The contribution of science museums to the physical concepts construction

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Abstract

The current society has gained a big set of scientific and technological advances that has become an obstacle for understanding concepts from science in general and especially, from physics. In the present paper, the contribution made by science museums towards the physical concepts apprehension is revised and analyzed. One of the achievements perceived in museums through students` interaction with modules, workshops, teachers and the general audience is the self-esteem increase, which generates in turn questions and answers autonomously formulated, facilitating the comprehension of scientific concepts.

Keywords: Physics education, teacher training, teaching methods.

Resumen

La sociedad actual ha recibido como herencia del siglo y milenio que termina un gran cúmulo de adelantos científicos y tecnológicos que en el contexto educativo en muchos casos se han convertido en un obstáculo para la comprensión de los conceptos de la ciencia en general y en particular de la Física. En el presente trabajo se muestra una revisión y análisis acerca de la contribución que pueden hacer los museos de ciencias en la aprehensión de conceptos físicos. Algunos de los logros que se han detectado en los museos a través de la interacción de los estudiantes con: los módulos, los guías, los profesores y público en general es una ganancia de autoestima, generando preguntas y respuestas en forma autónoma, facilitando la comprensión de conceptos científicos.

Palabras clave: Física educativa, enseñanza y aprendizaje, métodos de enseñanza.

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I. INTRODUCTION

The science museums are commonly interactive centers equipped with sections or modules from different areas led by guiders where a vast number of people pass around. These ones at the same time present a strong curiosity that has not been met effectively by either, the school or the cultural environment.

Specifically, the analysis developed here is the result of the work carried out for a decade by teachers and students from the group of scientific & didactic instrumentation. Correspondingly, some data provided by the simple questions applied to both, high school and university students have been systematized during the last four academic semesters (2009 and 2010). Needless to say, this population was in a science and technology museum composed of 60 modules on the sciences subjects (physics, chemistry, biology and math) and others from systems and electronics.

It is worth noticing that those questions are asked during the events promoted in the sciences and education branch, such as: the physics week, the biology week, the chemistry week, among others.

II. STATEMENT OF THE PROBLEM

The academic community working with worldwide museums wonders: *What does a visitor learn in a museum? What is the role of science museums in the educational context? What is the impact caused in the sciences museums environment?* These questions and other ones have produced a working, reflective and analytical atmosphere around the educational role of the interactive centers in question. Some researchers are disappointed while others optimistic about museums contribution in the understanding of science and technology in general. For instance, authors like [1, 2, 3], point out that the literature focused on the learning in museums seems anecdotal,

artificial and contradictory. Hence, it becomes necessary to do something else beyond entertaining and surprising visitors.

Similarly, further researchers assert that the number of rigorous investigations concerning museums is limited. For example, one of those accomplished by Boisvert, D. L. and Slez J. B. [4] aimed at exploring how the modules shown called the visitor`s attention and then which ones kept them concentrated for a longer time. In unison, the effect of museums activities on an exhibition understanding is examined by Allen [5] Heard *et al.* [6], and Tunnicliffe [7]. Dierking and Martín [8] specify that science is learned in any scenario.

In contrast, Lucas [9] goes beyond the common issue, showing the beneficial outcomes when pre-visit, in situ and post-visit activities are done. Melved and Oatley [10] explore the contribution of the interactive center to the scientific literacy of adults. Rix and McSorley [11] study the role of science centers in primary school children`s education. Fisher [12] examines the impact of mood on learning and Rennie together with Willliams [13] inquire into the museum staff`s and adults visitors` ideas and understanding on science. Given that, the situation is complex and challenging inasmuch as these centers have a diverse audience with cultural and theoretical differences that are thought to meet each visitor`s expectations.

III. BACKGROUND

The science museums or science centers reached their peak in the middle of the 70's; however, their formalization needed the urge of the Haya meeting in the Netherlands on September 5th, 1989. At that moment, the general regulations from the International Council of Museums (ICOM) as well as a series of policies are accepted and directed. These latter in turn are intended to support the global museistic communities and face the challenges caused by the local development.

In this context, various field-related events take place similar to the first "Science Center World Congress" in 1996 organized by the *Association of Science-Technology Centres (*ASTC), the *European Collaborative for Science, Industry and Technology Exhibition* (ECSITE), Asia Pacific Network of Science and Technology Centers (ASPAC), Southern African Association of Science and Technology Centers (SAASTEC) together with Red Pop UNESCO (association for the science and technology spread in Latin America and the Caribbean). In fact, this was the first attempt to have science centers worldwide professionals together so as to discuss about collaboration modes, coming then into light the opportunity of qualified exchanges of experiences internationally.

Thereby, the SCWC (Science Center World Congress) has been then realized every three years. The earliest one (1996) occurred in Vantaa, Finland and dealt with the chief theme called: science centers: the learning for tomorrow. Subsequently, the second one (1999) in Calcutta, India had to do with "catalysts for a better future". Next, the third one (February, 2002) focused on the line "Inspiring a new generation" was carried out in Canberra, Australia. And finally, the fourth one (2005) was organized by the life Museum in Fiocruz from Río de Janeiro, Brazil.

