

School-visit to a science centre: student interaction with exhibits and the relevance of teachers' behaviour

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Abstract: This study is centred on the behaviour of students and teachers during a school-visit to a Science Centre, with the purpose to answer to the following research questions: How do the students interact with the exhibits? With whom students interact during the visit? How do the teachers behave during the visit? The study was conducted in two science exhibitions, a permanent one and a temporary one. A total of 52 students and 23 teachers were observed. Data analysis showed that students used to wandering around, interacting with the exhibits for very short periods of time. However, some differences were detected between both exhibitions. In the temporary one, most students seemed to miss the interpretation of the phenomena under observation, just manipulating the exhibits, whereas in the permanent one, they tried to interpret the results of their manipulation. These results can be related to teachers' behaviour. In fact, only in the permanent exhibition teachers remained focused in the visit for almost all the time, manipulating the exhibits while explaining it to students. It is suggested that the role assumed by the teacher during a school visit to a science centre could determine the level of students' engagement with the visit.

Keywords: science centres, science education, non-formal learning, students' behaviour, teachers' role.

Introduction

In the last decades, science education movements have enhanced the need to promote a better understanding of science and technology, to develop applicable knowledge on fundamental science concepts, on the methodological nature of science and on its relations with other domains of the society. In order to promote the development of active citizens, willing to engage in present and relevant scientific issues with an impact on the society to evolve, it is essential to develop innovative activities and methodologies, in science teaching and in science teacher education, and to encourage collaborative actions between different stakeholders, of both formal and non-formal education, such as science museums and science centres, aimed at accelerating the pace of change through the sharing of know-how. By strengthening school science, these institutions can contribute to the creation of a more interested and receptive audience for future and lifelong science learning (Chin, 2004; Bell, Lewenstein, Shouse and Feder, 2009).

Contemporary learning theories, such as social constructivism, that view learning as an active, constructive process, have led to increased attention to learners' motivations, prior experiences, tacit knowledge and cultural identity. This is particularly salient in designed spaces, such as science museums and science centres, where learners can control their own learning agenda (Bell et al., 2009). According to Paris, Yambor and Packard (1998) these institutions are environments that provide key conditions for visitors to "construct personal meaning, have genuine choices, encounter challenging tasks, take control over their own learning, collaborate with others, and feel positive about their efforts" (p. 271). Learning science in non-formal environments serves a broad range of intended outcomes, like inspiring emotional reactions, reframing ideas, introducing new concepts, communicating the social and personal value of science, and promoting deep experiences of natural phenomena (Bell et al., 2009).

Many authors (e.g. Ramey-Gassert, Walberg and Walberg, 1994; Pedretti, 2002) have already highlighted that science museums and science centres can generate a sense of wonder, interest, enthusiasm and motivation to learn that should be explored. Students usually enjoy visits to these non-formal institutions and reiterate their satisfaction, which can have an effect on their interest and enjoyment toward science activities (Wolins, Jensen and Ulzheimer, 1992; Ramey-Gassert et al., 1994; Rennie, 1994; Anderson, Lucas and Ginns, 2003). These positive attitudes not only influence views of science and aspirations to future careers, but also can influence attainment and the willingness to participate more in science activities (Germann, 1988; Jarvis and Pell, 2005).

Moreover, science centres can address aspects of science education that might be missing in more formal, class-based learning, like the promotion of an awareness of the relevance of science to society (Jarvis and Pell, 2005). Indeed, science centre environments are ideal for the development of science concepts since there is an emphasis on hands-on activities related to real-world objects and events, with social interaction and group performance emphasized (Ramey-Gassert et al., 1994; Falk and Dierking, 2000; Jarvis and Pell, 2005).

