Interactive Science and Technology Centres: Helping Teachers Make Best Use of Them

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Abstract

Interactive science and technology centres are flourishing in Australia. They offer exciting opportunities for children and adults to experience science and technology in a non-threatening and stimulating environment. But how do such centres affect learning? Do they offer valuable motivational opportunities for students to learn science? If so, how can teachers use them to promote students' engagement in school science, which might seem boring and mundane by comparison? A review of research related to science learning is presented, together with a summary of findings intended to enable teachers to use these centres effectively.

The theme of this year's AARE conference is "Educational Research: Making a Difference". This paper addresses the theme by synthesising some of the growing body of educational research in museums, zoos and interactive science and technology centres and extracting from it the knowledge that can help teachers make a difference to the learning of their students from class visits to such centres.

The growth in the number of interactive science and technology centres 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. Three questions provide the focus for this paper: How do such centres affect learning? Do they offer valuable motivational opportunities for students to learn science? If so, how can teachers use them to promote students' engagement in school science, which might seem boring and mundane by comparison? In this paper, the answers to the first two questions are used to structure an answer for the third. The first part of the paper presents a review of research findings related to school-aged children's visits to interactive science
and technology centres, including museums and zoos where there is opportunity for interaction with exhibits. The review (which is not exhaustive) is organised around three headings: Why visit? What happens there? What are the outcomes? The second part of the paper addresses the question of how teachers can use interactive science and technology centres to promote students' engagement in school science.

Review of Research about Interactive Science and Technology Centres

Why Visit Interactive Science and Technology Centres?

There are a number of reasons why teachers might take their class to visit an interactive science and technology centre. Gottfried (1980) reported that teachers' visits to the Biolab, at the Lawrence Hall of Science, included the desire for a "change of pace", science enrichment, a social experience for the students, and to increase their exposure to science. Rennie and Elliott (1991) found that teachers took their classes to a CSIRO Science Education Centre for similar reasons. If the purpose of a visit is essentially related to entertainment, such as a reward for students at the end of term, a social experience or a change of pace, it is quite 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 at Interactive Science and Technology Centres?

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 (Diamond, 1986; Falk, Koran, Dierking, & Dreblow, 1985; Stevenson, 1991). Similar behaviour is observed for children, with a period of "roaring around" followed by "settling down" (Carlisle, 1985; Javlekar, 1989). From their extensive evaluations, Price and Hein (1991) 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 they are visiting for the first time, exploration and setting-orientated learning is a high priority for students, and in a new, unfamiliar setting this behaviour takes precedence over the teacher's plans for the visit (Falk, Martin & Balling, 1978). Children familiar with a setting tend to learn more than those
who are not (Balling & Falk, 1980), although if students are very familiar, they may find the setting or the exhibits boring (Balling & Falk, 1980; Talisayon & Talisayon, 1987). Research on the use of novelty reducing interventions, such as slide shows before a visit, indicates that the amount of purposeful exploratory behaviour can be increased (Kubota & Olstad, 1991). Other pre-visit orientation activities, including a variety of lectures about concepts, readings and other guide materials, have effectively promoted the learning of students (Gennaro, 1981; Stankiewicz, 1984) and young adults (Braverman & Yates, 1989). Not surprisingly, it has been found that both cognitive and affective learning can be increased when teachers use pre-instructional activities to structure their class's visits (Finson & Enochs, 1987; Koran, Lehman, Schafer & Koran, 1983). In fact, Finson and Enochs (1987) suggest that unstructured visits may cause anxiety in children, thus reducing their enjoyment.

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 (Carlisle, 1985). It is clear that students' prior knowledge is important in how they interact and what they learn from exhibits (Beiers & McRobbie, 1992; Falk, Koran & Dierking, 1986; Gottfried, 1979; Lucas, McManus & Thomas, 1986; Sneider, Eason & Friedman, 1979; Tulley & Lucas, 1991). Students, even undergraduate students, also need time to play with and explore the exhibits before they begin to understand them (Semper, Diamond & St. John, 1982). Exhibits are interacted with most effectively by children whose thought processes match those required to understand the exhibit (Boram & Marek, 1991; Feher & Rice, 1985; Javlekar, 1989).

The social nature of the visit is another important factor. According to Diamond (1986), 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 the way the exhibit works (Carlisle, 1985; Gottfried, 1980; Rennie & Elliott, 1991; Tuckey, 1992). Some students who are not usually successful in school may be successful peer leaders during visit activities (Gottfried, 1980). The optimum group size is small, so that students are more able to ask questions, receive answers and have their hands on the exhibit (Price & Hein, 1991). Gottfried (1980) and Tuckey (1992) report that pairs get most deeply involved in the activities. In larger groups, some members' experience may be vicarious, reducing the opportunity to learn (Tuckey, 1992). According to some research, children prefer to be with peer companions rather than adults (Birney, 1988) and many prefer to teach themselves, even when exhibits are not interactive (Stronck, 1983). Generally, children have been observed to behave
in a more social way than adults, demonstrating more cooperative and sharing behaviours (Carlisle, 1985). Although students enjoy the social aspects of their visit, they also have solitary experiences, and even then learning can occur by watching other people interact with exhibits (Tulley & Lucas, 1991).

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 and there is a considerable body of research about the optimal style and positioning of labels. This relates to exhibit design, and is not reviewed here (see, for example, Screven, 1986). Many visitors read labels and often read them to each other (McManus, 1989), but children are less likely to attend to labels (Carlisle, 1985).

