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DON'T COMPARE, COMPLEMENT

Making the best use of Science Centres and Museums

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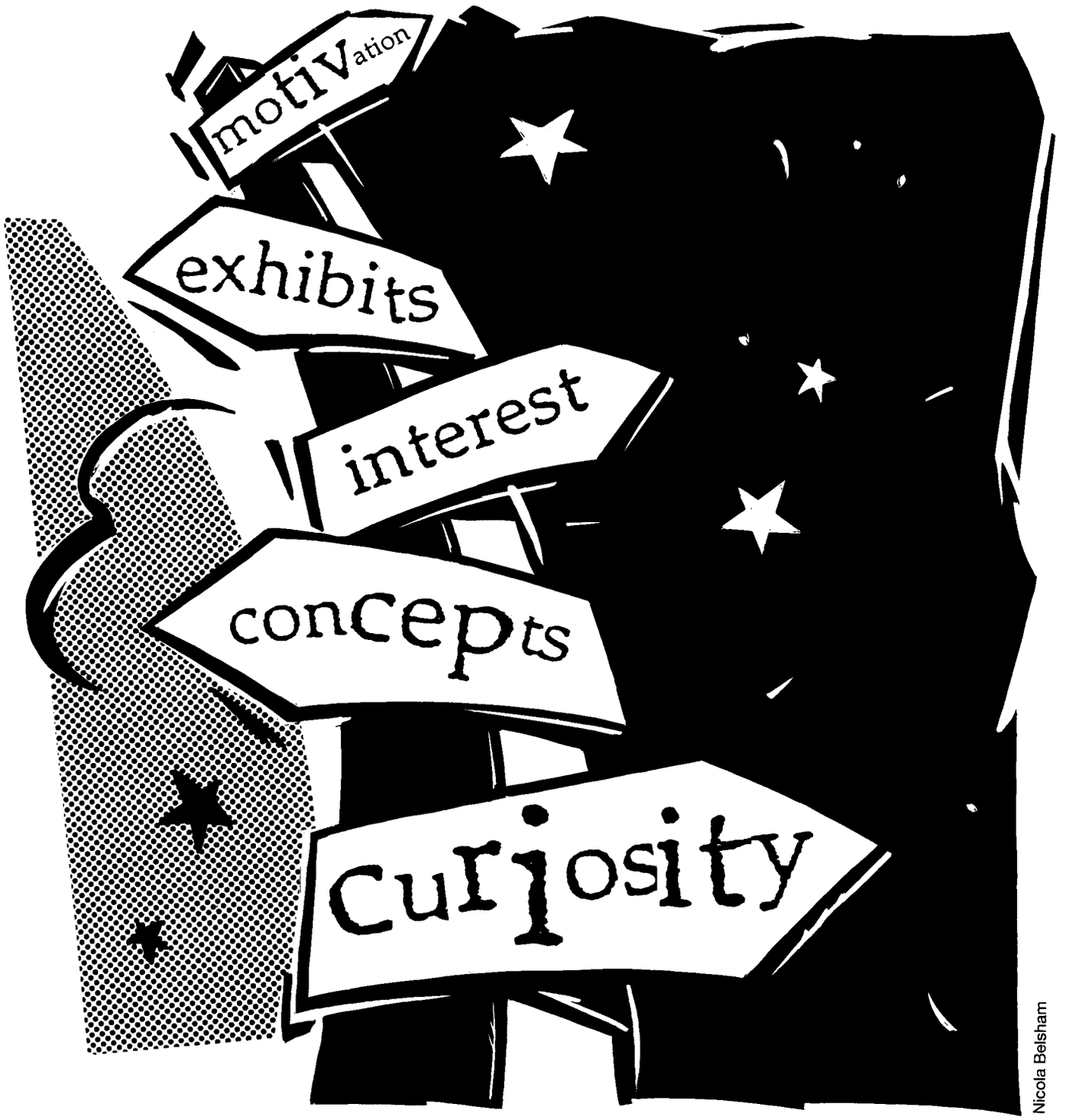

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Don't Compare, Complement

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SCIENCE CENTRES AND MUSEUMS are a growth industry in Australia and New Zealand. The increase in the number of interactive science and technology centres in Australia and New Zealand has been accompanied by an increase in the number of school visitors, in fact school groups are a major target audience for these centres. They offer exciting exhibits and themes, providing opportunities for children (and adults) to experience science and technology in a non-threatening and stimulating environment. How can teachers use these centres to promote students' engagement in school science, which might seem boring and mundane by comparison? Do such centres affect learning? Do they offer valuable motivational opportunities for students to learn science? Or, is the fun of the visit soon forgotten in the routine of science lessons back at school? Answers to these questions are provided by a review of research findings related to school-aged children's visits to interactive science and technology centres, including museums, zoos, botanical gardens and aquaria where there is opportunity for interaction with exhibits.

