The Role of Technology in Protecting the Environment: Evaluating the Liquidity of Interactive Waste Bins

Fabiana Neiva Veloso Brasileiro[1], Jully Elias Melo[1], José Eurico de Vasconcelos Filho[2] and Lucas de Abrantes Marques[2]

[1]*Ocio, Educação e saúde: Investigações conceituais, básicas e aplicadas em Análise do Comportamento, Universidade de Fortaleza, Fortaleza, Brazil*

[2]*Nucleo de Aplicação em tecnologia da Informação, Universidade de Fortaleza, Fortaleza, Brazil*

fabianaveloso@uniforbr

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Abstract: Issues related to the pollution of ecosystems and possible alternatives for their preservation are present in various debates. Behavior analysis has been devoted to the study of sustainable social behaviors and cultural practices involved in such problems. In this perspective, the project presented is an evaluation of the effectiveness of the "Interactive Waste Bin", a prototype developed by the Nucleus of Information Technology Application (NATI) that emits a sound after trash disposal, developed as an alternative to traditional waste bins models. The hypothesis is that the use of "interactive waste bins" is more efficient for the acquisition and maintenance of the behavioral patterns sought, reducing pollution levels and their effects for future generations through the use of immediate social reinforcement. To achieve the proposed goal in the project, there will be experiments aimed at exposing people that walk inside UNIFOR to the equipment, called the "interactive waste bin". The volumetric monitoring tool contained in the bin will count the waste dumped. The study will contain a Baseline Session (SA1); Intervention Sessions (B) and Baseline Return Session (SA2), seeking to evaluate the maintenance of the obtained effect.

1 INTRODUCTION

In the scenario of 21st century society, there are daily debates that raise questions about the availability of quality water, the reduction of biodiversity and changes in the world climate in the coming decades. (Zulauf, 2000). Ferreira (1998) discusses the lack of commitment of the human being in the exploration of nature, which generates, consequently, a constant situation of environmental degradation.

Social processes related to the environment and its preservation have been continuously studied by Behavior Analysis aiming not only to understand the phenomenon, but also the search for effective ways of modifying cultural practices that threaten the quality of life of future generations. (Camargo, 2014). In order to be able to intervene in inappropriate human practices, it becomes necessary to understand why certain behaviors occur. Starting from this problematic, the Analytical Behavioral theory brings the definition of Operant Behavior.

Galvão and Barros (2001) point out that the main characteristic of this category of behaviorism is that they are controlled by their consequences, that is, in the act of behaving the human being produces consequences in the environment and these consequences may define or not the future probability of repetition of that specific behavior. This science argues that if these consequences are responsible for maintaining the behavior in question, it is said that it has been reinforced; if this consequence has contributed to the reduction of the frequency of the behavior, it can be said that it has been punished.

Conducting studies in the area of social behavior, however, demands analyzes that go beyond the observation and study of behaviors of a specific individual; in case of studies on culture a broader analysis is required, after all, social behavior involves interlocking systems of behavior. (Skinner, 1953). There is then a third level of selection, cultural selection, which will occur when "Behavior can be passed from one organism to another, as in imitation, or more importantly in language" (Catania, 1998, p. .57).

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The concept of Macrocontingency becomes relevant to the this research, since it refers to unrelated operant behaviors of individuals that, when performed by a large number of people, generate effects of social importance. It is the case of individuals who drink and drive, or, in examples applied to the theme worked in this study, when a specific individual chooses to throw a plastic packaging away, instead of looking for a trash can, or even , when someone prefers to leave his/her house on a Sunday morning, alone, in a car, instead of using the bicycle and public transportation knowing that this is a great alternative to reduce pollution. The problem, however, lies in the fact that, as already mentioned, in macrocontacts we have the sum of transformations generated by individual practices of several individuals, causing cumulative effects that can generate serious environmental issues. (Malott & Gleen, 2006).

According to Perozzi and Carrara (2012), the strategies currently used to promote the practice of throwing garbage in suitable environments are limited, mainly to the mere distribution of information about how the individual should behave, as well as verbal descriptions about probable future consequences. Still according to the authors, "participants, at the end, are more able to verbalize about the importance of preservation and conservation, than, properly speaking, to be involved with effective pro-environmental actions" (p.120).

