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Roboable project: educational robotics for inclusive didactics

Progetto Roboable: didattica inclusiva con la robotica educativa

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Abstract

Roboable is a project aimed at weak users: the goal is to create a new edutainment tool that can convey therapeutic and rehabilitative contents. Moreover, the aim is to make technology accessible to create a playful and didactic tool that can also be loaded with therapeutic contents. The project draws inspiration from the expressive potential of the mask, already a well-known tool used by psychotherapy in order to bring out emotions and feelings. Once identified with the device, users have the opportunity to express their emotions; they are also motivated to maintain a high level of concentration and collaboration.

Keywords: inclusion; educational robotics; design; mask.

Abstract

Roboable è un progetto rivolto all'utenza debole: l'obiettivo è la creazione di un nuovo strumento di intrattenimento educativo in grado di veicolare contenuti terapeutici e riabilitativi. Lo scopo è quello di rendere accessibile la tecnologia per creare uno strumento ludico e didattico che possa caricarsi anche di contenuti terapeutici. Il progetto trae ispirazione dalle potenzialità espressive della maschera, già noto strumento di cui si avvale la psicoterapia allo scopo di far emergere emozioni e sentimenti. Attraverso l'identificazione con il device, l'utente ha la possibilità di esprimere le proprie emozioni, motivato a mantenere un alto livello di concentrazione e collaborazione.

Parole chiave: inclusione; robotica educativa; progettazione; maschera.

1. Introduction

Roboable is a project and a kit aimed at users with Special Educational Needs (SEN). Its objective is the creation of a new edutainment tool that can convey educational, therapeutic and rehabilitative contents. It also aims to make technology accessible to kids and students with SEN and to create a playful and didactic tool that can also be loaded with therapeutic contents.

The project draws inspiration from the expressive potential of the mask, already a well-known tool used by psychotherapy in order to bring out emotions and feelings. By using the device as avatar, and mask, users have the opportunity to express their emotions, motivated to maintain a high level of concentration and collaboration. In the case of the application of Roboable for SEN, it ensures a continuous and updated engagement. Actually, visual, auditory and movement stimulations stimulated by Roboable kit and program are helping children express themselves using various kinds of instruments as transference.

Roboable is above all a system, an open-source work platform (a software whose authors, more precisely, the rights holders, make the source code public, favoring their free study and allowing independent programmers to make changes and extensions) and source-in-progress which can be accessed to create and share content. The kit includes a basic unit that can be interfaced with many sensor-fitted covers (masks), emotional devices equipped with sensors (Figure 1).

In 2015 Roboable kit – developed by the School of Robotics and by the Artù Association – entered its beta phase and in 2019 will become a standard educational tool. In 2017, thanks to the support of the Piacenza and Vigevano Foundation in Italy, the robotic kit was donated to all Comprehensive Institutes of the province of Piacenza and it has been tested in a primary and secondary schools in Piacenza and Piacenza Province in 25 Comprehensive Institutes for a total of 170 schools and several thousand of children.

Roboable masks can display several shapes (theoretically, almost all shapes we could imagine or educational purposes): now they are the shape of a fairy's wand, of an umbrella, of a fan, of a bee, of a turtle, a car, of a snorkel, and of a drum. All the covers interact with supports (PC and projector, smartphone and tablet) capable of reproducing interactive game scenarios appropriately designed (using Scratch 2.0) and downloadable for free from the dedicated website.

Figure 1. One of Roboable covers, here shaped as a fairy's wand.

The essential design principles adopted are axioms centered on human beings that express the general philosophy embraced by the project, based on user satisfaction, and not subject

to the pressures of technology (Norman, 2012). The project has tried to take its first steps based on the axioms of: simplicity, versatility and pleasantness (Beckhaus & Kruijff, 2004):

- simplicity: Roboable's complexity was measured with respect to functional complexity, not to the instrument, as the technology must always be *invisible*. For this reason it was decided to work on a formally simple object, which in turn led to the simplicity of realization, and finally to the simplicity of use;
- versatility: Roboable was designed to allow and encourage innovation and creative interaction;
- pleasantness: Roboable was designed to be pleasant, fun and enjoyable. Pleasant to use and to own.

The base unit is the true heart of the Roboable system. Inside there is an Arduino hardware board and a rechargeable battery via USB (while the sensors are housed in the covers). The base unit also has two side rooms to allow it to be attached to the covers.

The device has a symmetrical shape that makes it equally usable by right-handed and left-handed users. Its octagonal section takes inspiration from the shape of the tennis rackets handle. This section is very functional and ergonomic as it allows different types of handles.

