A CULTURE OF LEARNING IN THE INFORMAL MUSEUM SETTING?

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ABSTRACT

An interactive science exhibition was used as the basis for a study of young children's behaviour and learning in an informal setting. Young primary school children were observed during school excursions to the exhibition, and the interactions of the children with the exhibits, with each other and with the adults supervising the visit were examined. In the context of this exhibition, learning was enhanced by student interaction with other students, and by the involvement of supervisory adults in guiding the students in the exploration of the activities provided. It is suggested that an appropriate environment for learning in this informal museum environment, is one where the children are free to interact with their peers, where the activities encourage co-operative activity between students, and where assistance from adult supervisors is available to facilitate student investigation of exhibits. Teachers, parents and museum staff involved in school visits to the informal setting need to take an active role in promoting a culture of learning.

INTRODUCTION

Young children in interactive museums are often observed to be running and apparently aimlessly playing. Staff and other visitors are often alarmed by this behaviour, and assume that no learning is taking place. The audience for the Sydney Children's Museum is largely made up of pre-school and early primary school groups, and young children with their families. The children's enthusiasm and excitement is apparent, but there is some concern about the outcomes of their visit. In 1998 the Sydney Children's Museum was host to an exhibition called 'Mighty Sciencе' (developed by the Investigator Centre in Adelaide). This provided an opportunity to investigate the question of play and learning within a hands-on museum environment.

Ramey-Gasssert, Walberg & Walberg (1994, p. 35) assert that 'Museum learning has many potential advantages: nurturing curiosity, improving motivation and attitudes, engaging the audience through participation and social interaction, and enrichment'. Museums provide an environment for 'informal learning' that can be 'characterised by free choice and by being non-sequential; voluntary and exploratory; non-assessed and open ended; and social' (Griffin and Symington, 1997, p. 764). The Mitey Science exhibition aimed to provide such an environment for informal learning. It offered a unique chance for young primary school children to experience materials and hands-on activities in science. However, such informal environments, while exciting for the children, do not necessarily create the conditions in which learning is optimised.

Rennie and McClafferty (1995) have reviewed the literature on the learning outcomes of school visits to interactive science centres, and found that cognitive learning is not always enhanced by such visits, although affective learning is more consistently improved. The outcomes were affected by a range of factors, described as 'the extent to which students are familiar with the setting, their

Rennie and McClafferty (1995) have reviewed the literature on the learning outcomes of school visits to interactive science centres, and found that cognitive learning is not always enhanced by such visits, although affective learning is more consistently improved. The outcomes were affected by a range of factors, described as 'the extent to which students are familiar with the setting, their prior knowledge, the match between the cognitive level of the students and the thought processes required by the exhibits, the degree of structure of the visit, the provision and nature of the cues for the learning and the social aspects of the visit' (Rennie and McClafferty, 1995, p 179). It follows that the total museum environment makes an important contribution to learning outcomes.

The museum saw the 'Mitey Science' exhibition as a way for children to play, explore and investigate as a prelude to learning about science and technology. The guidebook for the exhibition states that 'Mitey Science is about encouraging children to experiment, manipulate things, to observe and to predict. It is a collection of challenging activities that are fun and exciting', (Mitey Science Manual, 1993, p. 6). The activities included a simulated quarry that used balls, buckets and conveyor belts; a set of sound instruments, including a piano, harp and windpipes; and a section on light, involving mirrors, shadow play and a kaleidoscope. The educational objectives of the exhibition, which were linked to curriculum development in early childhood education, were listed as:

- to encourage creative exploration;
- to contribute to the development of children's life skills and competencies in order to meet challenges with confidence and independence;
- to encourage children and families to find mutual enjoyment from a range of science based activities that can be performed in a range of environments;
- to provide interactions and experiences that are part of the individual child's experiences of his/her world;
- to present science as central to our understanding and awareness of the world around us;
- to provide experiences in science and technology with a view to contributing to attitude development and learning for both adults and children;
- to involve adult participation at every stage;
- to be a high quality service for the early childhood community.
(Mitey Science Manual, 1993, p. 15)

The visit of school groups to the Mitey Science Exhibition offered an opportunity where learning in an informal environment could be examined. By identifying factors in the museum environment that were contributing to student learning, suggestions could be made about the ways in which museum culture might be modified to maximise learning during school visits to informal museum settings.