This type of strategy, commonly used to modify population behaviors, is described in Behavior Analysis as a rule. Rules, for Schlinger and Blakely (1987), are function-altering stimuli, and involve the verbal behavior of the person who issues it, describing contingencies, that is, through the rule it becomes possible to learn new behaviors without it being necessary access the contingencies directly. The rule announces the stimuli (antecedent and consequent) and the response, for example: "Water: saving is better than being without". Skinner (1969), however, warns that the effect of this stimulus is not as effective as the direct contingency modeling, since in this case the immediate consequences of the behavior, not simply the probability, are responsible for changing the functions of stimuli.

Starting on this point of view, Perozzi and Carrara (2012), based on the definition of operant behavior, say that, in order for successful practices to take place, it is important to plan the consequences of individuals' actions, objectives or not. Thus, the central problem of the issue arises from conflicts between behaviors with immediate consequences that bring advantage to the individual (getting rid of the garbage quickly by throwing it on the ground) and behaviors with consequences that are late, but which bring benefits to the group in the long run (a clean and unpolluted environment, which would avoid contact between artificial materials and nature, as well as avoidance of floods and diseases), in which case the subject is led to choose between behaving in order to benefit immediately, or advantages in the future for an entire population.

Based on the above definition, the problem of controlling mass behaviors in favor of preserving natural resources lies in the fact that the consequences of the littering, degradation and expense of natural reserves, despite being punitive, are in the future, so that the consequences of these actions are delayed and do not affect us, and, therefore, they do not control people's behavior. (Camargo, 2014). According to Medeiros et al (2001, page 130), "people only commit to the environmental issue and do something about it when the consequences of their initiatives produce information in the short term or bring some kind of benefit to them." From this, an alternative to the problem would be to devise an action that makes it possible to change the behavior of the largest number of people involved, however, it is necessary to identify and change operant contingencies of the individuals who maintain the habit (Glenn, 2004).).

One of the methods of behavior modification adopted by Behaviorism is related to the use of games to change behaviors established in daily life. According to Momford et al. (2014, page 25): "A series of measures, which we collectively label as" Gamification ", refer to efforts to redefine life activities, drawing on game design methods" (Apud Deterding et al. 2011; Kapp, 2012). The difference of this idea lies in the fact that, when a subject deals with games, the consequences of most of the actions taken by him during the process are immediate and, therefore, are more likely to exert control over the desired behaviors. (Momford et al., 2014)

The present study seeks to propose the use of a similar proposal to the methodologies described above, called an interactive waste bin, as a way to evaluate if the effect of immediate reinforcement on the wanted behavior (the dumping of waste in suitable environments), generates an increasing in the frequency of these behaviors. in other words, the overall objective of the experiment is to test whether the volume of trash dumped in the trash increases when a sound (immediate reinforcement) is added as a consequence of the trash throwing behavior in the proper environment.

The idea of the waste bin and its design model was inspired by an initiative, called The fun Theory,

promoted by the Volksvagen car brand, which conducted a series of experiments for campaigns that sought to reduce environmental impact without affecting or compromising the joy and fun of people, the campaign aimed to prove that fun can change behavior for the better. The central questioning of the creators of the "The world's deepest dump" program about having fun using a bin. For this, a regular garbage device, equipped with an infrared device and a speaker, that released a sound when something was dumped inside, was placed in a square and filmed, so that the reaction of the passers-by could be analyzed. As a result, the apeaking waste bin had gotten 41 kg more garbage thrown in him than the regular waste that was located in a short distance away. (Janson, 2016).

2 METHODS

2.1 Study Schedule

This research is characterized by the use of the almost-experimental method. A monitoring and observation procedure with ABA structure was carried out, in which the trash was initially evaluated under normal conditions and exposed in the next phase to an intervention to return, in the third stage, to conditions of group A.

2.2 Proposed Methodology

A trash bin developed by the NATI (Information Technology Application Center) was placed in a specific block of the University of Fortaleza (UNIFOR), to test the effectiveness of the tool. The collection occurred on specific days of the month of October and November of 2018, the experimental subjects were passers-by from the mentioned institution.

2.3 Research Type

The almost-experimental research method was used, since it was an applied research, in which it was aimed to have experiments that involved the planning and delimitation of conditions, allowing comparisons between situations, in a way that, the subjects were subject to conditions, in order to measure performance.
However, given the short time available and the type of data sought, it became impossible to fulfill some of the criteria that would guarantee maximum degree of population control and variables involved in the study, as a control group, which justifies the fact that the research is almost experimental. (Cozby, 2003).
The comparison starts with the analysis of the results obtained in the baseline and the analysis of the frequency differences noted after the introduction of the determined variables; the last phase, will occur after phases A and B, trying to evaluate the maintenance of the effects of the trash after the determined time.