Why visit interactive science and technology centres?

Teachers take their class to visit an interactive science and technology centre for many reasons: the desire for a "change of pace", science enrichment, a social experience for the students, as well as to increase their exposure to science. There is good research evidence that school visits to science centres, museums, zoos, art galleries and so on, are memorable events. Teachers can probably remember field trips they attended when they were students, even though their memories of classroom events may be hazy. Of course, students will have their own personal and social agendas for the visit, which may be quite different from the teacher's educational agenda! It is important that teachers take this into account when planning the visit. If the purpose of a visit is essentially related to entertainment, it is likely that the learning outcomes will be quite different from those of visits which are structured to perform a specific role in a sequence of school work. In the following sections, the reasons for these differences in outcomes become clear.

What happens on a visit?

What visitors do at interactive science and technology centres is well documented. They orientate themselves for the first few minutes, attend to the exhibits for some considerable time, about 30 minutes or more, and then "cruise" for a further period, perhaps 15 to 30 minutes. Similar behaviour is observed for children, with a period of "roaring around" followed by "settling down". Some researchers suggest that a visit of two hours is an appropriate length, as shorter visits can lead to a lack of involvement, and longer visits result in lag of interest.

If students are visiting for the first time, exploring the centre and orientating themselves is a high priority, and in a new, unfamiliar setting this behaviour takes precedence over the teacher's plans for the visit. Students familiar with a setting tend to learn more than those who are not, although if students are very familiar, they may find the setting or the exhibits boring. On the other hand, some young children may become anxious in an unfamiliar setting, particularly if the visit is not structured. Students need time to explore the exhibits which interest them, as well as those the teacher has planned for them to see.

Research shows that when the novelty of the setting is reduced, for example by showing a videotape of the venue, the amount of purposeful exploratory behaviour can be increased. Information about how lunch will be organised, where the toilets are, and the price of dinosaurs in the centre shop are issues of great importance to children. Other pre-visit orientation activities, including a variety of lectures about concepts, readings and other guide materials, have been effective in promoting the learning of students and young adults. Not surprisingly, it has been found that both cognitive and affective learning can be increased when teachers use pre-visit activities to structure their class's visit and link it to class work.

Once students begin interacting with the exhibits, they tend to do it in a stop-start manner, revisiting exhibits that interest them, often several times. Students interact in different ways, ranging from careful studying of an exhibit to zooming past with a flick of a lever or a push of a button. It is clear that students' prior knowledge is important in how they interact and what they learn from exhibits. Students, even undergraduate students, also need time to play with and explore the exhibits before they begin to understand them. Exhibits are interacted with most effectively by children whose thought processes match those required to understand the exhibit.

The social nature of the visit is another important factor. Research evidence suggests that interactions between people are at least as important for learning as those between the individual and the exhibit. Peer-teaching is a frequent occurrence, with children taking on the role of explainers as they question their companions, read labels aloud, and demonstrate to each other the way the exhibit works. Some students who are not usually successful in school may be successful peer leaders during visit activities. The optimum size of a group for working at an exhibit is small, so that students are more able to ask questions, receive answers and handle the exhibits. Pairs get most deeply involved in the activities. In larger groups, some members' opportunity to learn is reduced because they have less time to interact with the exhibit themselves.

According to some research, children prefer to be with peer companions rather than adults and many prefer to teach themselves, even when exhibits are not interactive. Generally, children have been observed to behave in a more social way than adults, demonstrating more co-operative and sharing behaviours. Students enjoy the social aspects of their visit, but they may also have solitary experiences, learning by themselves or watching other people interact with exhibits.

Another factor affecting learning is the means by which students are cued to the salient features of the exhibits. The most common type of cue is the labelling of the exhibit. Complex labelling can be off-putting, and most science centres are aware of the optimal style and positioning of labels. Although labels often seem to be ignored, many visitors do read them and often read them to each other.

Young children are less likely to attend to labels and may need encouragement to stay with an exhibit long enough to "get it to work".