In this study, the interactions of young primary school children within the environment of the Children's Museum exhibition were investigated. Three types of interactions have been identified as important for estimating learning during a museum visit. These are:

- the quality of the interaction between students and the exhibit (Carlisle, 1985; Falk, 1983; Russell, 1995; Griffin, 1998);
- the interaction between the children themselves (Tuckey, 1991; Carlisle, 1985); and
- the interaction between supervising adult (teacher, chaperone or museum staff) and the students (Priest & Gilbert, 1994).

Tuckey (1992) found that interactions among students were not only as important as interactions between students and exhibits, but in fact enhanced the interactions between students and exhibits. However, in contrast to other authors, Orion and Hofstein (1991) observed that the social interactions of a field trip were at the expense of learning. The importance of social interactions to the children visiting the museum was therefore made a focus of the investigation.

Griffin and Symington (1997) have shown that many students on school visits were not encouraged to use the full potential of the museum environment, due to the restrictions placed on them by the teachers. Teachers were imposing formal teaching practices on the informal learning environment. Was this the case with school and preschool groups visiting the Children's Museum? There are significant differences between the school groups studied by Griffin and Symington (1997) and those that attended the Children's Museum exhibition. The groups in the Griffin and Symington (1997) study were comprised of children from grades 5-10. The Mitey Science exhibition was attended by younger children, between pre-school and grade 3. This age difference suggested that the museum visits would have to be approached in different ways, not least because the younger children were unable to read and fill in worksheets, and follow written instructions. The role of the teacher in the children's experience at the Mitey Science exhibition might be expected to be different to that observed in studies of older children. Therefore, the impact of the teacher on the children's learning during the museum visit was also a priority of this investigation.

METHOD

Carlisle (1985) observed students visiting a science centre and recorded which exhibits the students chose, the length of time spent at the exhibit and the level of involvement with the exhibit. These parameters were used to gain insights into the learning behaviours of the children. Falk (1983) also found that time spent and the quality of the interaction, evaluated through unobtrusive observation, yielded good correlation with pre- and post-test measures of learning.

A qualitative method, of unobtrusive observation in the natural setting, was used in this study. Data were collected in the form of case studies and from observing children's interactions throughout the museum. The case study data were collected by observing three children. These children were followed throughout their visit, to find out how they used the museum as a learning environment. The choice of exhibit, length of time spent at an exhibit and the nature of the involvement with the exhibit were recorded. In addition an observer stationed near exhibits collected data by recording the actions of children as they interacted with the exhibit. Interactions between children and supervising adults, and between the children themselves, were also recorded.

For the purpose of maintaining anonymity the Case Study children were allocated pseudonyms. May, aged six, Laura, aged 7 and Ben, aged 8 were observed throughout their entire visit to the museum. These children were chosen randomly, from three different school groups attending the museum on different days. The actions, words and interactions of each child were recorded as field notes. The average length of a museum visit was one hour. Data were analysed by a content analysis based on reoccurring themes. These themes were then grouped into general categories. Where extracts of field notes are quoted they appear in italics. Verbatim quotes have been used for their authenticity.

Throughout the study, children could potentially interact with 25 different exhibits. A brief description of the exhibits mentioned in this report is given in the Appendix.

OBSERVATIONS AND DISCUSSION

The observations and discussion have been organised in three sections:

- student interactions with exhibits;
- interactions between the children themselves; and
- interactions with supervising adults.

Student interactions with exhibits

The first few minutes of May's visit to the exhibition illustrates the pattern of activity exhibited by all three children observed. May: *Walked up stairs. Windpipes pushed a couple of times. Over to hospital room and looked at stethoscope. Then through glow room, womb room, feely room and seascape as a straight progression, following other children in line. Didn't stop to investigate. Handprints, on approximately six squares, made pattern whole hand and some finger dips only. Showed it to a couple of boys who came in. Over to the piano and pressed two keys. Windpipes: one push and looked to see what else was happening. Over to triangle on tree and hit two times. Touched a couple of strings on harp.* May moves rapidly through five activities, without stopping long enough to investigate any of them in depth.