2.4 Delimitation

The design used in the present study, as previously mentioned, was A-B-A, after all, it was sought to make comparisons between data collected over several phases. Therefore, the study counts with an initial stage in which behavior waste bin is evaluated in the baseline, (A1), then the introduction of an intervention (B), then returning to the initial phase, so as to remove the variables previously added (A2) to compare effects and results. (Velasco, Mijares & Tomanari, 2010).

2.5 The Location

Observations occurred in Block D of the University of Fortaleza (UNIFOR), the criterion for choosing the block was that it contained a large flow of people circulating, containing a snack bar in the occupations, which would generate garbage demand to be played. possibility of connecting the trash to an outlet. The place of accomplishment and all the requested physical conditions were authorized by the direction of Unifor. The collection always took place in the morning shift, beginning at 11 o'clock. On the days scheduled for collection, NATI members moved the bin from the lab to the indicated block and removed it at the end of the set time, so that passers-by had access to the bin only in the two-hour search time. The collection was always done at 1:00 p.m. The trash bin was located right next to a snack bar that works on the block next to one of the exits.

2.6 Materials and Equipment

- 1 Waste receptacles (interactive bin);
- Smartphones apparatus to monitor the number of residues collected daily;
- A device to connect electrical equipment, since the produced trash demands to be connected to electrical energy.

2.7 Prototype

For the prototyping phase of the waste bin, it was used methodologically the Interaction Design (Rogers, Sharp, Preece, 2015) that contemplates 4 interactive activities, 1) identify customer needs and establish technical requirements, 2) propose design based on requirements 3) build an interactive version and 4) evaluate (Figure 1).

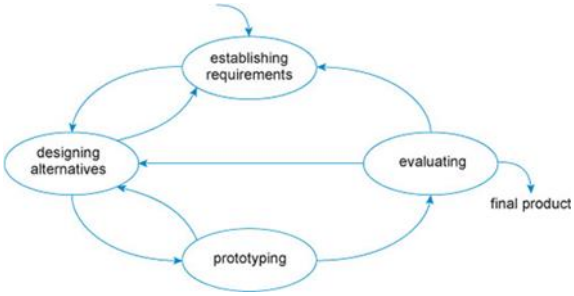

Figure 1: Interaction Design.
Font: Rogers, Sharp, Preece, 2015.

The main technological requirements for the waste bin were identified as:
1) sensing the deposit of any type of trash in the bin and emitting configurable sound;
2) dynamically calculate from the data collected by the sensor the percentage of filling of the waste bin to each garbage deposit effected;
3) send by data network the percentage of fulfillness;
4) The embedded hardware system should not be visible to users in the bin. The trash bin selected for the project is a standard trash bin used by the city's city hall (see Figure 2). It is composed of a holder integrated in the lid that allows the fixing of the dumps in a metallic structure, the container is made of plastic material resistant to climatic variations as well as the lid.

Figure 2: Waste bins used in the project.

The proposed design for the hardware that makes up the interactive waste bin solution includes:
1) sensors and loudspeakers that are affixed to the upper inner side of the bin lid, avoiding contact of the trash deposited with these components.
2) data processing system and network connection that sits in a box printed on a 3d printer which is affixed to the external support part of the bin (back) being waterproof and not being visible to users. The sound emission and sensing system is connected by wires exiting the back of the bin lid with the network connection and processing system.Associated with the interactive waste bin, there is a web system that receives the data sent by the bin, allowing the research team to track the percentage of accumulated garbage data.Hardware components used for the bin prototype were (see Figure 3):
- Microcontroller NodeMCU-32S from the manufacturer Espressif: responsible for connecting the device to the Internet and sending collected information;
- Ultrasonic Sensor: sensor responsible for the volume of waste;
- LDR sensor: light sensor that is positioned at the entrance of the bin to detect the dumping of incoming objects;
- Laser emitter;
- DFRobot mp3 module; responsible for sound storage;
- Sound amplifier module: responsible for volume control of the reproduced audio;
- Speakers 3 watts: responsible for the release of sound.

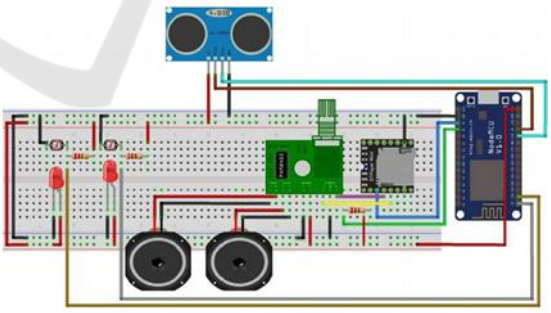

Figure 3: Schematic model of the circuit (hardware) implanted in the bin.