Worksheets provide another kind of cue to direct attention to exhibits, but their use is problematic. Good worksheets are directly related to the exhibits, unambiguous, integrated with school work, and they take considerable time to prepare! Some researchers believe that worksheets impede learning because they restrict the focus of children's thought processes and prevent them from thinking of their own questions to ask. In fact, some researchers have helped students to compile their own worksheets for visits to zoos and museums. Other research suggests that for older students, one worksheet per group can be effective, because this promotes opportunities for meaningful, co-operative group learning rather than simply trading answers, as often happens with individual worksheets. Particularly with younger children, the worksheets should focus on the exhibit itself, rather than its labels, to encourage children to develop their powers of observation.

Explainers (and teachers or parents who chaperone school groups) also provide cues by asking questions to help students to attend to significant aspects of the exhibits. The presence of explainers is important. Because students have different combinations of background experiences, interests and skills, they will interact differently with exhibits and thus need different kinds of help. Effective explainers try to open-up students' thinking rather than direct them to the right answer and their effectiveness tends to be greater when the exhibits are not interactive.

The effect of teachers' involvement during their class visits to interactive science and technology centres is significant. Research and the experience of science centre staff indicate that, although they realise the importance of preparing themselves and their class for the visit, many teachers do not plan either preparatory or follow-up activities. Some teachers involve themselves fully with students and others have been observed to abandon their class and occupy themselves in the coffee shop. Yet the participation of teachers in their class visit can be very beneficial, for both students and the teachers themselves. Teachers express surprise at how much, and which, students know about science when they see them interacting in the unstructured environment of the interactive science and technology centre.

What to expect from a visit

There are a range of possible outcomes from visits to interactive science and technology centres, although measuring them is not easy. Many studies have reported gains in cognitive learning and/or more positive attitudes to science as outcomes of visits, but the findings for cognitive and affective change are not always consistent. For example, one researcher found that cognitive learning was enhanced by a structured, docent-led tour of a natural history gallery, but an unguided group reported more favourable attitudes. Other researchers concluded that a well-structured class lesson was more effective in promoting learning than a visit to an exhibit at a science museum, but the visit was perceived to be far more enjoyable and interesting. The students in this study considered themselves to be learning during their visit and some thought they learned more than in the classroom lesson. Children, especially young children, often do not distinguish between learning and enjoyment and there is probably little point in trying to separate them.

Overall, the research findings suggest that clear, demonstrable cognitive gains from visits to interactive science and technology centres are not all that should be considered in deciding whether visits are beneficial. Researchers draw attention to the self-motivated learning that occurs during school field trips, and there is much evidence that students remember their visit long after it has occurred, and these memories are both affective and cognitive. Educationally effective programmes have been defined as "those in which products are not emphasised, inquiry is sparked, open-ended questions are generated, and students actively participate and appear involved". It is not surprising that a list of benefits from visits to interactive science and technology centres, aside from students' learning, include the excitement and pleasure children gain from visits; that non-academic and non-English speaking students can get involved; and that students develop co-operative ways of working.

Summary of research findings

The research reviewed provides answers to two of the questions posed in this paper. Visits to interactive science and technology centres are memorable events. They do affect students' learning and they do provide valuable motivational opportunities for students to learn science. Overall, the research suggests that although students usually find visits enjoyable, both the amount and nature of their cognitive and affective learning are variable. Learning is influenced by the extent to which students are familiar with the setting, their prior knowledge, the match between the cognitive level of students and the thought processes required by the exhibits, the degree of structure of the visit (including pre- and post-visit activities), the provision and nature of the cues for learning, and the social aspects of the visit. Many of these factors are under the direct control of the teacher, thus it follows that teachers can make a difference to the value of their class visits to interactive science and technology centres.

Practical suggestions

The research literature suggests recommendations for those who are organising a visit to an interactive science and technology centre in order to enhance students' learning in science. Remember that both students and teachers will have a say in what happens during a visit, so the most important thing is that they both have similar expectations of the outcomes of the visit.

Before the visit

Teacher preparation. It's a good idea to visit the interactive science and technology centre first to discover what exhibits there are, what concepts or phenomena they demonstrate, what level of thought processes they require to be understood, whether there are worksheets or other cues are available, and how movement around the centre can be organised. This information can help to determine how to make the visit fit the needs of the current teaching programme. Exhibits which demonstrate the concepts being dealt with in the class and which match the cognitive level of the students can be chosen. Learning activities can be built around the exhibits, in terms of pre, post and during visit instruction. Many interactive science and technology centres have inservice courses and/or education officers who can help plan a visit. Take advantage of them.