Despite the widespread acceptance of the cognitive, affective and social aspects of the learning experiences of visitors to science museums and science centres (e.g. Rennie and McClafferty, 1996; Anderson et al, 2003), these highly stimulating and novel physical and social environments have been linked to ineffective learning by visiting school students (e.g. Kubolta and Olstad, 1991). Many school trips are often conducted in a manner that do not maximise the learning opportunities they could afford. In spite of many studies have already showed that pre-visit orientation and post-visit follow-up generally improve the learning potential of a school fieldtrip, usually there is little or no preparation to these visits (Kubota and Olstad, 1991; Kisiel, 2006). Moreover, there seems to be a gap between school-based and museum-based activities that is a major impediment for students' learning in a visit. How to close this gap in order to effectively integrate formal and non-formal practices is a current discussion issue among researchers (Tal and Morag, 2007; Bell et al., 2009).

A key educational challenge for science museums is to link emotional and sensory responses with science-specific phenomena. Associating scientific thinking with engaging and enjoyable events and real-world outcomes can create important connections on a personal level (Bell et al., 2009). In this sense, non-formal settings occupy an important and unique space in science learning, presenting strengths that are unique and complementary to the strengths of schools (Ramey-Gassert et al., 1994; Pedretti, 2002; Jarvis and Pell, 2005; Bell et al., 2009;). For this to be accomplished, "future research in science education should focus on how to effectively blend informal and formal learning experiences in order to significantly enhance the learning of science" (Hofstein and Rosenfeld, 1996, p. 107).

Integrated in these modern movements that intended to improve scientific literacy of every citizen, it was created in Portugal, in 1996, a national agency for scientific and technological culture, "Ciência Viva", with the main goal of engaging the public in general, and the school public in particular, in scientific and technological issues. To achieve this purpose, it has been created a network of science centres, distributed throughout the country, which are intended to be interactive spaces of science and technology. These science centres are now visited by hundreds of schools every year, assuming an important role in science education nowadays. For this reason, it is essential to understand what really happens in this type of non-formal science learning contexts. How is the school visit implemented? What are the roles for teachers and for museum educators? How students behave during the visit? The purpose of the present study was to contribute to the understanding of these issues through the analysis of the behaviour of students and teachers during a school-visit to a Science Centre, trying to understand: How do students interact with the exhibits? With whom students interact during the visit? And how do teachers behave during the visit?

Methodology

Exhibition context

The study was conducted in two thematic exhibitions at the Science Centre of Lisbon (Portugal), an interactive Science Museum that intends to promote the exploration and experimentation of the physical world. A thematic exhibition supplies a conceptual framework for the visitor, which houses the entire set of exhibits under a single conceptual (thematic) umbrella (Sandifer, 1997). One of the exhibitions was temporary, "Disgusting! The indiscrete science of the human body!", and was focused on the human body functioning. The other exhibition was permanent, "Explore", and was focused on human perception. Each exhibition had a number of interactive modules which visitors could explore for themselves. Interactive modules are intended to be "minds-on" exhibits (and not only "hands-on" that merely requires physical manipulation) that allow visitors to explore and exercise control over one or more of the exhibits variable "parameters" and provoke further interaction through feedback (Rennie and McClafferty, 1996).

The temporary exhibition "Disgusting!" had 16 interactive modules, focused on the human body. These modules intended to explore all that is

more disgusting about the human body (e.g. bad breath, sweat, stomach noises, and rubbish inside the nose). The permanent exhibition "Explore" had 13 interactive modules, focused on natural phenomena having the human perception as a guiding theme. The modules were addressed to explore natural and everyday life phenomena (e.g. tornados, shadows, light refraction).

This science centre has a website where some information about the exhibits, namely the description of each module in each exhibition, is presented. Information is also given about the possibility offered to teachers to visit the exhibition with a monitor of the science centre before the school visit. During the school visit, each school group had a pre-determined time, 30 minutes, to visit each exhibition. However, different school groups could visit simultaneously a given exhibition room. Teachers were responsible for the design of the visit path. Monitors were always present in each exhibition room, acting only when required by any participant (e.g. for an explanation about some module) or for attendance related reasons (e.g. eventual visitors' unruly behaviour).