2.8 Data Collecting Period

The data collection was performed on specific days of each week of October, aiming at ensuring that the same experimental subjects participated in both phases of the experiment. The choice of the month and the short time for collection occurred due to the

limited amount of time provided by the discipline, added to the waiting period for preparation and improvement of the interactive waste bin, requested by the developers of this project. Another unforeseen event was the number of holidays this month, on Mondays and Fridays. In order to avoid interference from possible foreign variables, it was agreed that the collection days should be the same during all the weeks scheduled for the experiment, always on Tuesdays, Wednesdays and Thursdays, dates that were not affected by the holidays in none of the corresponding weeks. With the possible time for collection, the first three were destined to the phase A experiment; plus four (4) days for phase B; and (three) 3 days to return to phase A.

2.9 Collection Procedure

2.9.1 First Phase

The waste bin without sound activated technologies was placed for three (3) days of the week in a fixed environment within the University for two hours. At the end of the combined schedule, the collected waste was monitored. Every day someone was making the observation during the collection period.

2.9.2 Second Level

In the second phase, the same garbage deposit was positioned for four (4) days, at the same time and place and day of the week where the phase A was carried out. At this stage, however, the trash contained a sensor that releases a sound every time a residue is deposited in it. For the audio, the characteristic song from the game "Super Mario ", because this is a game very popular among varied generations.
The Interactive Waste Bin emitted an immediate sound of three seconds each time a residue was deposited. The reinforcement scheme of the study was CRF (Continuous Reinforcement Scheme), that is, whenever a waste was thrown in, reinforcement was issued. (Galvão & Barros, 2001). Once again, at the end of the collection, there was the analysis of the percentage of waste registration.

2.9.3 Third Phase

During the last week of October the vessel returned under the same conditions to the places where phase A and B had been carried out. There was therefore a return to baseline, where again the bin did not emit sound.

2.9.4 Inclusion Criteria

Passers-by from the University of Fortaleza, more specifically from Block D, with the possibility of being students, employees or visitors.

2.9.5 Inclusion Criteria

People who do not cross the environment of block D of the University of Fortaleza.

3 RESULTS AND IMPACTS

The results have not yet been fully collected and compiled, however, it is expected to prove that the immediate social reinforcement, that is, the sound produced in the act of throwing the garbage in the appropriate container, is more efficient in controlling the behavior of the individual and increase the volume of garbage in the waste bins that are used by the prefecture of Fortaleza and University of Fortaleza under normal conditions.It is hoped to prove that initiatives such as these are capable of contributing to the modification of the behavior of the subjects, so that there can be greater adherence by the population to the preservation of natural resources and a contribution to environmental reeducation.

4 CONCLUSION

It is concluded that, taking into account the environmental reality in which the planet is located, it is essential to create alternative technological measures to what is already thought, so that it can contribute to the establishment of a sustainable culture that is essential for the maintenance of resources for the next generations.The interactive waste bin therefore appears as an example of alternative proposals, which have already been used in various parts of the world. The present work, besides showing that this initiative is in accordance with the principles that were proposed by the Behaviorism, proposes, also to test the efficiency of the model quoted.

REFERENCES

Camargo, J. C., 2014. Desenvolvimento Sustentável: Uma Análise Experimental do Comportamento de Extração de Recursos em Microssociedades de Laboratório. Programa de PósGraduação em Análise do

Comportamento da Universidade Estadual de Londrina. Londrina.

Ferreira, I. S. Poluição e tutela ambiental. *Revista da Faculdade de Direito, Universidade de São Paulo, São Paulo*, v. 93, p. 249-288, jan. 2014.

Galvão, O.F; Barros, R.S., (2001) Curso de introdução à análise experimental do comportamento. *CopyMarket.com, 2001*.

Glenn, S. S., Malott, M. E., 2004. Complexity and Selection: Implications for Organizational Change. Behavior and Social Issues, 13(2), 89-106.

Medeiros, J. G., 2010. Efeitos de sinalização por meio de legendas sobre o comportamento de separar lixo em restaurante de uma universidade pública. *Psicol. teor. prat., São Paulo* , v. 12, n. 2, p. 127-143, fev.

Rogers, Y., Sharp, H., Preece, J., 2015. Interaction Design: Beyond Human-Computer Interaction. *4. ed. Wiley*.

Zulauf, W. E., 2000. O meio ambiente e o futuro. *Estud. av. São Paulo*, v. 14, n. 39, p. 85-100, Aug.