Museums Actively Researching Visitor Experiences and Learning (MARVEL): a methodological study

Introduction

Museums and similar institutions spend a great deal of time, money and effort developing exhibits that facilitate visitor learning. Learning outcomes are core business for most museums. Contemporary management practice recognises that performance is stronger when outcomes are measured, yet the typical performance measures used by museums are numeric counts of visitors, exhibitions, events, tickets sold or levels of 'satisfaction'. An effective, meaningful and economical way of measuring learning is needed. The development of a meaningful procedure for uncovering learning allows for the gathering of information that will have enormous impact on the quality of future exhibitions.

The MARVEL project (Museums Actively Researching Visitor Experiences and Learning) was a collaboration between the University of Technology Sydney, the Australian Museum, the Royal Botanic Gardens Sydney and Environmetrics Pty Ltd. The project team members are Janette Griffin, Lynda Kelly, Janelle Hatherly and Gillian Savage respectively from each of the above organisations. The aim was to develop a set of 'tools' for measuring aspects of learning in any cultural institution, and that could be used by staff who may have little evaluation experience. Three tools were developed and tested to meet this need. This paper reports on the development and initial testing of these tools. A following paper will include field trials of the tools and some tentative data gathered from five museums.

The tools that we developed can be used separately or collectively to:

- assess the degree of learning that takes place in an exhibition/museum

- understand the nature of learning that takes place in an exhibition/museum

- establish benchmarks for learning outcomes

- compare the learning outcomes for different exhibitions

- share data between institutions and make comparisons with them.

The aspects of the project that are reported in this paper include determining each tool's effectiveness in uncovering the extent and nature of learning which each of the individual strategies reveals; developing the most appropriate and effective use of each strategy; investigating the relationships between the learning revealed by combinations of the strategies, and determining the appropriate application of sets of combinations.

Background

Cultural institutions are an important part of the broader learning and knowledge society, playing a key role in lifelong learning and educational leisure. Museums are informal learning settings where learning is intrinsically motivated and proceeds through curiosity, observation and activity (Ramey-Gassert, Walberg and Walberg, 1994). Museums present a distinct context for learning, often described as free-choice learning environments and are visited by a broad range of people (Falk and Dierking, 2000). Museums have the opportunity to shape identities: through access to objects, knowledge and information, visitors can see themselves and their culture reflected in ways that encourage new connections, meaning making and learning (Silverman, 1995; Weil, 1997; Bradburne, 1998; Griffin, D., 1998; Hein, 1998; Carr, 1999; Pitman, 1999, Kelly, 2001). However, museums are finding themselves competing with other leisure and learning experiences in an increasingly complex world (Mintz, 1994; Falk and Dierking, 2000; Kelly, 2000a) where people engage in highly memorable, rich experiences in a range of contexts.

The emphasis in museums and similar institutions, such as zoos, aquaria and botanical gardens, has shifted from displaying curiosities and precious objects for their own sake to an emphasis on helping visitors learn about issues related to their collections. Museums are increasingly positioning themselves in the market as places for rich learning experiences, with mission statements that highlight their key role in public learning and education. Coupled with this, research has shown that when asked why they visit places such as museums visitors often say 'to learn' (Hood, 1995; Kelly, 2000a, 2001).

There have been a range of studies looking at people learning in informal contexts, including museums (Crane, Nicholson, Chen and Bitgood, 1994; Falk and Dierking, 1995; Hein, 1998). Research has been undertaken with specific visitor segments such as families (Borun, Chambers, and Cleghorn, 1996; Moussouri, 1997), school children (Birney, 1988; Griffin, 1998) and adult museum visitors (McManus, 1993; Silverman, 1995; Falk and Dierking, 1997; Falk, Moussouri, and Coulson, 1998). Most of these, however, have been either one-off studies or focussed on particular exhibitions. In Australia there is a growing body of museum visitor learning research (eg. Anderson et.al. 2002; Griffin, 1996, 1998; Rennie and McClafferty, 2002; Kelly, 2000b; Kelly et. al.2004; Piscitelli and Weier, 2002).

Learning in Museums

In the development of learning theory several models and theories have been proposed, with two – constructivism and sociocultural theory – being particularly relevant for museums. Constructivism is a theory of learning that focuses on the learner and the personal meanings they make based on their prior experience, knowledge and interests. Jeffrey-Clay (1998) pointed out that 'Constructivist theory holds that prior knowledge is of primary importance. Rather than learners being empty vessels into which information can be poured, they come … with a wealth of knowledge already organised. It is upon this knowledge structure that

learners hang new information, creating new links to their pre-existing knowledge. To learn meaningfully, a person must integrate new knowledge into his or her conceptual structure' (p.3).