This type of behaviour was not restricted to the first few minutes of a visit. A similar pattern was seen when Ben neared the end of his visit. Ben: *Went through caterpillar and started towards steady hand. As he got near it other children made a loud laugh under the kaleidoscope. Went under kaleidoscope as other children pressed buttons and noise attracted. Tried environmental Question & Answer board. Came over to steady hand and watched girls have turn. Had a turn-when it beeped, kept trying until he got it to end. Used two hands to manipulate. Watched while friend started turn. Then walked over to mirrors. Looked around mirror area, quickly looking into each one. When his friend moved to other end he followed. Moved back to touch panels (liquid crystals) and put handprints on them. Played game of noughts and crosses. Over to the feely faces and started with hair and eyes. Went back through glow room, womb room and squeezing smelly bottles.* Ben started with the feely faces, but did not persevere to produce a face, he quickly tried the mirrors then moved on, and he was diverted from the steady hand by the sounds from under the kaleidoscope. It is as if Ben and May were distracted by the number of new opportunities, and are reluctant to settle for one thing.

All the children were observed running through many exhibits very quickly, often in a random order, at various stages of their visit to the museum. Did such random and short-term manipulation of the resources provided allow for learning to occur? Carlisle (1985) has indicated choice of activity, length of stay and level of interaction as indicators of learning. Using these parameters, it seems that for a substantial portion of the visit to the Mitey Science exhibition, these children were only interacting superficially with the exhibits rather than engaging in substantial learning.

Although this pattern of moving from activity to activity was often observed, there were occasions when the children stopped and investigated an activity for longer, as the example of Ben's progress shows with the steady hand. In another instance, Laura spent considerable time experimenting with the different textures of the faces; *then went over to kaleidoscope-large group of children under there. Went down hall, looked at piano. Got another friend and took them under kaleidoscope.* Down *hallway to feely faces-added hair, eyebrows, eyes moustache. Friend then called her away, pressed two keys large piano. To the shadow room. Back to feely faces-different hair, ribbon, mouth.* Table 1 summarises those activities where the children who were observed for the duration of their visit spent at least a short time (approximately more than 1 but less than 5 minutes), and

TABLE 1

TIME SPENT AT EACH ACTIVITY BY EACH CHILD

Activity	May	Laura	Ben
Quarry	15 min	15 min	15 min
Space maze	10 min	5 min	5 min
Shape game	+		
Mirrors	+	+	
Glow room loop	+		+
Nail prints	+	5 min	
Liquid crystal prints	+	+	+
Steady hand		+	+
Chime tree	+	+	
Kaleidoscope		+	
Telephone		+	
Flicking pictures		+	5 min
Can telephone			+
Hospital room			+
Feely faces		+	
Caterpillar	+	+	+
Dice tower			
Piano		+	
Shape game	+		+

For each child, the greatest time was spent on the quarry and space maze. It seems likely that the time spent at each exhibit was insufficient for the full potential of the exhibit to be realised. However, some children did spend longer time at some exhibits than at others.

Another feature of student interactions was the number of times each student visited each exhibit. Carlisle (1989) found that most children orient themselves when they first arrive at the museum, and most children make repeated visits to some exhibits. Repetition of an activity may indicate that the child enjoyed the interaction. In the present study, it was noted that some activities were repeated many times, even though the visit in each case may have been short. Table 2 shows the number of times an exhibit was visited by the three children observed.

TABLE 2

NUMBER OF TIMES EACH CHILD VISITED EACH EXHIBIT

Exhibit	May	Laura	Ben
Caterpillar	4	2	1
Kaleidoscope	1	3	1
Music/sound area	3	3	2
Quarry	1	1	2
Glow room loop	2	2	4
Flicking pictures	1		1
Shadow play	1	1	1
Liquid crystal prints	1	1	2
Nail prints	1	3	1
Steady hand	1	1	1
Space maze	4	2	1
Mirrors	2	2	1
Feely faces	1	2	1
Hospital room	1	2	2
Dice game	1	3	1
Can telephones	1	1	2
Shape game	2		1

Exhibits such as the caterpillar, glow room and kaleidoscope, which involved tactile experiences designed to illustrate the senses of sight and touch, were often repeated. This repetition allowed the children to explore and discover aspects of the activities not experienced in one brief visit. By choosing to repeat the activity, the children are indicating that they enjoy that experience and they are spending the time to further investigate that activity. This enhances the probability that the children are learning.