Sample

A total of 52 students were observed, 30 students when visiting the temporary exhibition and 22 students when visiting the permanent exhibition. Students were from different school grades: 18 from the first grade (6 to 10 years old); five from the second grade (10 to 12 years old); 27 from the third grade (13 to 15 years old); 11 from the last grade before University (16 to 18 years old). Additionally, a total of 23 teachers were also observed: 11 when visiting the temporary exhibition and 12 when visiting the permanent exhibition (eight teachers of the first grade, 10 of the second grade and five of the third grade).

Data collection

The study focused on students' and on teachers' behaviour when participating in school visits to the science centre. The observation was non-participant and structured. First, *ab libitum* observations were made in order to identify the type of behaviours each participant (student or teacher) use to interact with the exhibition modules, which were subsequently organized into behavioural categories. Secondly, focused observations were made. In the beginning of a school visit, when the group first entered the exhibition room, one participant (student or teacher) was selected by chance and its behaviour was registered until the end of the visit (30 min). At each observation session, the frequency and duration of each pre-defined behavioural category was registered for each participant selected for being observed.

The information recorded was:

- Time of each module interaction
- Type of behavioural category observed in the interaction with the module
- Personal interactions with other participants (student, teacher, monitor)
- Total time teachers were not engaged with the school visit

Additionally, at the end of each school visit all observed teachers answered to a brief questionnaire about their opinion concerning: the interest and relevance of the exhibition (Likert scale questions, with 5 levels, ranging from very bad – level 1, to very good - level 5); what type of contact they established with the science centre prior to the visit (yes or no multiple choice questions); and the objectives of the visit (open question).

Results

Whenever a class group entered into the exhibition room, a small talk with the monitor was held in order to inform students about some rules, related to: the time they had to stay in the exhibition (30 min) before exiting to another room; the permission to manipulate every module freely; and the monitors' role elucidating any doubt they had about the modules.