This feature has made Roboable suitable for use in the base unit, which must be easily and differently challenged depending on the cover and the interactive scenario of reference. The size and the ratio between the lengths of the sides of the octagon are the result of comparison and study on the standard measures of racket handles for children.

Roboable can also connect to the Wi-Fi network, to any computer and can interact with the free Scratch 2 software.

1.1. Technical Card

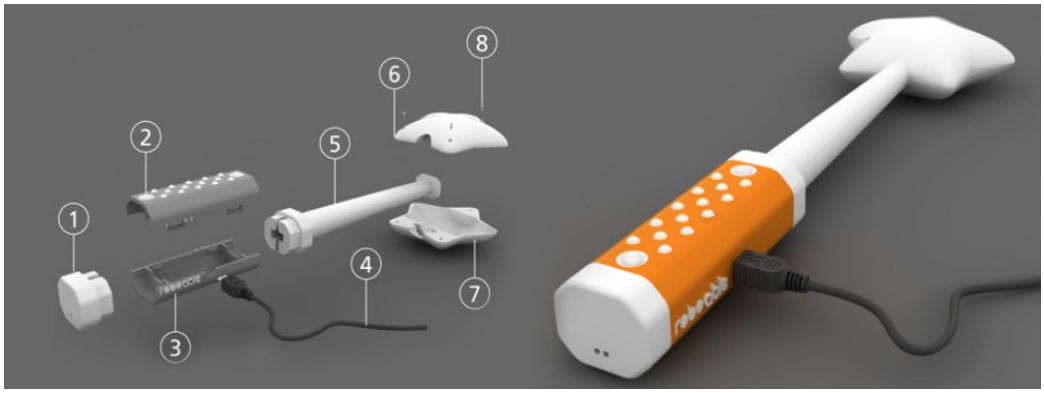

Figure 2. Roboable exploded.

Roboable consists of (Figure 2):

- many Recyclable plastics covers;
- a Wifi connection;
- an Accelerometer;
- a Gyroscope;
- a Magnetometer;
- four connection ports for digital IO devices;

- vibration;
- rechargeable battery up to 5 hours of intense use;
- thread compatible with most commercially available plastic bottles.

2. The expressive and educational potential of the mask

Masks are used in theatre, for performance, entertainment, disguise, concealment, or protection. They have been worn since ancient times and have been used in rituals, storytelling, and dramatic acting. Wearing a mask invites people to explore and express the emotions one may conceals or hide from the world. A mask could be any communication tool or costume we use to express ourselves as a façade offered to the world. It could help to disguise and repress those features and traits that are not approved (emotions considered negative). One may also express through the mask other aspects such as creativity, self-confidence, intellectual giftedness (it is the case of many gifted children, for instance) when these qualities are not appreciated.

For most of us self-consciousness includes a feeling of embodiment and perhaps the face is the part of the body that we consider *more body* than all the other parts. The embodiment of our face is central to our emotional existence and our social relationships. This allows us to transfer the expression of our emotions onto masks (mediation and at the same time curtain of our face).

The use of masks in the classroom for educational and social purposes is much less known, and rarely associated to traditional education. However, when using masks, students are able to disassociate from their sense of self, allowing them to engage without inhibition. They become able to view ideas and each other with a greater depth, as well as being more engaged (Roy, Baker & Hamilton, 2015).

In SEN, and chiefly in the case of children with Autism Spectrum Disorder (ASD) theatrical storytelling therapy could help them to view themselves as being separate from the problem; they are not the problem. Theatrical mask allows children to use their imaginations to create a dramatic reality, a reality they live and that they could not only express, they could use to communicate with others, sharing their internal world, see outside of themselves, confront stressful situations, and assume a positive attitude necessary for their development. With the mask that has an outside and an inside, children could imagine *how others see them*, outside of the mask and *how they feel inside*. For children with ASD who need to explore their emotional life this way is a deep and liberating experience.

Figure 3. Roboable cover in the shape of a snorkel.

The masks (covers) imagined and created in the frame of Roboable have the form of animals or objects that children may have seen, used or appreciated through cartoons. The snorkel (Figure 3) was much appreciated because with it children moved fish and other pictures on the monitor, representing flora and fauna of the marine environment that had previously been made using Scratch 2.0. Other masks (the umbrella, the car, the drum, the bee, and so on) inspired many games and stories, where these covers intervened during the narration.

3. Roboable for children with ASD

Among the so-called developmental disorders, autism is perhaps the least known, however it is less rare than one can believe: the most recent data indicate an incidence of 1: 100 and the ratio between females and males is 1: 4 (Moldin & Rubinstein, 2006). The symptoms of autism tend to be permanent, but can vary with significant improvements in many areas of development if an early and adequate educational intervention is implemented.