The patterns of movement show that there are exhibits at which children spend more time than at others as well as exhibits that are often repeated. These are two accepted indicators of learning (Carlisle, 1985). Falk (1983) and Carlisle (1985) also include the quality of the involvement with the exhibit, as being a measure of the children's learning in a museum situation. The quality of interaction with an exhibit was more difficult to estimate, particularly as these children seldom asked questions, or verbally expressed the extent of their understanding. Two contrasting examples, which may shed some light on the quality of the interaction of the children with the activities in the museum, are given below.

One example involved Ben's interaction with liquid crystals; *Moved over to liquid crystal panels and put a few handprints on them. Warmed up hands between legs and tried it again. Then rubbed them and warmed more, trying to darken prints. Went around back and tried board.* After his investigation, Ben has apparently discovered that heat is what causes the crystals to darken, and he had shown that there is a special substance involved that is only located at the front of the board. However, this was the only example identified where actions could be used to show that a child's behaviour indicated the development of a deeper understanding of the science and technology phenomenon being explored.

A different situation was observed with the windpipes in the sound area. These pipes were different lengths, so that when they were investigated in depth, it would be apparent that the sound was related to the length of the pipe. Most children observed in this study did not experiment with

the pipes in a way that would be necessary to make this discovery. Each child randomly tried the windpipes without conducting an investigation of the range of notes that could be produced. That is, the quality of the interaction with the windpipes was superficial. It is worth noting that the majority of the children returned to the sound area at least once. However, on each occasion they were content to press down the pipe bellows once or twice, without deeply exploring the range of pipes and the different sounds they produced. The windpipe activity may differ fundamentally from the sensory experiences such as the caterpillar and glow room, in that it requires a systematic study in order to yield its full potential. Simple repetition of the activity may be an indicator of learning and enjoyment, but that does not guarantee that the child has learned all that the activity can offer.

In summary, the children observed at the Children's Museum showed varying degrees of interaction with the activities provided. In some instances the children explored an exhibit in depth, but in other cases the interaction was superficial.

Interactions between the children themselves

Two activities where the children spent a lot of time were the quarry and the space maze, both of which were designed for children to share and/or work cooperatively. Two of the children repeated the space maze activity, spending a considerable time on each visit, which suggests this was an enjoyable activity. There is evidence that the quarry was a popular activity-*when teacher said they could move there was (always) a mad rush to the quarry*; Ben *looked at quarry (longingly) then went over to nail prints.* One feature that distinguished these activities was the level of interaction between the children and their friends. Children stayed longer on an exhibit when they have another friend to share the experience.

The value of the participation of other children is illustrated by the children's interaction with the space maze. Some notes made about this activity were: *shoes off, middle of floor and into space maze with friends.* (May) *into maze again, mainly on top level, talking to other children around her.* (May) *tried different levels then sat in ball pit with friends, then up and down through various levels with friends* (Laura). The experience of the maze was enhanced by the fun of playing with friends. Laura explores the different levels while following her friends, and May sits in the maze because she is talking with her friends. Friends also lure the children to return to the maze. The presence of friends increases the length of time spent on the activity and the number of times the activity is repeated, two indicators that have been used to show evidence of learning.