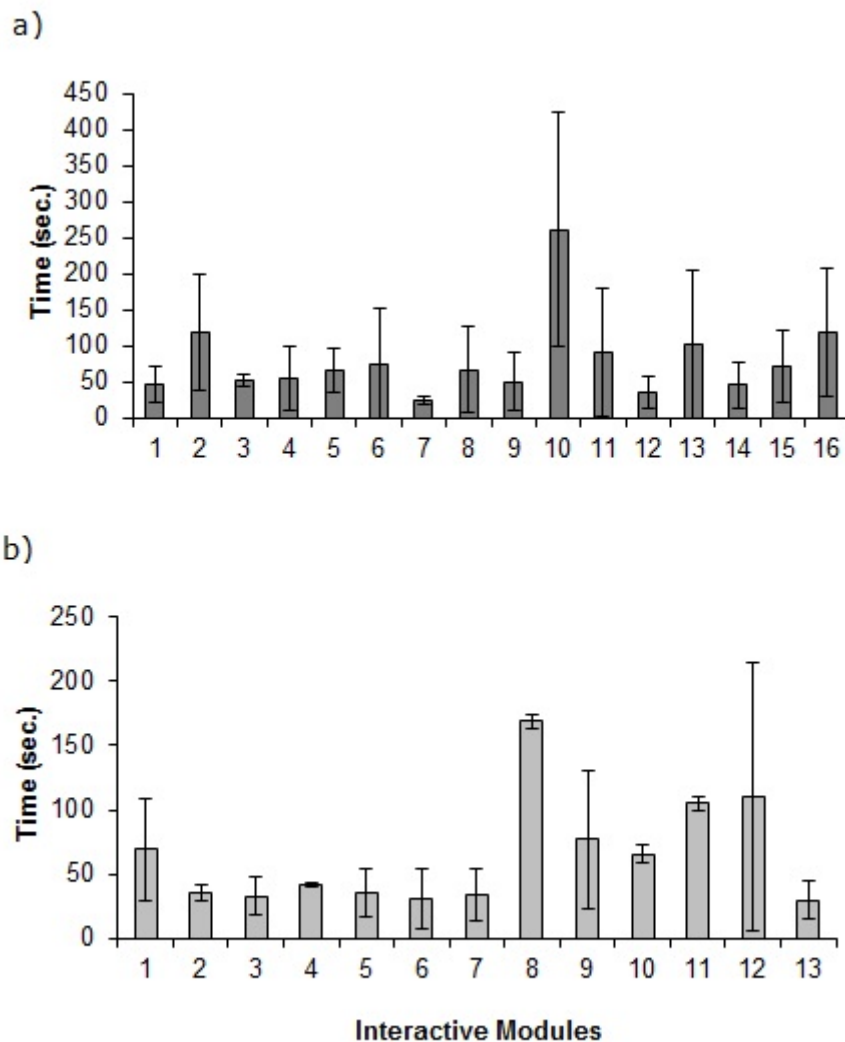


Figure 1.- Average time duration of students' interactions with the modules. a) "Disgusting!"; b) "Explore".

After this introduction, students usually spread out throughout the room, dispersing very rapidly from each other. Once arrived in the exhibit modules area, they usually walked along the exhibition, in small groups or alone, staring at the modules in general until they reached one that seemed to arouse their interest. At this point they used to stay at the module for some time. However, in both exhibitions, students interacted with the modules for very short periods of time, giving the impression that they were “shopping around”. Acting this way they visited many modules for very brief periods of time: 50% to 59% of the visits to a module lasted less than one minute and 73% to 90% lasted less than two minutes, in “Disgusting!” and “Explore” exhibitions respectively (Figure 1). Very few modules were visited for longer durations: 7% to 3% of the visits lasted about five minutes or more, in “Disgusting!” and “Explore” exhibitions respectively (Figure 2).