Student preparation. Informing students where they are going and determining their familiarity with the centre will indicate whether or not novelty is likely to be an important factor in the visit. It can then be decided whether or not to provide orientation information, such as maps showing the layout of the centre, including assembly points, lunch

areas, toilets and so on. Remember that students are often more concerned about whether they will be able to visit the museum shop than they are about the teachers' plans for the visit! Having students help to plan the objectives of the visit is an effective form of pre-visit instruction. Knowing what learning objectives are targeted serves as an advance organiser for students and they can be more self-directed in achieving them. Related preparation for students includes providing them with a list of the exhibits to be visited (although they may visit others) and ensuring that they have the necessary background knowledge and skills to use and understand how the exhibits work. The nature and requirements of post-visit activities should also be made clear before the visit.

During the visit

Orientation. Students unfamiliar with the environment of the interactive science and technology centre will require some time to settle down to work. Students will also engage in preliminary playing and exploration with exhibits even when they are seriously working.

Interacting with exhibits. Besides helping students keep track of time and their learning objectives, teachers can provide cues to facilitate learning by being available to respond to questions and make suggestions to extend their thinking and understanding. Students with different levels of skills may need different kinds of help.

Social interaction. To capitalise on students' enjoyment of social interaction and the peer teaching which occurs, students can be encouraged to work in small groups and share the responsibilities associated with learning.

Recording. If students are to use worksheets or some other means of recording their findings, this is usually most effective with one worksheet or record per group.

Concluding the visit. Near the end of the visit, it may be necessary to check how students are progressing in achieving the objectives of the visit, so the remainder of their time can be structured effectively. Teachers should be aware of the students' agendas for the visit. Make sure that students know they will have at least 20 minutes to explore the things that interest them.

After the visit

Common sense suggests that post-visit activities should reflect the varied nature of the experiences students had at the interactive science and technology centre. Young children in particular, should be given the opportunity to share their experiences and findings with their peers through class presentations, group reports or posters. Students can plan further research or experiments based on what they have found out. In subsequent lessons every opportunity should be taken to refer back to exhibits and activities experienced during the visit, thus reinforcing and extending the learning which occurred.

Discussion

The major question addressed in this paper was "how can teachers use interactive science and technology centres to promote students' engagement in school science, which might seem boring and mundane by comparison?" We think that, in three words, the answer is Don't Compare, Complement. Students find interactive science and technology centres exciting and different from school, and the visits more interesting and enjoyable than effective class lessons, even when given in the museum. It is not realistic to expect every lesson to be as exciting as a visit to an interactive science and technology centre, nor would that necessarily be an effective way to achieve the objectives of the science curriculum. Instead, we believe it is best to integrate visits to centres into the teaching programme to complement the learning activities at school.

In making visits integral to their programme, we suggest that the teachers' most important decisions relate to why they take their class to the interactive science and technology centre. The reasons for the visits determine how teachers should prepare themselves and their students to maximise the complementary effect. For example, if the purpose of a visit is to provide motivation, then the focus of the visit will be on affective outcomes, the arousal of interest and curiosity about concepts that the students are finding rather mundane at school. The exhibits chosen will be those that relate to school work, but provide new (and perhaps extra-curricular) perspectives on those concepts. If the focus of a visit is to provide an introduction to a topic, then the visit will need to be centred around a range of exhibits chosen because they demonstrate a variety of concepts to be covered in the topic, so that students will leave the centre with a range of unanswered questions they will be able to pursue back at school. And if a visit is to revise and consolidate the learning of concepts, exhibits should be chosen which provide new demonstrations of related phenomena and applications of associated properties. Through careful preparation, the enjoyment and enthusiasm aroused by the students' visit can be transferred to the achievement of science objectives back at school.

Notes

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A good overview of the science centre or museum visit experience and the factors which interact to determine its outcomes is presented in

Falk, J.H., & Dierking, L.D. (1993). *The Museum Experience.* Washington, DC: Whalesback Books.

The definition of educationally effective programmes is found in

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Lucas, A.M. (Ed.). (1991). Informal Sources for Learning Science [special issue]. *The International Journal of Science Education, 13,* no 5.

A general discussion of the potential for learning from museum visits is in

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