The value of co-operative activity among the children was observed in the Mitey Quarry exhibit. This activity was designed so that a group of children would have to work together in order to move the balls along the various conveyor systems from one station to the next, without allowing them to pile up. This is a different issue to the one outlined above. The nature of the exhibit requires children to co-operate and work together rather than just spend time at the activity. Ben's interaction with the quarry is typical. *Went over to quarry. Friend turned handle of long conveyor and he put handfuls of balls onto it. They swapped over. Balls finished in white bucket and he stood and looked. A girl came over and took a handle and turned it so balls went into white bucket. He stood and watched. Went and looked at green buckets. Then went over to red bucket to feed bucket conveyor. Went up to top of Archimedes screw and tried to negotiate turn. Girl at top of line of children waiting let him have a turn. Turned it a few times on his own, then let a friend help him. Took it in turns, and when not turning wheel, watched balls going into green buckets. Came down and moved around to turning green buckets, by handle. Friend joined him. Let friend turn handle and he fed fallen balls into buckets. Moved around quarry looking for vacancy-to turn handle, be involved. Started putting fallen balls onto blue bucket conveyor from inside. When handle became vacant started turning it. His friend came and joined him-feeding balls and then had a turn. Roles reversed. After few minutes looked around to see where else in quarry he could go.* Ben and his friend are enthusiastic to be part of the coordinated activity of the quarry. They

negotiate for turns with other children and look to see how they can contribute. They help each other to feed the balls into the buckets and turn the handles that keep the process moving.

Throughout the time spent in the quarry, by each of the children, there were numerous occasions when they had to share an activity, wait in line and negotiate for a turn and look about for how they could best participate in the chain of activities that kept the ball moving. It is clear that the children had a high quality of interaction with this activity, spent time on it and repeated the individual parts of the activity many times. These have been shown to be indicators that the children were learning, and it is likely that the co-operative activity is facilitating this learning. Tuckey (1992) also found that interactions among students are not only important, they enhance interactions between students and exhibits. In particular, she noted that children working in small groups were stimulated to read the labels.

It should be noted that other activities beside the quarry and space maze were shared with other children. Some examples were; May *played shape game with two friends*; Laura *worked with two other children building a tower of dice*; Ben *had a telephone conversation with a friend on the can telephone.*

Many instances of the importance of peers in the children's learning during the museum visit were observed. Other children were used as 'models' to show how an activity was meant to be used, they were used as pupils, to be shown how an activity worked, and they were used as partners in imaginative play.

Some examples, of the children using other children as 'models' were: *Ben came over to steady hand, watched girls have a turn*, before trying the activity himself; May *watched other children make shadows*; and May *watched other children, then made handprints with nails*. Eratuli and Schneider (1990) also observed that visitors to a museum, a physics discovery room, learnt by watching other participants.

Many instances the children shared what they had discovered by finding a friend and showing them how the activity worked. For example, May *made handprints across six squares, made pattern, some finger tips only. Showed it to a couple of boys who came in*; Laura *went over to kaleidoscope and showed two other children what you could do.*

Imaginative play was also used as a way of interacting with friends and with the activities. Two examples of this were observed, both from Ben. The first was in the glow room, where the children *were talking about aliens coming looking at glowing items of clothing, shoes, laces, hats etc.* They then moved into womb room and *continued alien idea, worlds going red, aliens here.* Later Ben joined in *pretend play in the hospital room*, (playing doctor and) *listening to a friend's heart.*

The children were helped by watching others, showing others and working as part of a team. There is considerable evidence that the children preferred working with other children. There is indication that when the children were able to share an activity, they spent longer on that activity and were therefore more likely to investigate and learn.

The importance of these social interactions between children may be much greater in the younger children than in the older primary school children who have been largely studied to date. The nature of interactions between children differs as they get older. The very young children studied here used imaginative play, which has not been reported as an important form of interaction among older children. These young children cannot read worksheets or labels; therefore those methods of interaction with an exhibit are unavailable to them. They are more dependent on other methods of learning. The design of the Mitey Science activities recognised the importance of peer interactions.

to learning in younger children. The present study supports the view that, at this exhibition, peer interactions are of central importance to the learning experienced by children. Peer interactions increased socialisation, which increased the time spent interacting with the exhibit and so increased the likelihood of children making connections with the exhibit. Peer interactions also promoted co-operation among children, thereby promoting children learning from one another.

Interactions with a supervisory adult.