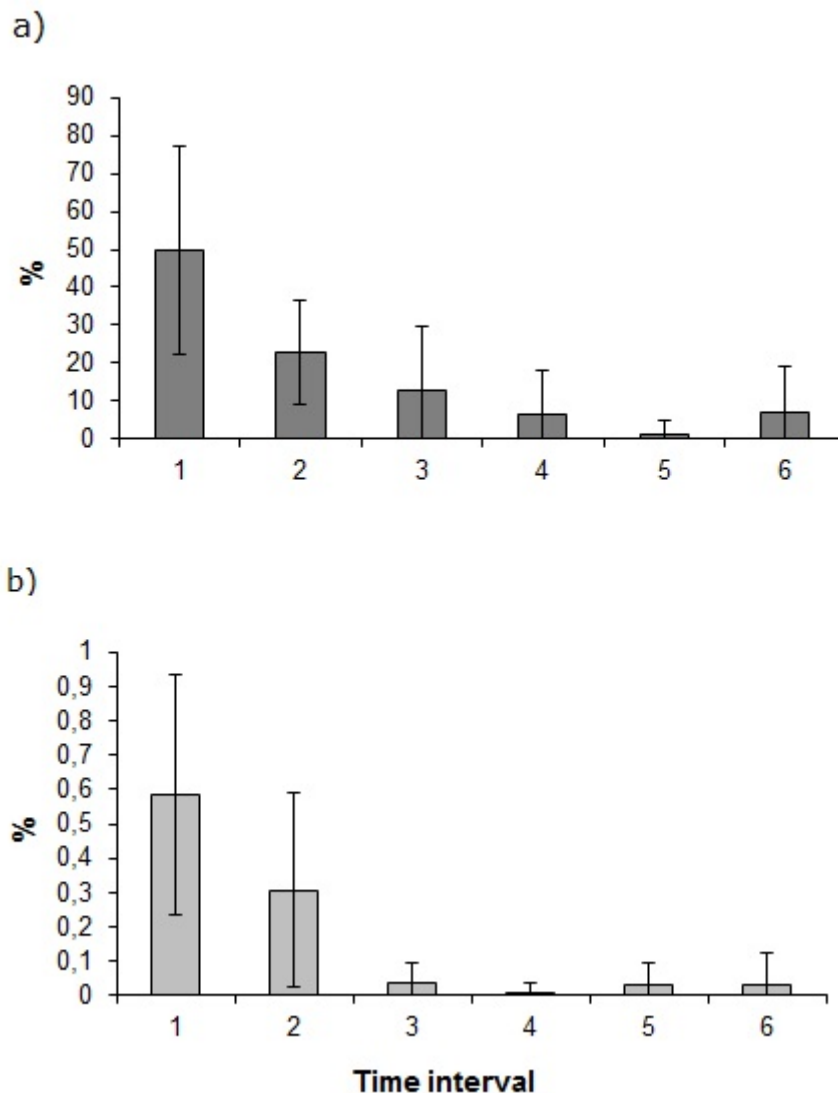


Figure 2.- Average frequency of time intervals (sec.). (1): [1, 60]; (2) [61, 120]; (3) [121, 180]; (4) [181, 240]; (5) [241, 300]; (6) > 300. a) “Disgusting!”; b) “Explore”.

When a student approached a module he/she usually showed one of the following behaviours: he/she looks at the module, without manipulating it ("look"); stays in the vicinity of the module, watching another student manipulating it ("see other"); reads the module instructions ("read"); starts by manipulating the module, without reading the instructions or watching anyone manipulating it ("manipulate directly"); starts by manipulating the module after watching the way another student has just manipulated it ("manipulate after see other") or after reading the instructions in the module ("manipulate after read"); explains to other student how to manipulate the module, after they both have read the instructions or manipulated the module ("explain") (Figure 3).

Students seemed to behave somehow differently in each one of the exhibitions ($\chi^2=109.47$, $df=6$, $p<0.001$). In "Disgusting!" the behaviours more frequently observed were "manipulate directly", "look" and "see other". In these cases students almost never showed any attempt to interpret the phenomena under observation in each module, such as, for instance, reading the module information, manipulating after reading, or even manipulating after seeing another visitor doing that. In "Explore", the behaviour "manipulate after read" was more frequently observed, although "manipulate directly" kept a higher frequency. Often students didn't seem to understand how to manipulate the modules. They used to touch in every button they could, and if nothing happened they merely gave up and moved to another module. In most of these cases the modules were poorly handled, and therefore the objectives by which each module was built were not reached. Additionally, the behaviour of explaining to other what they have seen or read was almost never present, although sometimes observed in "Explore" exhibition.

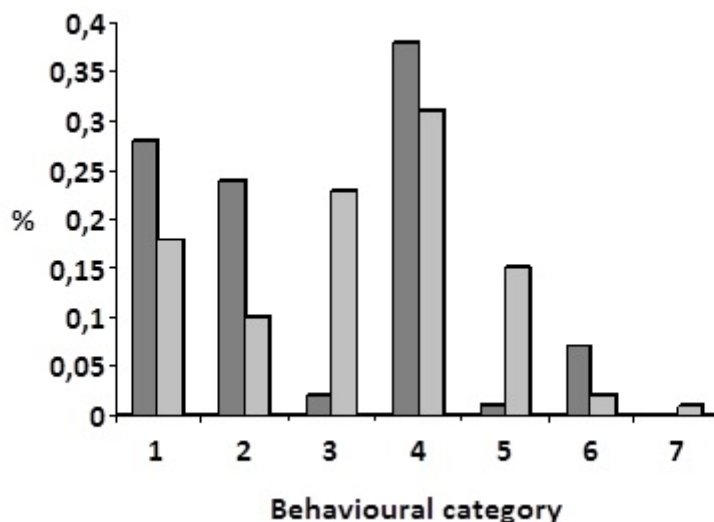


Figure 3.- Relative frequency of each student's behavioural category observed at each exhibition, "Disgusting" (grey) and "Explore" (pale grey). (1) "Look"; (2) "See other"; (3) "Read"; (4) "Manipulate directly"; (5) "Manipulate after read"; (6) "Manipulate after see other"; (7) "Explain".