George Hein (1998) proposed a set of nine learning principles that emerged from constructivist thought:

- learning is an active process of constructing meaning from sensory input

- as they learn, people learn about the process of learning, as well as content

- learning happens in the mind

- language and learning are inextricably linked

- learning is a social activity and happens with others

- learning is contextual, in that we learn in relation to what we already know, our beliefs and our prejudices

- previous knowledge impacts on new learning

- learning happens over long periods of time, through repeated exposure and thought

- motivation is essential for learning.

The second theory, sociocultural theory, is based on the work of Lev Vygotsky who first proposed that learning was a socially mediated process where learners, in his case adults and children, were jointly responsible for their learning (Matusov & Rogoff, 1995; Vygotsky, 1978). In a sociocultural model learning is shaped by the context, culture, and artifacts in the learning situation.

Schauble, Leinhardt and Martin (1997) argue for a sociocultural approach as an appropriate theoretical framework in museum learning research as it accounts for meanings made within a social context, rather than facts learned, focusing on the interplay between '… individuals acting in social contexts and the mediators – including tools, talk, activity structures, signs and symbol systems – that are employed in those contexts' (Schauble et al,

1997, p.4). In a similar vein, Matusov & Rogoff (1995) stated that: 'Museums, as educational institutions, provide opportunities for people to bridge different sociocultural practices and, through this process, to bridge different institutions and communities' (p.101).

Based on these views a definition of museum learning is offered as follows:

'[museum] learning is a dynamic process dependant on the individual and their environment within a social context that focuses on some change. … Ultimately, museum learning is about "changing as a person": how well a visit inspires and stimulates people into wanting to know more, as well as changing how they see themselves and their world both as an individual and as part of a community.' (Kelly & Gordon, 2002, p.161)

It has been widely recognised that museum learning research needs to be theoretically based, undertaken across a range of institutions, collaborative within the industry and the wider research community, creative and innovative with wide ranging methods, as well as related to other learning experiences (Falk and Dierking, 1995, 2000; Schauble, Leinhardt and Martin, 1997; Hein, 1998). However, capturing and measuring the nature, depth and breadth of museum learning is problematic. Evaluation of the success of museums in achieving their learning goals is proving a challenge. In museums, visitors choose their experiences, ideas may not necessarily be met in any particular sequence, opportunities for learning may be fragmentary and unstructured. The informal nature of the setting means that museum professionals cannot determine the specific content to which learners are exposed (Griffin, 1999).

Uncovering Learning in Museums – the strategies used in MARVEL

The purpose of this project then was to investigate methods by which we could uncover learning in a museum. The partners in this project had each previously developed strategies that attempted to determine aspects of visitor learning. However we recognised that individually these tools capture only some aspects of the learning that may be taking place. This project was designed to firstly develop and investigate the range of strategies, then to

look at correlations between results from different tests, the feasibility of their use in different contexts and their comparative effectiveness.

Based on earlier findings, our research team believe that it is more valuable to look at how and whether visitors *are learning*, rather than only looking at what they *have learned.* We understand that learning by people of any age is not simple and cannot be measured using simple tools. Each person will gather different information and understandings from the same exhibit. Each person's learning incorporates many experiences beyond the museum visit. The methods we used reflect this view. Further the development of the tools was based on the understanding that learning:

- involves action (mental and/or physical), implying a degree of choice and ownership

- is stimulated when new experiences or phenomena are met

- occurs when new and existing ideas can be linked or when new ideas fill a gap

- involves arousing curiosity

- is supported by social interaction

- is invariably linked to enjoyment

- involves emotional engagement.

So we needed to be innovative in how we discovered whether museum visitors were learning from museum exhibitions. We chose to approach this using three perspectives, which are described below:

- visitors' understanding of the big ideas of an exhibit

- visitors' personal declarations of their learning, and

- visitors' observable behaviours that indicated learning was happening.

Looking for understanding of the BIG IDEAS

 In a series of exit surveys two strategies were trialled that use open-ended techniques to determine the overall learning within exhibitions. First, *narrative methods* (Kelly, 2000b) involving brief stories presented as newspaper articles shown to visitors as they leave an exhibit and a range of open-ended questions, allow for free range discussions revealing the level of understanding of ideas from exhibitions as well as links made to other concepts and contexts. Further tests of this procedure were developed. Second, two *open ended questions* were used in a survey to directly tap visitors' views of the important ideas. These were:

- What do you think are the main messages that the …exhibition is trying to communicate?

