Justifications on the behavior in relation to the consumption of electric power at home and at work: a qualitative analysisa

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***Abstract*—The main contribution of this work is the development of a qualitative analysis on the behavior of a group of university students and teachers in relation to the type of motivation revealed by a process of awareness about their domestic electric energy consumption. The identification of this behavior profile enables the organization of motivational messages that, when sent to users of mobile technologies, can enhance the ubiquitous learning process in this work related to environmental education. The methodological approach used was the Discourse of the Collective Subject, which is a method that allows the researcher to know and describe descriptive opinions and representations, allowing the delineation of behavioral profiles. In the results we can observe the need for greater clarity regarding the information related to energy consumption. However, for this information to achieve a change in consumer behavior it is necessary that it be customized. This information can auxiliary to the learning process, due to the fact that technology is increasingly integrated with "anytime" and "anywhere" human actions and behaviors, providing a learning process that can be obtained on any occasions, contingencies, circumstances and contexts**

***Index Terms*—Energy consumption behavior, discourse of collective subject, influence of technology.**

I. Introduction

The Brazilian Electric Energy Agency approved in 2017 a rate increase of approximately 29% in its service charge. In the South of the Brazil, in the State Electric Power Distribution Company, the rate can vary between 29% and 34%, representing the highest historical increase in the whole national territory [1]. In addition to this tax increase, [2] observed a growth in residential electric energy consumption in Bazil and Europe related to family income. Analyze these increase is a complex task. Since it involves the observation of a series of factors inherent in consumer behavior, such as: *(i)* population income growth; *(ii)* increase in the purchase of electrical equipment; and *(iii)* average time of device use. However, residential consumers can not see the individual impact of each equipment on its monthly consumption, and therefore in the cost of its electricity bill.

From this context, we believe that by stimulating processes of knowledge and awareness about the individualized consumption of devices can achieve a more sustainable behavior use in the population. For [3], all behavior is influenced by a motivation via human and nonhuman factors that are available in the social environment. The motivation can be of two types: intrinsic and extrinsic. Intrinsic motivation refers to individual's satisfaction when performing an activity, while extrinsic motivation is related to goals presented in the environment. Amotivation, on the other hand, is related to feelings of incompetence and lack of control. Both can be ordered over a *continuum* which ranges from lower to higher levels of motivation, considering the intrinsic as the highest level and the amotivation the lowest.

The main contribution of this work is the development of a qualitative analysis on the behavior of a group of university students and teachers in relation to the type of motivation revealed by a process of awareness about their domestic electric energy consumption. The opinion of the individuals was analyzed with respect to the following aspects: *(i)* the disconnection of household devices in the absence of the individual in the spaces of his/her residence; *(ii)* the impact of their energy consumption on the environment; and *(iii)* presentation of electric bill. The methodological approach used was the Discourse of the Collective Subject, which is a method that allows the researcher to know and describe descriptive opinions and representations. From these procedures we developed our research model, which aims in its final process to verify if mediations of ubiquitous learning, in the motivational processes of individuals, are able to qualify a more sustainable

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behavior. This process of knowledge acquisition characterized by ubiquitous learning consists of a type of open learning, obtained in any occasions and contexts from the use of technological artifacts. The remaining of this paper is organized as follows: Sec.2 describe the methodology. In Sec. 3 the results of the qualitative evaluation are discussed, and in Sec. 4 the conclusion and future work are presented.

II. Methodology

For the analysis of the behavior of a group of university students and teachers in relation to their domestic consumption of electric energy, was used the Discourse of the Collective Subject - DCS [4]. This methodology aims to demonstrate self-expression of a individual or collective opinion, respecting the qualitative and quantitative condition of each individual [4]. Allowing social representations to be expressed as facts inherent to the qualitative (speech) and quantitative (individuals) collectivity. The DCS is a proposal of organization and tabulation of data that were obtained from testimonials, being configured in a quali-quantitative analysis of verbal nature that presents as a result one or several speeches-synthesis written in the first person of the singular presenting the thought of a group or collectivity [5]. It consists in selecting, from each individual response of the testimony, Key Expressions, which are the most significant sections. In addition, the Central Ideas (CI) are also selected which are the synthesis of the discursive content manifested in the Key Expressions. The excerpts from the testimony (key expressions) are organized in discourses-synthesis from the Central Ideas.