The sequences of behaviours more frequently performed by students (Table 1 and table 2) in both exhibitions were: "manipulate directly" or "see other" before giving up and moving to another module, without making an effort to interpret what they had seen by reading the module information (for "Disgusting!": $\chi^2=309.68$, $df=20$, $p<0.001$; for "Explore": $\chi^2=389.58$, $df=25$, $p<0.001$) (Figure 4).

	See other	Read	Manipulate	Explain	Listen other	Give up
Look	54	5	86		3	63
See other			8			46
Read			3	3		2
Manipulate						100
Listen other			3			

Table 1.-Sequence of behaviours observed in the "Disgusting!" exhibition.

	See other	Read	Manipulate	Explain	Listen other	Give up
Look		2	68	26	4	70
See other			4			22
Read			40	4		14
Manipulate		12				114
Explain	4					
Listen other			4			

Table 2.-Sequence of behaviours observed in the "Explore" exhibition.

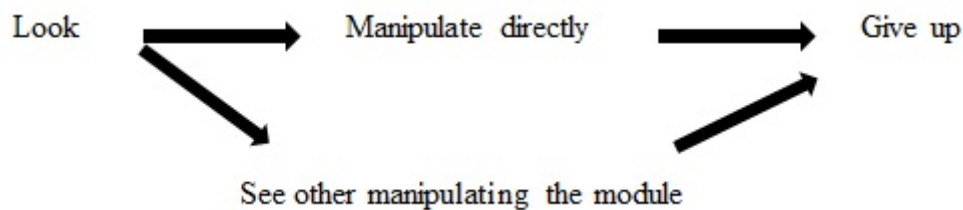


Figure 4.- Sequences of behaviour more frequently performed by students in both exhibitions.

Considering the behaviours differentially observed in each exhibition according to the school grade (Table 3), some differences were registered. While in "Disgusting!" students seemed to behave in the same way, independently of their grades ($\chi^2=42.61$, $df=15$, $p<0.05$), in "Explore" the younger students appeared to be less active, showing behaviours like "see other" and "look" more frequently, while the older students presented more active behaviours, manipulating the exhibits ("manipulate without see or read", "manipulate after read") ($\chi^2=211.20$, $df=12$, $p<0.001$).

The teachers also seemed to behave differently in each exhibition (Figure 5). Indeed, in "Disgusting!" they seemed looking around the exhibition, alone or in pairs, monitoring students' behaviour and reading, apparently at chance, some instructions in the modules. Consequently, teachers' behaviours less frequently observed were those related to manipulation of the modules. Additionally, for 40% of the visit time ($sd=0.38$, range: 0%-100%, $n=12$) teachers were not engaged with the visit itself. They kept talking with other teachers or resting in some place of the exhibition. On

contrary, in "Explore" teachers were observed manipulating the modules while explaining to students, demonstrating a remarkable "interactive" attitude. Actually, in this exhibition teachers remained not engaged with the school visit for only 9% of the visit time (sd=0.19, range: 0%-50%, n=11).

	"Disgusting!"				"Explore"			
	1 st grade	2 nd grade	3 rd grade	Last grade	1 st grade	2 nd grade	3 rd grade	Last grade
Look	9	23	27	11	4	--	40	4
See other	9	8	27	16	16	--	8	2
Read	0	0	5	0	2	--	0	58
Manipulate directly	18	14	43	21	2	--	34	44
Manipulate after read	0	0	3	0	0	--	4	36
Manipulate after see	9	3	2	3	2	--	0	2
Explain	0	0	0	0	2	--	0	2

Table 3.- Frequency of behaviour categories observed according the school grade in each exhibition.