- Were there some things that you found particularly interesting in the ….exhibition, that you might tell other people about?

Personal Declarations of visitors' own views of their Learning*:*

The Modes of Learning Inventory (MOLI) was developed by Environmetrics Pty Ltd (Gillian Savage) to provide a structured interview protocol for uncovering visitors' own impressions and expressions of their learning from a particular exhibit. This tool provides a measure of *whether* the visitors themselves consider that they have been learning and *how* they have been learning, rather than what was learned. MOLI measures the process of learning rather than the content. The Index uses a series of statements each with a five point Likert scale from *Strongly disagree* to *Strongly agree*.

The MOLI statements:

- I discovered things that I didn't know

- I learnt more about things I already knew

- I remembered things I hadn't thought of for a while

- I shared some of my knowledge with other people

- I got curious about finding out more about some things

- I was reminded of the importance of some issues

- I got a real buzz out of what I learnt

- It was pleasant to be reminded and to learn more

- It was all very familiar to me

- Some of the things I learnt will be very useful to me

These strategies were combined into the one tool that was administered as an exit interview.

Looking for behaviours that indicate learning is happening

Two methods, visual observation and listening to conversations were used to uncover visitor behaviours that were indicative of learning.

Visual observations.

Griffin (1999) created a visual observation tool for determining school children's engagement in learning in a museum setting. It uses a set of learning behaviours derived from research into behaviours that are exhibited during learning episodes. Engagement in learning is indicated when visitors:

- initiate their own learning activities

- are actively involved with the exhibit

- purposefully manipulate the exhibit

- share ideas with others

- help others to use the exhibit

- show emotive reactions

Behaviours exhibiting non-learning (about the exhibits) were also recorded, such as watching other visitors, walking quickly through an exhibit etc.

Within a particular exhibition a number of specific indicators are developed for each learning or non-learning behaviour by watching visitors in that exhibition. Once the tool is 'tuned' for that exhibition, visitors are observed and their behaviour indicators recorded every 30 seconds.

Listening to Visitor Conversations

Listening to visitor conversations conducted while they are viewing exhibitions can be achieved by asking visitors to carry a tape recorder with a lapel microphone. These conversations can be analysed to reveal discussion, comments and questions which are indicative of learning as described by the behaviours above. This technique has been trialed by other researchers (eg. Allen 2002) and has been further developed in this project to provide a listening strategy. The segments of conversation are attributed to indicators of behaviours in a similar way to the observation tool.

Trials of the Strategies

The trials were conducted at two sites – the Australian Museum in Sydney and the Royal Botanic Gardens, Sydney. In the first phase, each strategy was tested by the investigator who developed it, in conjunction with one of the other investigators. Up to 100 visitors were involved in testing each strategy. Modifications to each strategy were made following these trials.

A second set of trials with the modified tools was then conducted again in each institution. In this phase we conducted cross testing between strategies with the same visitors. This involved observing and taping conversations of each visitor and then

interviewing them at the end of their viewing of the exhibition. At least 20 visitors were involved in this multiple testing in each institution.

The third phase involved analysis of the results of the data collected, looking at the depth and breadth of learning revealed as well as the efficiency and practicality of each strategy.

Modifications to individual strategies

The narrative exit interview was found to be difficult to write in a way that was not misinterpreted by a number of the visitors, and as the ultimate purpose of the project was to develop strategies that could be used easily by non-trained staff in many museums it was decided that this would not be an appropriate tool. Therefore this strategy was set aside for further investigation in a later study.

The open ended questions and the questions used in the Modes of Learning Inventory were modified very slightly to remove some repetition and increase clarity.

The procedure for collecting data for the Visual Observation Study was redeveloped to allow for easier and quicker recording of visitor behaviours. Indicators of the behaviours needed to be modified to suit each venue. It was found inappropriate to attempt to record some of the original set of behaviours using visual observation only as some were more appropriate for the listening strategy. Similarly some behaviours were not appropriately captured using taped conversations, particularly hands-on activity.

Strategy combinations

Different types of information and levels of specificity and sophistication of results were obtained through use of the Exit interviews, the Observations, and Listening to conversations.