Worksheets provide another kind of cue but their use is problematic. Gottfried (1979) reported that no children in his study were observed to record on their data sheets, although his follow up work indicated that learning had occurred. Price and Hein (1991) believe worksheets impede learning because they restrict the focus of children's thought processes and prevent them from thinking of their own questions to ask. McManus (1985) suggests that for older students, one worksheet per group can be effective, because this promotes opportunities for meaningful, cooperative 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.

Docents or explainers (or teachers who fill this role) also provide cues by asking questions to help students to attend to significant aspects of the exhibits (Diamond, St. John, Cleary & Librero, 1987). 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 (Gottfried, 1979). Effective explainers try to open-up students' thinking rather than direct them to the right answer (Price & Hein, 1991), and their effectiveness tends to be greater when the exhibits are not interactive (Lehman & Lehman, 1984; Stronk, 1983).

What do teachers do during their class visits to interactive science and technology centre? Their involvement in the visit can be total, as in some classes observed by Rennie and Elliott (1991), or zero, in the cases of the teachers seen to disappear into the cafeteria during programs evaluated by Price and Hein (1991). Gottfried (1980) reported that two thirds of the teachers in his study did not plan either preparatory or follow-up activities. The participation of teachers in their class visit can be very beneficial, even for teachers themselves. As Price and Hein report, 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 are the Outcomes of Visits to Interactive Science and Technology Centres?

There are a range of possible outcomes from visits to interactive science and technology centres, although the measurement of them is not straightforward (Donald, 1991; Falk, Koran, & Dierking, 1991; Koran & Ellis, 1991; Koran, Longino & Shafer, 1983). Many studies have reported a range of gains in cognitive learning and/or more positive attitudes to science as outcomes of visits (Balling & Falk, 1980; Dymond, Goodrum & Kerr, 1990; Erätuuli & Sneider, 1990; Finson & Enochs, 1987; Gottfried, 1980; Javlekar, 1989; Lam-Kan, 1985; Schibeci, 1991; Wright, 1980), but the findings for cognitive and affective change are not always consistent. For example, Stronck (1983) 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. Flexer and Borun (1984) concluded that a well-structured class lesson was more effective in promoting learning than a visit to an exhibit at the Franklin Institute Science Museum, but the visit was perceived to be far more enjoyable and interesting. The students in Flexer and Borun's study considered themselves to be learning during their visit and some thought they learned more than in the classroom lesson. Similarly, children interviewed by Birney (1988) did not distinguish between learning and enjoyment.

These findings suggest that clear-cut, empirically-demonstrated cognitive gains from visits to interactive science and technology centres are not all that should be considered in deciding whether visits are beneficial. Gottfried (1980, p. 173) draws attention to the "unique type of self-motivated learning that occurs" during a school field trip to Biolab, and Stevenson (1991) reports that even six months after their visit to Launch Pad at the London Science Museum, families still talked about their experiences there. Price and Hein (1991, p. 510) define "educationally effective programs 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 their 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 cooperative ways of working.

Summary
The research reviewed provides answers to the first two questions posed in this paper. Visits to interactive science and technology centres 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, 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.

Using Visits to Interactive Science and Technology Centres to Promote Students' Engagement in School Science

The recommendations in this section follow from the findings presented above and assume that teachers are organising a visit to an interactive science and technology centre to enhance students' learning in science. The section is structured around the three phases of the visit to the interactive science and technology centre: before, during and after. Other sets of guidelines from slightly different perspectives are provided by Follette (1987) and Gottfried (1979).

Before the Visit

Teacher Preparation. Teachers need to visit the interactive science and technology centre to discover what exhibits are there, 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. With this information, teachers can determine how to make the visit fit the needs of their current teaching program. They can select the exhibits which demonstrate the concepts they are dealing with, and choose those which match the cognitive level of the students. They can devise and prepare the learning activities which can be built around the exhibits, in terms of pre, post and during visit instruction. Teachers should try to take advantage of the inservice courses many interactive science and technology centres provide to help them plan their visits.
Student Preparation. Informing students where they are going and determining their familiarity with the centre helps teachers consider whether novelty is likely to be an important factor in the visit. If so, teachers can decide whether to provide orientation information, such as maps. Sharing with students the objectives of the visit is an effective form of previsit instruction (Follette, 1987). 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. Teacher should expect that 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, teachers should encourage students to work in small groups and share the responsibilities associated with learning.

Recording. If teachers have decided that students will use worksheets or some other means of recording their findings, this is usually done most effectively with one worksheet or record per group.

Regrouping. Near the end of the visit, teachers may need to check how students are progressing in achieving the objectives of the visit, so they can structure the remainder of their time effectively.

After the Visit

The research literature speaks least eloquently on the nature of post-visit activities. Common sense suggests that
teachers should plan them to reflect the varied nature of the experiences students will have 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 teachers should take every opportunity to refer back to exhibits and activities experienced during the visit, thus reinforcing and extending the learning which occurred.

Discussion

The third 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 (Flexer & Borun, 1984). 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 that teachers should integrate visits to centres into their teaching program to complement the learning activities at school.

In making visits integral to their program, we suggest that the teacher's most important decision relates to why they take their class to the interactive science and technology centre. The reason for the visit determines how teachers should prepare themselves and their students to maximise the complementary effect. For example, if the purpose of the 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 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 the 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.
References

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