Play has been found to be a critical way for young learners to encounter new ideas in science museums (Eideken, 1992; Yahya, 1996) and in the classroom (Hodgkin, 1985; Kimball, 1995; Prentice, 1994). If learning through play is to occur in the museum setting, then those supervising the visit should allow students the freedom to follow their own path of learning (Griffin & Symington, 1997; Davis & Gartner, 1993). Griffin and Symington (1997) investigated the strategies used by class teachers during museum visits, and found that teachers used mainly task–oriented teaching practices, such as worksheets. Hein (1990) also found that teachers were apt to curb exploratory behaviour in the students, and impose formal learning behaviours. Thus it seems that the teachers tend to transfer the culture of learning from the classroom to the informal setting. By contrast, the children adapt to the museum environment modifying their behaviour to the informal setting.

The role of the adults in organising student interaction with the museum environment was investigated in this study at the Children's Museum. The schools observed divided the children into groups, one in the care of the class teacher, and others under the supervision of a parent. Parents and teachers have been grouped into a category of 'supervisory adult' for the purpose of this discussion. The interaction of the children with the supervisory adults is described in some detail. What is most noticeable about the involvement of these adults, is the infrequency with which any mention of them is made during the visit of the children. There were individual differences, but in general, the time the children spent with adults was very small, compared to the time spent with other children or alone.

Laura's recorded interactions with teacher or adult consisted of: *went over to piano and sat with friends and played. Teacher's camera flash went off; liquid crystal and showed teacher handprints. Went up other end to steady hand. Adult showed her how to do it and she had a few attempts. Adult took her over to mirror area and she looked in each mirror quickly. Then when positioned to look at changes spent longer. Asked if someone was behind the moving mirrors. Teacher told them to stop and pick up three balls each; showed nail prints to teacher.* Of sixteen activities, which Laura investigated, only two were facilitated by the presence of an adult, and only five involved any adult presence at all. The role adopted by the teacher appears to have been to walk about and check on progress, sometimes being shown activities that the children found interesting. In the cases where Laura was assisted to understand an activity one of the supervisory parents was involved. The evidence is that this assistance was beneficial. Laura had already paid a brief visit to the mirrors and steady hand. Once the adult showed her what to do, she was prepared to participate in these activities. This participation resulted in Laura asking a question about why the mirrors showed different reflections.

Ben spent very little time with adult or teacher. His teacher sat all the children down and gave them a general explanation before sending them into the exhibition. His next recorded interaction with teacher or adult is that the *teacher gathered children and they moved downstairs and outside.* Out of a total of 25 interactions between teacher and children that were recorded during this study, 13 were of this type, i.e. moving groups of children between activities. Another 4 were housekeeping instructions such as *teacher asked children to make sure all balls were off the floor.* Only five of the interactions involved the students' learning.

May was more involved with the teacher during her visit. The interactions that were recorded are: *teacher over at chime tree said "can we make noises". May went back to tree then when teacher went back to windpipes, May followed. Teacher said to group of children, "go under there and tell me what is there". May went under and looked. Teacher said, "what is in this room?" May went over to her. Teacher divided up pieces for shape game, 3 children playing. Teacher helping children to form shapes when joining, guided until started and knew what they were doing, then left to supervise other children.* When the teacher spoke, May was attracted to the activity where the teacher was stationed. However, the teacher's routine questions did not stimulate May to further investigating. Once attracted to the chime tree she *went back to windpipes, then back to tree, over to pipes, to harp.* The teacher's words did not lead to a thorough understanding of the purpose of the sound area. The same is true of the teacher's general questions about the kaleidoscope and the hospital room. It was only when the teacher became involved in organising the shape game activity that the children *played well* after she left. Tunnicliffe (1994) compared the forms of 'talk' used in a zoo and in the classroom, and found that adults initiated conversation in a school-talk manner even at the zoo, whereas the children's conversations were different at the zoo. The type of questioning used by May's teacher resembles this style of school-talk. This teacher is attempting to bring some formal learning into the informal setting. The children ignore these attempts, or are temporarily distracted from their own investigations.