Quite consistent results were found between the Observation and Listening study data for the same people within a particular exhibit for some Learning Behaviours, however there was considerable variability in others. This was clearly due to the nature of the data collection. As a result we suggest that not all the Learning Behaviours are sought with both tools and recommend that the Visual Observation tool be used to collect data on:

- Actively Involved

- Purposeful Manipulating

- Sharing learning (including Helping others)

- Non-learning

and the Listening tool be used to collect data on:

- Initiate own learning

- Actively Involved

- Sharing learning (including Helping others)

- Non-learning

- Emotive responses

    Further we found that combining some behaviours was more realistic, for example:

- Purposeful Manipulating and Actively Involved and

- Sharing Learning and Helping Others

Apart from missing the hands-on aspect (although this may be discernible through conversation or extraneous noises) the listening studies appear to yield a more accurate and extensive picture of the learning that is taking place.

What information can the data tell us?

The trials of the different strategies demonstrated that a wide variety of information about visitor learning can be obtained using relatively simple tools. Exit surveys are the most

popular method of gathering information from visitors and this study has shown that they can be used to measure learning outcomes. The survey that we used has been designed to uncover visitor perceptions of the main messages of an exhibition as well as visitors' own perceptions of their learning. In particular it gives a good indication of the extent to which the intended message of the exhibition is being understood, while the MOLI data provides a clear indication of personal views of learning and comprehension of the exhibition. As such, it can be used to measure *whether* learning has taken place, *how* it took place, and to give a broad indication of *what* has been learnt.

An initial useful way to use the listening and visual observation data is to determine the percentage of records for each learning behaviour. This will give a picture of *how* visitors are learning. The total number of records over a given time will reveal *how much* learning was taking place. More detail can be determined such as comparisons for students of a particular age or particular groups of visitors. The data also allow investigation of the *range* of learning behaviours used by individual or general visitors.

At a deeper level the data can be scrutinised to answer questions such as:

- What are the different types of learning behaviours being used in an exhibition?

- How much relative time is being spent on learning vs non-learning behaviours?

- To what extent is social learning being used?

- Are particular elements of the exhibition being used as intended? (e.g. are they using the hands-on elements or the videos as intended?)

- Do people seem to be learning more from some parts of the exhibition than others?

- What is the range of learning processes used by visitors within a particular exhibition?

In summary, visual observation data tells us *that* people are learning and aspects of *how* they are learning. It gives a good indication of the extent and nature of visitors' use of hands-

on exhibits. It also provides information on a number of behaviours which do not involve talking, such as reading, manipulating, looking at objects etc. Listening data tells us more about *how* they are learning as well as some information about *what* they are learning. It gives a much deeper understanding of the learning that is taking place, how visitors are relating what they see to other experiences, how the exhibits stimulate discussion which is not always directly related to what they see. Only from the listening data were we able to get a good picture of the emotive responses to the exhibitions. At the same time the listening data also gave a more accurate picture of non-learning behaviour as much of this was revealed by hearing what they were talking about. Exit survey data tells us *what* visitors are learning and *if they know* they are learning. They give good comparisons with the listening data regarding emotive responses, interest and curiosity. We found that surveys were the best way to determine understanding of the main messages. Visitor's views about the exhibit itself are revealed in the surveys as well as the listening data.

Balancing Feasibility and Value

In addition to developing and testings tools to uncover visitor learning in museums, the other purpose of this project was to determine the effectiveness and feasibility of using each tool. We found that exit surveys are the quickest and simplest way of obtaining data, and while the Visual Observation tool is not difficult it was more time consuming, and staff needed to practice using it. The Listening tool is more invasive but appears to provide the most comprehensive and rich data.   We were surprised, however, that most (but not all) visitors who were approached, were happy to carry the tape recorder and rarely was it evident that they were consciously speaking into the tape. Most visitors apparently forgot about the tape's presence very quickly and continued their conversations as normal.

The decisions as to which combination of tools to use for any specific investigation, will therefore depend on the amount of time available and the expertise of the users of the tools (there is considerable analysis required particularly for the listening data) compared with the depth of information that is sought.

Following our researchers' trials of the tools, a package was developed and provided to three museums who were asked to trial the kit. The results of their trials along with some tentative comparative data gathered from five museums will be reported in a following paper.