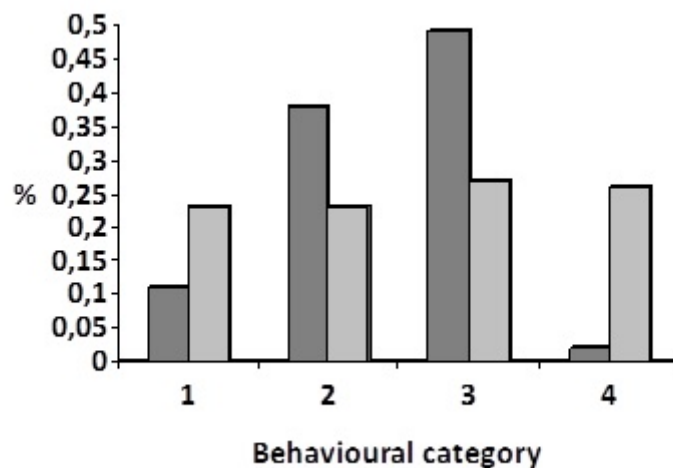


Figure 5.- Relative frequency of each teacher's behavioural category observed at each exhibition, "Disgusting" (grey) and "Explore" (pale grey). (1) Explaining the module to other (2) Reading module instructions; (3) Manipulating the module (4) Seeing a student manipulating the module.

Students' personal interactions also seemed in each exhibition. In "Disgusting!" the majority of the interactions were with other students. It was possible to observe students manipulating some modules in groups of three or four, assuming a "play posture", touching every button they could at the same time. In this exhibition, interactions between students and teachers or students and monitors were almost absent. This kind of interactions occurred only when adults needed to control students' conduct. On contrary, in "Explore", interactions among students and between students and teachers were equally observed. In this exhibition, students

and teachers used to call each other attention to a given phenomenon, to ask for an explanation or to explain what they have observed. However, in what concerns interactions with monitors they were also almost never observed.

Finally, considering the analysis of teachers' answers to the questionnaire, all of them valued the exhibitions concerning their interest and relevance for science learning, and gave an overall evaluation of good or very good to all aspects questioned (Table 4). However, concerning the type of contact they had with the science centre prior to the visit, all of them referred that they didn't visit the exhibit previously, neither alone or with the monitors of the centre, as offered by the Institution. Teachers also referred that they didn't visit the webpage of the exhibition, although all of them considered that both aspects would be important for the visit preparation. Their objectives about the school visit were all related with the promotion of students' motivation to learn science having fun when learning and the improvement of scientific knowledge about the topics addressed in both exhibitions.

What is your evaluation about the exhibition, concerning:	Average	Range	SD
Interest of the thematic	4.74	4-5	0.46
Interactivity of the modules	4.65	4-5	0.48
Adequacy of the modules	4.30	4-5	0.46
Type of information present in the modules	4.69	4-5	0.44
Contribution to development of new knowledge	4.52	4-5	0.49
Complement of school learning	4.48	3-5	0.77
Promotion of willingness to learn more	4.35	4-5	0.48
Promotion of fun	4.62	4-5	0.48

Table 4.-Teachers' evaluation of the exhibition (n=23).

Discussion

The results in this study showed that students behaved differently in each exhibition. In the temporary exhibition it seems that the interpretation of the phenomena under observation was not concretized by the majority of the students, since they manipulated the exhibits without even read the instructions and information in the modules (performing a "blind" manipulation). They seemed "to play" with the exhibits in an unstructured and unreflective way, whatever their age. In the permanent exhibition especially the older students, seemed very interested in interpreting the results of their manipulations because they used to read not only the instructions for manipulation but also the explanations offered in the exhibit. Besides, the behaviour of "explaining" to others was also observed in this exhibition, which may be an indicator of some degree of interactions among students that were not merely of playing nature but resulted in learning.