Those interactions with teacher or adult that resulted in the children participating to a greater degree in the activity, were those where the adult explained how the activity could be best experienced and then allowed the children to conduct further investigation. One example of this was May and the shape game, another was Laura's investigation of the mirrors. Two other examples were observed. A boy was observed in the music area; *tried a few windpipes, then moved on. Shown how to lift the pump up to make it work. Then moved around table trying each pump. Did higher yellow one a few times.* In another instance a *girl came into the area (liquid crystals), seemed unsure what to do. Adult put handprint on and she watched. Gasped when she saw the imprint left, then proceeded to put a hand in each square. Another boy and girl came over and watched what she was doing, then put on handprints, finger marks on board. Stayed five minutes on activity.* The involvement of these supervisory adults was strategic, encouraging the children to pursue an exploration that they might have otherwise abandoned without identifying an appropriate way to interact with the exhibit. Adults were able to enhance the quality of interactions between the children and exhibits and thereby promote learning.

MAIN FINDINGS

From the observations of children visiting the exhibition at the Children's Museum the main findings are as stated below.

- While the children spend a portion of their time in random manipulation of activities, they also chose some exhibits for more prolonged investigation. Prolonged engagement has been identified as an indicator of learning (Carlisle, 1985).
- Interaction with other children is of central importance to the children's interaction with the exhibits. The interaction with other children can be through sharing an activity, co-operative manipulation of an activity, watching other children carry out an activity, showing other children an activity, or through imaginative play.
- The adults (parents, teachers and museum staff) present on the school visit participated little in the children's interaction with the exhibition. When they assisted students to pursue explorations, which the students had initiated with exhibits themselves, the children tended

to play and investigate the exhibit for a prolonged period, indicating more potential for learning.

These findings are summarised in Figure 1. The design of the exhibit and the promotion of increased student socialisation (time spent together and cooperation) are shown as a consequence of the intrinsic nature of the exhibit while adult input is regarded as a factor external to the exhibit.

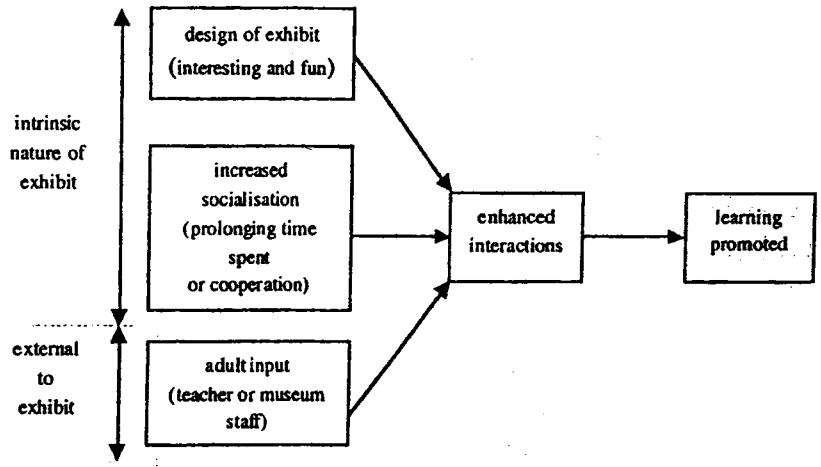

Figure 1: Factors that enhance interactions and promote student learning

IMPLICATIONS

Rennie and McClafferty, (1996) expand on four reasons given by Semper (1990) as to why the interactive science centres are both attractive and a potential centre for learning. The reasons are that they:

- offer the intrinsic motivation and curiosity that is the first step in learning;
- provide opportunities for people to interact and learn in multiple modes;
- invite play and exploration, which are important in the process of learning; and
- allow the development of individual worldviews.

These authors oppose the view espoused by Shortland (1987), that by offering play and excitement these centres were prohibiting learning. Brooke and Solomon (1998) agree that play is important to the success of the museum visit, but argue that a progression from play to problem solving, of the type required for a scientific investigation, is desirable. In their study of the Vista Centre, Brooke and Solomon (1998) found that while some pupils manipulated the activities in a repetitive way, others progressed through a problem solving loop of "questioning, prediction, action, result and reformulation of the problem". The degree of investigation varied between exhibits and between children. These authors argued that the effective visit is one where the child moves from play to meaningful investigation.

investigation, but these instances were infrequent. Some activities, e.g. the windpipes, were not investigated by any of the children in such a way that their scientific principle would be apparent. The design of this exhibit was such that it offered the potential for the type of problem solving recommended by Brooke and Solomon (1998), yet this investigation was generally failing to occur. The implication is that the design or the nature of the exhibit itself is central in promoting interactions with children. Figure 1 shows that the intrinsic nature of an exhibit has a significant influence on enhancing interactions that promote learning.