In conclusion

The findings so far from this project have shown that the suite of strategies that were developed are complementary, each providing a different insight into visitor learning and together providing a rich portrait of visitors' experiences. In particular listening to visitors' conversations proved invaluable in uncovering the way in which visitors related what they were seeing and experiencing with past knowledge and experiences and in providing insight into the way in which visitors collaborate in their learning. In recent years there has been increasing interest in learning conversations in museums, as evidenced by the book edited by Leinhardt, Crowley and Knutson (2002). The findings from their research clearly show that visitors learn through social experiences in museums. At the same time, Allen (2002) found, as we have, that listening to conversations has many logistical issues, making this the most challenging of the strategies. Another way of giving voice to the visitor is by asking them directly for their views of their own learning, as we did using the MOLI tool. Birney (1995), Griffin & Symington (1997) and Kelly & Groundwater-Smith (2004) have found that both children and adults will readily articulate their views of their own learning and what hinders or helps this learning in a museum setting.

Together the strategies that we have employed go a long way to helping us to uncover the extent to which each of Hein's (1998) learning principles are being employed in the museum environment. It was found, however, that while each strategy could provide considerable information they also each were missing out on some aspects of the visitors' learning – an important discovery for museum evaluators. The level to which we are able to uncover learning in a museum is determined by the feasibility, in terms of money and time, of gathering the information. However, we feel that by investigating the learning process that is taking place we are moving toward a more realistic measure of the visitors' experience. We have moved a long way from pre- and post-evaluations of content remembered from the brief time of the visit.

We believe that this project will contribute to better understanding of learning in museums. The tested procedures will be able to be used by museums to not only measure the learning outcomes of their programs, but to provide reliable information to external agencies as evidence of achieving their key performance goals. More importantly, by investigating whether and how people are learning we can gain insight into what people are actually doing in an exhibit and in turn, learn more about the way that exhibits could be planned and designed to improve the quality of learning experiences for visitors. Most importantly the tools that have been developed here rely on and celebrate the visitors' contribution to the research on their own learning.

Acknowledgement

References

Allen,S., 2002, 'Looking for learning in visitor talk: a methodological exploration', in *Learning Conversations in Museums*, eds G. Leinhardt, K. Crowley, and K. Knutson, Lawrence Erlbaum, Mahwah, N.J., 259-304.

Anderson, D., Piscitelli, B., Weier, K., Everett, M., & Tayler, C. (2002), 'Children's Museum Experiences: Identifying Powerful Mediators of Learning', *Curator*, 45(3), 213-231.

Birney, B., 1988, 'Criteria for successful museums and zoo visits: children offer guidance', *Curator* no. 31(4), 292-316.

Birney, B., 1995, 'Children, animals and leisure settings', *Society and Animals* no.3(2), 171-187.

Borun, M., Chambers, M. and Cleghorn, A., 1996, 'Families are learning in science museums', *Curator* no. 39(2), 123-138.

Bradburne, J., 1998, 'Dinosaurs and white elephants: the Science Centre in the 21st Century', *Museum Management and Curatorship* no.17(2), 119-137.

Carr, D., 1999, 'The Need for the Museum', *Museum News* March/April, 31-52.

Crane, V., Nicholson, H., Chen, M. and Bitgood, S., 1994, (Eds.) *Informal Science Learning: What the Research Says About Television, Science Museums, and Community-Based Projects*, Research Communications Ltd, Dedham, MA.

Falk, J. and Dierking, L., 1995, (Eds.) *Public Institutions for Personal Learning: Establishing a Research Agenda,* American Association of Museums, Washington, D.C.

Falk, J. and Dierking, L., 1997, 'School field trips: assessing their long-term impact', *Curator* no.40(3), 211-218.

Falk, J. and Dierking, L., 2000, *Learning from Museums: Visitor Experiences and the Making of Meaning*, AltaMira Press, Walnut Creek, CA.

Falk, J., Moussouri, T., and Coulson, D., 1998, 'The effect of visitors' agendas on museum learning', *Curator* no. 41(2), 107-120.

Griffin, D., 1998, 'Not the Last Hurrah!', *Muse* September/October no.2-3, 13-15.

Griffin, J., 1996, 'Museums are educational institutions but are they always places of learning?',
in *Identity, Icons and Artefacts: Proceedings of the Inaugural Museums Australia Conference*,
eds M. Anderson, A. Delroy and D. Tout-Smith, Museums Australia, Perth, 99-102.

Griffin, J., 1998, *School-Museum Integrated Learning Experiences in Science: A Learning
Journey.* Unpublished PhD Dissertation, University of Technology, Sydney.