For the composition of this DCS, we conducted interviews with the objective of extracting statements from Brazilian and Spanish reality. The interviews took place in the period from July 5, 2017 to July 10, 2017, in Spain and in the period from November 21, 2017 to December 4, 2017 in Brazil. The Brazilian sample consisted of 13 individuals, 8 teachers and 5 students, aged between 25 and 40, all members of a higher education institution. The Spanish sample consisted of 8 individuals, 5 students and 3 teachers, aged between 23 and 51 years, also members of a higher education institution. The issues were developed with the following themes and objectives: *(a)* individual's routine: self-perception, consumption behavior; *(b)* consumption behavior: residential and at work; *(c)* motivation and challenges to reduce energy consumption; *(d)* concept of sustainability: perceive, situate and ground the individual on the concept of sustainability; *(e)* know the motivation and the challenges related to the reduction of energy consumption. We used as a research instrument a semi-structured interview in Portuguese and translated into Spanish.

After the transcription of all the recorded interviews, we performed the analysis of the answers of each question that were tabulated and analyzed in order to identify the central ideas and the anchors present in the speeches of the individuals. We verify that the contents of these refer to more than one CI. The key expressions used in the construction of the speeches are not related to the questions but the central idea because we consider that the most important factor is the relevance between the excerpts from the CI rather than the question itself, so the SC belong to more than one question. We found 3 anchors that are related to 4 central ideas and gave origin to 5 discourses, being 2 in Portuguese and 3 in Spanish, both were translated into English.

TABLE I
SpanishDCS1: Justifications on behavior in relation to domestic energy consumption.

In general I turn off lights, I turn off television if we are not watching it, because my father always said: lights! On the other hand, I don't have this same habit with my computer. In fact, I usually leave it on, even if I'm going to be out a couple of hours. Well, it depends on the time I will be without using it. If I am going to be less than an hour normally I leave it on (or maybe in suspension mode) because I prefer do not wait for 5 or 10 minutes to turn it on. I try to be responsible and I understand that my contribution is minimal. But of course, many minimums is a maximum. Then, everything that I reduce will be better. I do not think it consumes much energy.I try to have things that do not consume too much, or try to put the refrigerator at a correct temperature. There is an impact on all this, but how much? I do not know, we should measure it. I do not consider it an excessive waste. In fact, I do not pay a very high electricity bill, the worse are my parents or my family who like to have the air conditioning put on 24 hours.

III. Results and discussion

The anchor "residential electrical energy consumption" originated from the discourses related to the questions "Do you usually worry about turning off the equipment when you leave the room? If not, why?" , "Do you usually forget the connected equipment when you leave the room? If so, why not?" , "How do you perceive your energy consumption practices?" and "What practices do you believe you could adopt in relation to sustainability?" in Brazil and the questions "What equipment do you usually use? when you're at home?", "Do you generally forget the connected equipment when you leave the room? Does not go away why?" , "How do you evaluate the impact of your behavior on the environment?" and "How do you perceive your practices of electricity consumption?" in Spain, which were brought together from the central idea "The residence and the consumption of electrical energy" and we obtained as results the SpanishDCS1 and the BrazilianDCS1.

The SpanishDCS1 and the BrazilianDCS1 present individuals' justifications for their electricity consumption. [6] argues that increasing the individual's exposure to information about consumption can increase awareness and knowledge, resulting in changes in behavior. In fact, information and feedback have often been discussed as ways to reduce energy consumption [7], [8]. [7] found a positive relationship between information and behavior in energy consumption, particularly when information was action oriented. However, [9] argued that information may increase knowledge, but not necessarily change behaviors. We agree with the authors when they say that access to information. However, we believe this feedback should be available at any time. Through ubiquitous technologies that are embedded in household devices and integrated

TABLE II
BRAZILIANDCS1: JUSTIFICATIONS ON BEHAVIOR IN RELATION TO DOMESTIC ENERGY CONSUMPTION.