In the area of social communication there are compromises both in the development of verbal and non-verbal language, and in the ability to start a social interaction and respond to the initiative of others. In the behavioral area, on the other hand, children with autism show a deficit in imagination, which is evidenced through a restricted repertoire of activities and interests, with repetitive and stereotyped behaviors.

Autism manifests itself in a very heterogeneous way and rarely two children have similar autistic traits. There is also talk of *autism spectrum disorders* and *autistic syndromes* as the disorder can be considered a continuum of conditions that have many characteristics in common and whose borders are blurred.

These include Asperger's, Heller's and Rett's syndromes and the so-called Pervasive Developmental Disorder. With the advent of the last DSM-5 (APA, 2013) an important modification was introduced: first we could speak of Asperger subjects while now this wording has been eliminated and falls within a series defined as autism and which can have different levels from those more serious to that subthreshold or variant to the standard.

Roboable wants to break the complexity barrier of many devices in relation to learning, use and maintenance, and has been designed to perform a specific function and its shape has been designed to be appropriate to the desired usage modalities as it is given great attention to user preferences.

The project aims to provide hospital staff and/or family members, teachers and volunteers with a new tool to dialogue and to *connect* to the specificities of users with autism spectrum disorders. The exceptional nature of the project lies in giving the possibility to interact also to those who live in situations of extreme cognitive or motor limitation. By virtue of its elementary technical and technological morphology, Roboable can easily be adapted to different needs and situations from time to time, can grow together with its user, even become an element of play in pairs or groups. The activity carried out has highlighted how the use of the Roboable system is well suited to achieving the most important objectives for individuals with autism.

Social objectives: Understanding the elementary rules to participate in social exchanges and cooperation-based activities such as looking into other people's eyes, waiting for their turn, sharing material, etc. Development of the ability to interpret the social behavior of others – to understand if another child wants to play or not. Understanding of compliance

with the times and methods of social interactions. Development of problem solving skills to face personal difficulties or those that can be encountered during a relational exchange.

Communicative-linguistic objectives: In this sector the priority was to teach the child to use communication systems that allowed him to express his desires and emotional states and to understand those of others even beyond the literal content. Furthermore we worked on how to correctly understand and use non-verbal communication and to understand the aspects linked to the pragmatics of communication (for example, personal data, telephone numbers in case of loss or danger).

Cognitive objectives: In the cognitive sphere autistic children must be helped in the acquisition of those skills that allow them to notice regularities in the environment, draw inferences and act in a finalized manner. So, we worked to try to help them develop the ability to represent themselves in an integrated manner with the physical, functional and conceptual properties of the reality that surrounds them (for example, coupling / dividing objects or images based on their shape, function or other abstract properties); to manage different tasks or different information simultaneously (multi-tasking) to find effective solutions to solve problematic situations.

Affective-relational goals: In the cognitive sphere autistic children must be helped in acquiring those skills that allow them to notice regularities in the environment, draw inferences and act in a finalized way. So, we worked to try to help them develop the ability to represent themselves in an integrated manner with the physical, functional and conceptual properties of the reality that surrounds them (for example, coupling / dividing objects or images based on their shape, function or other abstract properties); to manage different tasks or different information simultaneously (multi-tasking) to find effective solutions to solve problematic situations.

Sensory objectives: In the sensory sphere the objectives identified by the team of didactic experts were to teach the child to actively avoid certain sensory stimulations, which interfere with learning and hinder participation in shared activities, replacing them with socially more acceptable ones; to tolerate the stimuli to which it is hypersensitive (noises, sounds, brightness); to work in crowded and noisy situations.

The latent aim of all the identified objectives is obviously that of autonomy: one of the most important and gratifying things to grow and become pro-social adults, safe, satisfied with themselves and ready to interact with others in a constructive manner. In fact, autistic children often need assistance in simple everyday routines (dressing, washing, eating, going to the bathroom), because they do not spontaneously pay attention to others and therefore do not try to imitate them. Activities carried out in the frame of Roboable project have tried to teach these children to divide each complex routine into many small gestures, one sequential to the other, and to organize the environments and materials to facilitate the planning and execution of tasks.

4. Roboable educational scenarios of real situations

Roboable scenarios of real situations (in artistic simulation) developed for the kit are inspired by non-formal/informal educational and edutainment methodology. In the case of the kids in need of special education, educational barriers could be represented by:

- the logical-critical barrier, product of a school environment, and of negative experiences experienced as a child such as report cards, exams;

- the intuitive-emotional barrier that influences those who do not trust their abilities, mistrust reinforced by stereotypes or prejudices;
- the fatigue barrier: I stop – or I don't even start – because learning is neither easy nor fun.