Although in this work it is not possible to establish with certainty a direct correlation between students' and teachers' behaviour, the results obtained suggested a possible relation between them. In fact, teachers also behaved differently in both exhibitions. While in "Disgusting!" they almost never

interacted, neither with students or with the exhibits, remaining many times even unaware of what their students were doing during the visit, in "Explore" they presented a much more active behaviour, interacting both with students and the exhibits and staying focused in the visit for almost all the time.

According to many studies, teachers' personal interest in the exhibitions appears to be important for students' behaviour. Jarvis and Pell (2005) have stressed that teachers' enthusiasm and enjoyment, which usually is clearly evident to students, seemed to help promoting and establishing students' attitude gains. Indeed, students' attitudes tend to mirror their teachers' attitude (e.g. Price and Hein, 1991; Griffin and Symington, 1997).

The different behaviour of the teachers observed in this work could be derived from the fact that "Explore" is a permanent exhibition, allowing teachers a greater familiarity with the exhibits due to school visits in previous years, since none of them have made any effort to visit any of the exhibitions prior to the school visits itself. Numerous studies (e.g. Price and Hein, 1991; Woolard and Pontin, 2000) have already highlighted the importance for increasing teachers' enthusiasm and engagement in pre-visit orientation, getting some input into the design of the exhibits. Indeed, according to Griffin and Symington (1997), besides management concerns, teachers usually feel intimidated when they take classes to science centres because of their unfamiliarity with the place and modules functioning, not knowing where to go, and being asked questions they cannot answer. Teachers who made a prior visit to the institution were clearly more confident about taking their groups to the appropriate exhibits (Jarvis and Pell, 2005). Moreover, this greater involvement seems to affect both teacher and student attitudes, discipline, interest, willingness to help and carryover to school (Price and Hein, 1991).

Teachers are well situated to meet challenges and capitalize on the opportunities inherent to non-formal environments, making the adequate bridge between learners' knowledge and understandings. To exploit these opportunities, it is crucial that, as part of their planning and implementation, teachers should listen to and actively seek to explore students' accounts of their responses to the museum and science centre and its exhibits (Anderson et al, 2003).

Learning in this type of environment doesn't seem to occur only or perhaps even primarily as a result of the interaction between individual visitors and the exhibits. There is substantial evidence that social interactions between visitors may be important in stimulating learning (Diamond, 1986). Jarvis and Pell (2005) suggested that teachers should provide open-ended tasks to be carried out by their students at the science centre, that require observation, discussion and deduction, creating mechanisms for students to search information and to interact with peers, whereas interacting with modules, as a way to support and value appropriate play with the exhibits, while promoting social interactions directed to the understanding of the science topics under observation. Moreover, the results obtained in this work suggested that to optimize students' attitudinal and cognitive gains, teachers should assume an active role during the visit, calling students' attention to a given phenomenon,

asking them to explain the phenomena under observation, providing support and "scaffolding" between students' existing concepts and the exhibits.

To assure this kind of active involvement on the part of teachers it seems to be urgent to help them understanding their own role as promoters of students' engagement during the school visit. Pre-service and in-service teacher education courses could, and should, provide teachers with the support necessary to achieve this goal (MacLeod and Keistead, 1990; Forber, 1993; Chin, 2004). According to Chin (2004), one way could be the design of a science teacher course in close connection with a science museum, in which participants can do several visits, can discuss different aspects of the exhibitions with museum educators, and can develop and implement lesson plans to be developed in the museum setting, based on selected teaching topics. This type of experience would help teachers to acquire more in-depth knowledge about the connections between the museum resources and school science, to gain deep consciousness about the importance of knowing the museum resources before planning their school visit, and so to become a very much more active participant during their own school visits.

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