I regulate myself a lot, actually at home I were turned on the lights, and my wife had were turned off the light. Then she turned on the lights, I turn off it, but we'll turn off it a lot, so we have a slightly more confident habit. Usually I hang up, I really worry a lot. But of course sometimes you leave in a hurry, especially when you're late for something and as I sometimes go on a ride to other city, for example, I'm late and the guys coming so I'm running and I always forget. However, there are some equipment that I leave on purpose because that equipment is working, the example is the computer, I do not turn off the computer because I have 70 open windows, you see, doing a lot of things at the same time, but I use the computer suspension very much, I close the notebook and it is suspended, that I do, but it's what I say is a standby there is consuming a little bit. I end up having a high consumption but not out of necessity because of forgetting the connected devices and bad habits or for the sake of accessibility so sometimes it is very laborious and I just forget.

TABLE III
SPANISHDCS2: IMPORTANCE OF INFORMATION ABOUT THE INVOICE ON ENERGY CONSUMPTION

Usually I try to save everything on the electricity bill. The bill is designed to not be understand. I really think this. If you control more or less this topic, you get to understand it. But normal people do not understand it. You have to learn how to understand it, because it is completely encrypted, that is, someone sees an electricity bill and does not know very well what the concepts are or what each euro is paid for there, nothing is clear. Besides, I think that, regarding taxes, they are badly reflected in the bill, I suppose that is due to the companies charge much money by energy and they make it complicated to understand how much you pay. Then, if you can not pay, it is probably tue to energy is too expensive. Here, in Spain, it is very expensive, but in other countries in Europe it is cheaper.

with people's actions, allowing consumers to visualize and monitor their consumption in their daily lives and not only through the bill at the end of the month.

The anchor "Information about the electric bill" originated from the speeches related to the questions "What is your opinion about the value of the electricity bill?", "What is your opinion about the impact of electricity consumption on the environment " and "How do you perceive your electrical energy consumption practices?" in Brazil, and the questions "Do you usually forget connected equipment when you leave the environment? Does not go away why?", "What is your opinion on how the bill is displayed?" and "What practices do you think you could adopt regarding sustainability?" in Spain that were gathered from the central idea "The electricity bill and its presentation" and we obtained as results the SpanishDCS2 and the BrazilianDCS2.

The SpanishDCS2 and the BrazilianDCS2 present the statements of individuals regarding the information contained in the light bill, according to the subjects the account is *confusing* and *inefficient*. According to [10], [11], the feedback can help an individual achieve a goal and change him/her behavior. With regard to residential electric power consumption, there is evidence that feedback can play an important role in reducing consumption [12], [13].

TABLE IV
BRAZILIANDCS2:IMPORTANCE OF INVOICE INFORMATION ON ENERGY CONSUMPTION

I believe it is so confusing are too many data in the account and it gets a hard to understand, it could be a bit more simplified. However, the presentation of the bill value it is clear, but in relation to the whole consumption it is a bit confusing a lot of data. In fact, what I see is that it does not give you a parameter, a detailing, in fact the detailing that it gives you is very insufficient for us to be able to map where the expense is that could be saved, for example, it is very generic for gives you a value only and you do not know where you are consuming that energy where you could save more and so on. But I'm not a good example because I always look there how much I spent and how much I spent more I'm boring because is not everyone who does this, but it is not easiear for normally people, lay people but I do not consider myself 100% lazy then more or less I understand what is there, but in fact it is complicated if you have to explain to someone the account of light I have difficulty I understand but I have difficulty explaining to others.