Griffin, J., 1999, 'Finding evidence of learning in museum settings', in *Communicating Science:
Contexts and Channels*, eds E. Scanlon, E.Whitelegg and S. Yates, Routledge, London , 110-
119.

Griffin, J. & Symington, D., 1997, 'Moving from task-oriented to learning-oriented strategies on
school excursions to museums', *Science Education* no.81(6), 763-779.

Hein, G., 1998, *Learning in the Museum*, Routledge, London.

Hood, M., 1995, 'Audience research tells us why visitors come to museums, and why they don't',
in *Evaluation and Visitor Research in Museums: Towards 2000*, ed. C. Scott,Powerhouse
Publishing, Sydney, 3-10.

Jeffrey-Clay, K., 1998, 'Constructivism in museums: how museums create meaningful learning
environments', *Journal of Museum Education* no.23 (1) 3-7.

Kelly, L., 2000a, 'Understanding conceptions of learning', in *Change and Choice in the New
Century: is education Y2K compliant? Change in Education Research Group Conference
Proceedings*, 115-121.

Kelly, L., 2000b, 'Finding evidence of visitor learning', *Informal Learning Review* May/June, 1,
8-12,

Kelly, L., 2001, 'Developing a model of museum visiting', in *National Collections, National
Culture,. 2001 Museums Australia Conference Proceedings,* Canberra,
<http://www.amonline.net.au/amarc/>

Kelly, L., & Gordon, P., 2002, 'Developing a Community of Practice: Museums

and Reconciliation in Australia', in *Museums, Society, Inequality*, ed. R. Sandell, Routledge, London, 153-174.

Kelly, L. & Groundwater-Smith, S., 2004, 'As We See It: Learning in the Museums Using Multiple Perspectives'[1] Paper Presented to the *Students Learning In Museum Conference*, University of Technology, Sydney.

Kelly, L., Savage, G., Griffin, J., & Tonkin, S., 2004, *Knowledge Quest: Australian Families Visit Museums*, Australian Museum, Sydney.

Leinhardt, G., Crowley, K., Knutson, K., 2002, *Learning Conversations in Museums*, Lawrence Erlbaum, Mahwah, N.J.

Matusov, E. & Rogoff, B., 1995, 'Evidence of development from people's participation in communities of learners', in *Public Institutions for Personal Learning*, eds J.Falk & L.Dierking, American Association of Museums, Washington D.C., 97-104.

McManus, P., 1993, 'Memories as indicators of the impact of museum visits', *Museum Management and Curatorship* no.12, 367-380.

Mintz, A., 1994, 'That's Edutainment!', *Museum News*, November/December, 32-35.

Moussouri, T., 1997, *Family Agendas and Family Learning in Hands-On Museums*, Unpublished PhD Dissertation, University of Leicester.

Pines, B. and Gilmore, J., 1999, 'The experience economy', *Museum News* March/April, 45-48.

Piscitelli, B. and Weier, K., 2002, 'Learning with, through and about art: the role of social interactions' in *Perspectives on Object-Centered Learning in Museums*, ed. S. Paris,. Lawrence Erlbaum, Mahwah, N.J.121-152.

Pitman, B., 1999, ed., *Presence of Mind: Museums and the Spirit of Learning*, American Association of Museums, Washington, D.C.

---

[1] A version of this paper was presented to the British Educational Research Association, Edinburgh, September, 2003.

Ramey-Gassert, L., Walberg, H. and Walberg, H., 1994, 'Reexamining connections: museums as science learning environments', *Science Education* no.78(4), 345-363.

Rennie, L., & McClafferty, T., 2002, 'Objects and learning: understanding young children's interaction with science exhibits', in *Perspectives on Object-Centered Learning in Museums*, ed. S. Paris, Lawrence Erlbaum, Mahwah, N.J.,191-213.

Savage, G., 2000, *Youth Audiences: Recalcitrant or Discerning*? [http://www.environmetrics.com/youthmuseums.pdf].

Schauble, L., Leinhardt, G. and Martin, L., 1997, 'A framework for organising a cumulative research agenda in informal learning', *Journal of Museum Education* no. 22(2/3), 3-8.

Silverman, L., 1995, 'Visitor meaning making in museums for a new age', *Curator* no. 38(3), 161-169.

Vygotsky, L., 1978, *Mind in Society*, Harvard University Press, Cambridge.

Weil, S., 1997, 'The museum and the public', *Curator* no. 16(3), 257-271.