The aim of Roboable is to prepare an educational environment where educational experiences are positive, cheerful, global learning scenarios, where everyone has an active role.

For each emotional mask or cover, a dedicated interactive scenario is developed that conveys specific contents (essentially didactic or recreational). The objectives of the scenario are simple and intuitive in some cases, complex and articulated in others, depending on the capabilities of the potential user. Precisely because of its adaptability, Roboable is able to develop interactive scenarios even for situations of extreme mental and physical discomfort.

The Scratch 2.0 programming language leverages a graphic structure that translates the elements of programming into *blocks* to build and then relate to each other. Objects can be chosen from a library, as well as imported. Once stacked in blocks, it allows you to choose which action to perform. The slogan of Scratch online community *Imagine, Program, Share* focuses on sharing and on the social aspects of creativity as a fundamental part of the Scratch philosophy.

4.1. The developed scenarios

The Pina Bee (Figure 4).

Figure 4. The Pina bee: a Roboable cover and scenario.

Goals of this scenario:

- fine motor skills;
- caution;
- form recognition.

The mother turtle (Figure 5).

Figure 5. The mother turtle a Roboable cover and scenario.

The purpose of this scenario is to find the tortoise's mother's children hidden in the game room. In this application the Roboable magnetometer sensor is used. In fact the turtles hidden in the room will be equipped with different names and numbers of magnets, thus allowing their recognition. It will be enough to place the Roboable base on the found tortoise and the application will recognize its name. All user speed data is saved and exported at the end of the activity.
Goals of this scenario:

- interaction with space;
- caution;
- form recognition.

The Lambo Race (Figure 6).

Figure 6. The lambo race: a Roboable cover and scenario.

The purpose of this scenario is to drive a car to a target point through the intricate roads of different maps, avoiding going off-road. All user speed data is saved and exported at the end of the activity.

Goals of this scenario:

- fine motor skills.

The Moto Life (Figure 7).

The purpose of this scenario is to drive a scooter on a road collecting hearts and avoiding obstacles and trying to stay on the road. In this application Roboable is used as a throttle grip on a motorcycle handlebar. All speed and accuracy data of the user are saved and exported at the end of the activity.

Figure 7. The moto life: Roboable cover and scenario.

Goals of this scenario:

- fine motor skills;
- caution;
- form recognition.

The first swimming (Figure 8).

The purpose of this scenario is to hatch turtle eggs by beating Roboable 10 times and then guiding the unborn to the sea avoiding litter on the beach. All speed and accuracy data of the user are saved and exported at the end of the activity.

Goals scenario

- fine motor skills;
- caution;
- form recognition.

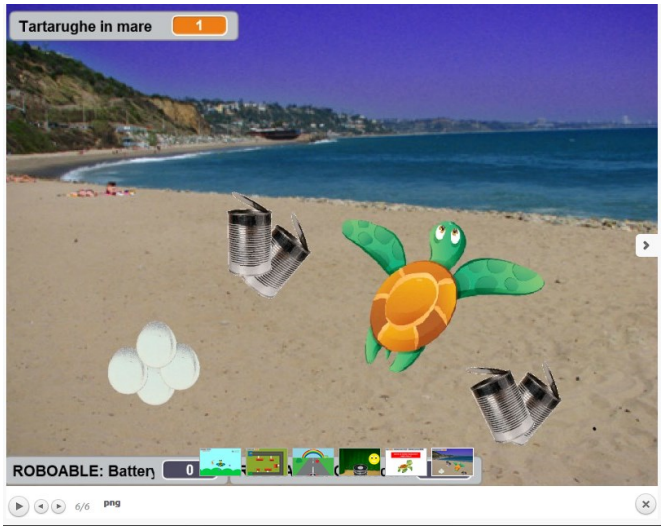

Figure 8. The first swimming: a Roboable cover and scenario.

The drum (Figure 9):

Figure 9. The drum: a Roboable cover and scenario.

The purpose of this scenario is to play a drum for a present period of time by moving Roboable as if it was a drummer's wand.

Goals scenario

- fine motor skills;
- time concept.

5. Conclusions

From 2016-2017 the School of Robotics has created several training courses for teachers on Roboable. Based on the scenarios described, the teachers developed inclusive learning units which were then tested at school. The kit was presented to Handimatica (2016), Maker Faire European Edition (Rome, 2018), Orientamenti (Genoa, 2018), and during the European Robotics Week (2017). In 2019, next steps will be to standardize the Roboable kit for every type of primary and secondary school and to spread it throughout the national territory.

Figure 10. Children playing with the Roboable cover shaped as a fairy's wand.

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