Studies related to the theory of self-determination highlight the use of technologies as a means to influence the motivation of individuals. [14], [15] evaluated the use of sustainable technology by means of psychometric instruments to evaluate the type of individuals' motivation when using sensors to measure the consumption of electric energy. The need for greater clarity regarding information on energy consumption is evident, but for this information to lead to a change in consumer behavior it is necessary that it be customized. Currently, technological devices allow the sending of information through resources (reminders, messages, alerts, notifications) that can induce the individual to perform a given activity, however, such messages must be in accordance with the level of motivation and hability of each person.

The anchor "Energy Efficient Behavior" originated from the discourses related to the questions "How do you define consumption sustainable use of electricity?" , "What is your opinion about the impact of electric energy consumption on the environment¿' , "How do you evaluate the impact of your behavior on the environment¿' , "How do you perceive your practices of electricity consumption¿' and "What practices do you think you could adopt with regard to sustainability¿' in Spain that were brought together from the "Sustainable Consumption and the Behavior of the Individual" and we obtained SpanishDCS3.

In the discourse of the Spanish, an inversion of these social values was evidenced, showing greater concern with the energy efficiency of the equipment, which corroborates with the statements presented by [16]. We can see that despite this distinction of focus of individuals there is a need to build learning processes capable of making ubiquity an awareness resource for sustainability. The striking feature of this form of learning, called ubiquitous learning, lies in spontaneity, occasional curiosity or doubt about some information. [17] affirms that a process of ubiquitous learning process occurs, when some knowledge is acquired and starts to integrate the behavioral repertoire of the individual. In this sense, the evaluation of ubiquitous learning must be carried out through

TABLE V
SPANISHDCS3: POTENTIALIZING TECHNOLOGIES FOR SUSTAINABILITY

Well, of course there is energy consumption when computers are really working, because they need energy to run, and not only because we forget to turn off. The issue of energy efficiency is obviously very, very fashionable. Obviously, we consume more than we need, and it has a negative impact on the environment. So, sustainable consumption could improve the environment. If we continue with these bad habits, we will end all nature resources. I do not know if my children will live in the same world that I live. My point of viue is very very pessimistic. I want to change my habits, trying to improve it, because we really have a planet that, in the last years, has been mistreated. It is true that at home we try to take care, for example, we have a door in the living room that does not close well, an outdoor door that does not close as it must do it, and we have to fix it to try to improve the energy consumption. As soon as we leave the room, lights are turned off. We also try that children have these same habits of not forgetting lights on, for instnace, etc.

concrete situations in which the individual can manifest the behavioral repertoires acquired.

IV. CONCLUSION

The main contribution of this work is the development of a qualitative analysis on the behavior of a group of university students and teachers in relation to the type of motivation revealed by a process of awareness about their domestic consumption of electric energy. The analysis of these discourses was used to know and describe opinions and representations of a descriptive character, allowing the delineation of behavioral profiles of electric energy consumers, as well as the identification of motivations that make behavior more sustainable.

The identification of this behavior profile enables the organization of motivational messages that, when sent to users of mobile technologies, can enhance the ubiquitous learning process in this work related to environmental education. In the qualitative analysis we found 3 anchors that are related to 4 central ideas and gave rise to 5 discourses, being 2 in Portuguese and 3 in Spanish. The analysis of these discourses was used to know and describe the opinions and representations, allowing the delineation of behavioral profiles of electric energy consumers, as well as identifying the limitations to make their behavior more sustainable.

After analyzing the speeches, we believe that technology can raise awareness for the efficient use of electricity, but for individuals to be aware of their consumption, the information contained in the invoice must be clearer and more educational. From these analisys it can be possible to propose ubiquitous learning processes capable of fostering a change in the behavior of individuals in relation to an intervention in their motivation regarding sustainability. As future works, it is proposed: *(i)* to develop a system that uses the information contained in the discourse that can be used to change behavior in ubiquitous learning processes; *(ii)* apply other instruments in the sample in order to evaluate the motivation profile of the individuals to reduce the consumption of electric energy.

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