Brooke and Solomon (1998) suggest that one way to encourage more children to take the step from play to investigation is to reduce the 'instructional density', that is the degree to which children are assisted to understand the activity, rather than manipulate it for themselves. However, this was not the case for the windpipe exhibit. The children spent time in the vicinity of the windpipes, without adult interference, with ample opportunity to manipulate it for themselves. Yet, they only investigated the exhibit superficially. With other activities, such as the liquid crystal display, when the children were given more information about how to participate in an activity, the probability of them spending time on a further investigation was increased.

Other research (reviewed in Rennie and McClafferty 1996) has shown that the presence of museum staff who 'explain' exhibits to visitors is important to visitor interaction with the exhibits. The Mitey Science exhibition did not have explainers provided by the museum. In those few situations where adults encouraged children to continue their exploration of the exhibits the students investigated further. Thus the role for supervising adults is that of "providing cues by asking questions, to help visitors attend to the salient aspects of the exhibits", the role of explainers as described by Rennie and McClafferty (1996, p. 76) and of facilitators as described by Griffin and Symington (1997). The findings of this study support this facilitator/explainer role for teachers and adults working with young children in the museum, that is, encouraging the children to explore activities, such as the windpipes by asking questions and, when necessary, providing hints about how to manipulate the exhibit.

Both in this study and in other research (Tuckey, 1991; Rennie & McClafferty, 1995, Griffin, 1998), social interactions have been shown to be important to the children's interaction with the activities and consequently, with the learning that is taking place. It follows that the design of the exhibition, and the design of the school visit, need to take into account the need to enhance these social interactions. The teachers in this study did not inhibit the children's interactions with their peers, and this interaction was a rich source of motivation for further investigation. It is suggested that teachers and adults involved in school visits to museums should encourage their students to play, talk and co-operate with their peers during the visit. Further, exhibits should be designed to promote interaction not just with the exhibit itself but among children. This was most evident in the Quarry exhibit where children had to cooperate with each other in order to successfully manipulate the equipment.

CONCLUSION

The informal museum setting offers the first step in learning, the stimulation of curiosity through play and motivation. The value of this play should not be underestimated as young children learn by playing. The question that arises is how the play can best be extended to prolonged investigation that may enhance learning? The museum wants to promote a culture of learning among young children. This is not likely to be achieved by eliminating play but by valuing and extending play. Those supervising the school visit need to allow children the freedom to explore and actively scaffold their learning. Play may then be extended along the continuum towards deeper investigation by subtle cues provided by adults to open up enquiry, encouraging friends to

explore and investigate together. The design and development of exhibits that promote extended interactions and require cooperation among children will further promote the natural learning strategies children employ in informal settings.

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APPENDIX

Caterpillar	a large tube lined with different materials, through which children crawl
Kaleidoscope	a crawl under light display
Music area	windpipes of different lengths through which air is pumped piano chime tree where children hit a range of different objects harp
Mitey Quarry	a co-operative learning exhibit where a number of conveyors move coloured balls, simulating a stone quarry.
Glow room loop	a sequence of 3 rooms, a glow room with UV light where children dress up in coloured coats; a womb room, dark and enclosed to resemble the womb; and a sense room offering a variety of smells and textures
Flicking pictures	a spinning drum that creates a movie like effect
Shadow play	children make different shadows
Liquid crystal handprints	a board of liquid crystals where children make handprints
Nail prints	a tray of nails that can be pushed into different shapes
Steady hand	a wire loop is moved over a coil. The coil makes a sound if touched by the loop.
Space maze	a crawl through play area, including a ball pit
Mirrors	a number of curved mirrors to create distorted reflections
Feely faces	children make their own faces with stick-on hair, mouth, eyes etc.
Hospital room	a simulation of a hospital room, including stethoscope and crutches
Pattern game	children insert pieces on a board to make a pattern
Dice game	foam dice were provided
Can telephone	two cans linked by a string
Shape game	life sized jigsaw of the human body