To finish, the last event led to the 5° Science centers world congress announcement held in Toronto, Ontario, Canada from June 14th to 19th in 2008. In this case, the aspects to stress on from prior meetings are retackled, providing some common ideas around them (http://www.oei.es/noticias/spip.php?article3113) as:

- "Science centers are highly visible and reliable for the dialogue, the action and discourse pertaining to science and technology".
- "They support the abilities required for an effective problems solution, the creativity, innovation, critical thinking and decisions making. Hence, they enhance the science and technology long life learning".
- "They are essential resources in the formal educational system through which they contribute to the knowledge foundations from the particular communities".
- "They influence students` motivation, learning process and professional choice".
- "They assist teachers affording them more effective manners to teach sciences, math and technology".
- "They create important platforms for an increasing number of virtual visitors to engage with themselves and science on line".
- "They have an impact on research and museology in regard to the science communication, involvement and education".
- "They show the global knowledge on science and technology inside the local reality".
- "They are reliable places for inclusion and equity where the audience is able to participate in critical social issues."
- "They develop strategic alliances that support the act of approaching key local, national and global challenges".

Therefore, the academic community is expected to share new experiences in the 6th Sciences Centers World Congress (2011) to be held in the Cape city, South Africa.

IV. METHODOLOGY

Having a broad set of methodologies pushed all of them by the information technology progress evident in the communication and information technologies (ICTs), the science museums appear in a context where both, the passive sensorial information taking and an active participation are considered.

Along these lines, the principal aim of this paper was to show how learning became meaningful when mediated by Science museums-guided experiences.

The activity developed with different groups of high school or university students followed the subsequent usual procedures:

- First of all, the modules or prototype are shown to students as well as described, drawn and questioned in

terms of use. In a nutshell, these modules were identified.

- Then the question *what will happen if…?* is asked involving as a response each student`s hypothesis.
- The activity based on the question above is carried out then with the objective to justify its hypothesis: *does what is observed connect to what is explained?*
- Several answers are put on debate and analysis.
- In order to make this task more fruitful, the activity has to be performed in groups to socialize afterward their conclusions.
- At last, verifying hypothesis in a myriad of ways (experiment, theoretical analysis, questions for experts, colleagues, teachers, etc) is stated as the next challenge.

Activity fulfilled by groups of students who visit an outside museum. It unfolds in three stages:

1st: Earlier preparation to the Museum visit (Warm up activity).

2nd: Activity during the visit.

3rd: Activity after the visit (Expansion activity).

With the purpose to keep track of this activity in groups, it is necessary for teachers to know the modules exhibited by the Museum in detail. Also, teachers are required to have the theoretical models involved along with the three stages-methodology to approach the visit clear. In relation to those levels, the former embraces an instrument containing three questions to discover the preceding ideas about the most interesting modules` phenomenology. At this instant, hypotheses to contrast during the visit and after it –where a justification for the answer is needed- are allowed.

V. FINDINGS AND CONCLUSIONS

Generally, it was found that the interactivity between subjects and objects was privileged, indicating three types of actions namely, the manual interactivity, the emotional interactivity and the intellectual interactivity. Concerning the former, each individual`s potentiality to involve all of his/her senses in the reconstruction of the phenomena produced by the appliances is entailed. Conversely, the second one implies an environment centered on the motivation, the interest, the ludic dimension, and the curiosity appealed. Lastly, the third one is related to the visitor`s opportunity to wonder about the phenomenon observed, hypotheses stated and solution strategies to compare those hypotheses suggested. To sum up, the relevant tenet of the interactivities mentioned is that the three of them occur at once. In other words, the manual abilities are coordinated by the other ones corresponding to the thought (analogies, concepts formation) with extra factors such as motivation and affective management at the same time. [14].

In consequence, the theoretical- experimental debate around the question: *Can science be learned in science museums?* has an underlying and multiple set of facets demonstrated by the manner to call the attention in various exhibitions. Some of these include: “it is asked to touch” [15], “learning by doing something” [16], “it is forbidden not to touch” [17], among others that lead us to a better understanding or comprehension of phenomena presented.

Nevertheless, certain schools or trends of thought claim that there is a big unknown gap between sensations perceived by senses and the concepts construction. Therefore, further questions that complement the main one emerge such as: in a museum visit, does learning take place? What is learned?, how is something learned?, do visitors really learn or just play and have fun?

Overall, the opinions gathered from a vast number of users arrive at a consensus on the science centers` (museums) function which can be synthesized as follows:

Science centers:

- Encourage students to inquire into the sciences, especially physics.
- Promote the physics learning in a ludic and creative mode.
- Support community`s interest in sciences and scientific development.
- Contribute to the scientific disclosure, spread and orientation about the latest technological advances.
- Motivate users to reflect on and question themselves concerning how to explain a given machine`s physical functioning.
- Contribute to the concepts learning and understanding, letting individuals connect theory and reality so as to increase their concern with science.
- Offer learning facilities in diverse topics: collecting, storing, researching, diffusing and educating.
- Deal culturally with the enlargement of aptitudes and attitudes towards science and education as the society`s transforming role being a structurally knowledge based-disciplined one.
- Cause willingness and interest to happen, making then learning easier.

To end with, some agreements between investigators in museums and their impact on the visitor as well as the effectiveness of the visit indicate an important conclusion. There is a clear difference among the preceding and post visit situation in respect to modules` interpretations, entailing a useful and meaningful effect on human development. This is because of the behavioral changes within the intellectual, motivational and procedural dimensions.

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