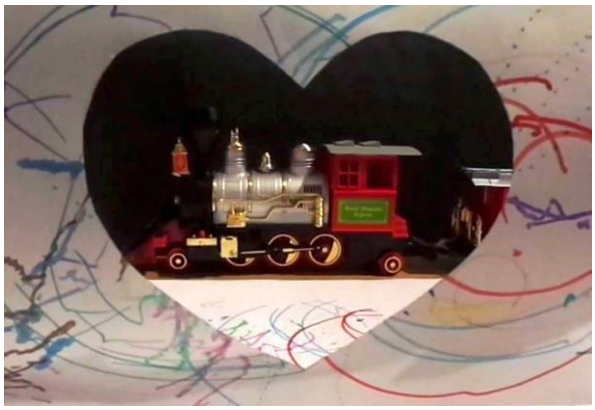

Figure 11.a. and 11.b. Anastasia Zoi Souliotou, Screenshots from *HEARTBOTS*, the entire movie is available at https://vimeo.com/311006972

The artbots of this paper can, however, be incorporated into wider artistic activities that do not necessarily include drawing alone.

First of all, artbots are constructions with recyclable materials and, thus, can be associated with contemporary art streams in which useless objects and recyclable materials are used for art-making, such as junk art and trash art. Furthermore, the ability of artbots to move and draw with the aid of technologies also integrates them into robotic art.

Another example in which artbots can be included in an interdisciplinary, as well as in a wider artistic context, is the short film *HEARTBOTS* (Figure 11, the entire movie is available at https://vimeo.com/311006972) in which artbots create a collective drawing in the shape of a heart giving a message of love.

This film was created by the writer in order to propose a new kind of theatre, the artbots theatre in which artbots move and create drawings that give extra information about the case and the plot of the play. This particular genre can be included in the puppet theatre when all artbots are dolls that the animator puts into operation. However, the artbots theatre can also be considered as a sub-genre of the theater of objects. The recent term "object theatre" tends in many cases to replace the traditional term "puppet theatre" (Pavis, 2006: 207) and includes small-scale animations and representations in which the animator gives to the objects a role and they dissociate themselves from this role, as the latter is moved into objects of different kinds. (Djenane, 2019) In the case of the artbots theatre, the term "theatre of objects" is more precise than "puppet theatre", since artbots may not be dolls, but objects that have been transformed with a mechanism into artbots, as for example in the case of artbot 1.C. and with 1.F. which are merely objects and not dolls.

From the above, it becomes clear that the *HEARTBOTS* project combines visual arts with the performing arts as well as with science and technology.

The artbots theatre can be a theme of educational workshops where participants prepare and give a performance in which they animate and handle artbots. Alternatively, the final product of the artbots theatre can be a movie (as in the case of *HEARTBOTS*) which will be determined by the purpose and context of each workshop. The artbots theatre's educational activities are expected to promote interdisciplinary thinking, since, as demonstrated above, it combines various forms of arts, sciences and technologies. Moreover, the artbots theatre workshops can create collaborative learning conditions and cultivate a sense of responsibility for the participants.

3 CONCLUSIONS AND FUTURE PROSPECTS

The artbots presented in this paper are easy-to-make, easy-to-use and low-cost DIY constructions. Thus, the artbots art implemented in the above activities is accessible to all ages (from pre-schoolers to adults) and to most –if not all– social strata. Furthermore, the fact that all different people who participated in the above activities very much enjoyed seeing artbots drawing during the demonstration and then found interest in drawing with artbots, shows that activities with artbots attract, impress and inspire people of different age, social and cultural groups.

Moreover, the artbots activities of this paper involve merely the production of drawings and do not need perfect knowledge of any language or advanced skills in art, technology, coding or mathematics. This means that this kind of activities can be easily carried out in various intercultural, intergenerational and interdisciplinary contexts and they can bring together people by bridging many kinds of gaps: linguistic, cultural, social, political and economic.

Most of the activities presented in this paper are collective projects which increase the sense of the team as well as the sense of belonging to a community in the classroom and beyond.

Through these activities, it is understood that artbots are catalysts of artistic expression and creativity and at the same time they constitute a springboard for the cultivation of scientific thinking. Thus, the STEAM approach is achieved with a strong presence of the A (Art), while science and technology are used creatively.

The above statements show that artbots activities are a promising field of research and creation in education with multiple opportunities for original activities which benefit education and society.

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