

The Measurement of Learning in the Museum

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With increased interest in the educational role of museums, learning in museums and its measurement have become important questions. The most frequently used measures in museums are attracting power and holding power; but measures used by educators are of time on task, knowledge gained, thinking and problem-solving skills, motivation or attitudes, and creativity. The objective of this study was to delineate and to evaluate measures of learning applicable to museum experience. Different kinds of museums—fine arts, natural history, science, and centres of interpretation—promote different kinds of learning, but all pay attention to specific measures of learning: knowledge gain and thinking.

Plus on s'intéresse au rôle éducatif des musées, plus l'apprentissage dans les musées et les instruments de mesure connexes prennent de l'importance. Les critères de mesure souvent retenus dans les musées sont le pouvoir d'attraction et de rétention; les éducateurs, eux, considèrent plutôt le temps consacré à la tâche, les connaissances acquises, la pensée et l'aptitude à résoudre des problèmes, la motivation ou les attitudes et la créativité. L'étude présentée dans cet article visait à distinguer et à évaluer les mesures de l'apprentissage applicables à l'expérience muséale. Les divers types de musées—musées des beaux-arts, de sciences naturelles, des sciences et de la technologie, centres d'interprétation—privilégient différents types d'apprentissage, mais tous accordent de l'importance à deux critères de mesure, l'acquisition des connaissances et la pensée.

Museums have always played an important role as repositories of knowledge or artifacts of knowledge, but in the 20th century they have increasingly become active disseminators of knowledge. Adoption of this active educational role has occurred in several phases. Fine arts museums, which most clearly epitomized the idea of the museum in the 19th century, moved from being quiet corners for connoisseurs through a period where visitors with the aid of museum docents viewed great works and learned their history, to the current phase, in which classes in the production of art as well as art history are regular museum activities. For example, the brochure of the National Gallery of Canada (1990) describes lectures, presentations, talks, tours, studio workshops and activities, and performances.

Natural history museums at the middle of the 20th century were stocked with long cases in which sat rows of arrowheads, pottery, or jars of specimens. They have become halls where displays beckon, narrative is woven by

a push-button audiotape, computers answer questions, and schoolchildren dart by, questionnaires in hand, in search of the next clue in their treasure hunt or rally. Science museums, most of which date from the 1960s in North America, expressly provide education in science (Fowles, 1986). Recently, park museums and centres of interpretation have gained attention as places that invite the public to participate in a particular milieu or phenomenon, most often social or ecological (Rivard, 1985).

In these different kinds of museums, very different kinds of learning could be expected, not only in terms of content but also in terms of how people think or what people are able to do after their museum experience. Although some evaluations of what takes place in the museum have led to the coining of such terms as "edutainment" (Wolf & Tymitz, 1978), and others talk of "mindlessness" in the museum, where there is little questioning of new information (Pearce & Moscardo, 1985), many more studies show that museum experience changes people. Studies of museums and their effects have taken one of four forms (Screven, 1984). The first kind of study is of the demographic characteristics of museum visitors and why they visit the museum; the second is of how museum visitors behave, particularly how they move in the museum. The third kind of research is on the effect of different variables on museum behaviour: for example, the effects of guided tours compared with theme visits. Finally, there are evaluative studies of whether exhibits or programs meet their intended objectives.

But how is learning in the museum measured? The measures most frequently mentioned are associated with visitors' movements in the museum and are discussed in terms of the success of exhibits, specifically their *attracting power* and *holding power* (Kool, 1986; Miles, Alt, Gosling, Lewis, & Tout, 1982). Attracting power refers to the number and kinds of visitors who approach a particular exhibit or display (Miles et al., 1982). Holding power refers to the amount of time visitors spend examining an exhibit, expressed as the total number of seconds a person remains stopped at an exhibit divided by the minimum number of seconds necessary to read and see an exhibit (Kool, 1986). Other measures could also justifiably be applied to museum settings and would show the educational value of a museum experience.

The first objective in this study is to delineate measures of learning applicable to museum experience. The second objective is to examine studies that use these measures and the limitations in their use. Knowing what measures of learning have been used will suggest the kinds of learning that can be expected in different kinds of museums.

MEASURES OF LEARNING

Learning can be measured at several levels of specificity. Perhaps the most global measure is that of *time on task*, the amount of time a learner spends on a particular learning task. Most frequently, learning is measured in terms

of the amount of knowledge gained: the difference between what is known before instruction and after instruction, often broken down into facts learned and concepts or ideas gained. Measures of thinking or problem solving are increasingly gaining attention. Motivation or attitude toward learning is also considered an important measure of learning because it is a harbinger of future learning. Finally, creativity, intellectual provocation, or the generation of meaning are more general and more difficult-to-use measures, but they capture the joy or higher purpose of learning. Each of these kinds of measures will be examined for appropriateness and usefulness in measuring learning in a museum. Some measures are more often used with elementary and secondary students and others with adults, and sometimes the same measures are used differently with adults and students. The situation often determines the validity as well as the appropriateness of the measures.

Time On Task

One of two measures most frequently used by museum evaluators, holding power, has a parallel in the educational research literature on time on task. Studies of time on task in schools compare the time that students spend in focused task activity with how much they learn, for example, the relationship of students' cognition to time on task during mathematics instruction (Peterson, Swing, Stark, & Waas, 1984). Researchers who have done studies of this kind suggest that time on task is an important variable with a major effect on learning. Museum evaluators talk of holding power as the time a person remains stopped at an exhibit divided by the minimum time necessary to read and see an exhibit. Holding power is a more highly specified measure than time on task since in the classroom the student is expected to accomplish activities in addition to reading and seeing. The classroom activities may include applying what is read, writing, or problem solving. Holding power is also defined more precisely because time on task does not specify a particular expected time. In fact, in the classroom, learning time is expected to vary with the needs of a heterogeneous group of children.

Another important difference between these two measures is that holding power is measured in seconds, whereas time on task is measured in larger units: minutes or proportions of a class period. The paradox for educators measuring learning in museums is that students visiting the museum for a specific learning experience are often organized in a rally to collect information efficiently, that is, in the shortest time possible. The idea of a required viewing time necessary to read and see an exhibit is also foreign to the experience of schoolchildren visiting a museum since they do not usually read in museums. For example, Gottfried (1979) reported that students in a science museum approached exhibits on a physical level, rarely reading instructions or observing graphics but learning through peer instruction. Exhibits in science museums are designed to hold attention: fossil and mineral exhibits at the Lawrence Hall of Science are viewed for an average

of forty seconds, puzzle tablets for close to five minutes and computer terminals for an average of sixteen minutes (Linn, 1976). Comparison with the average expected museum exhibit viewing time of one minute suggests students need much more time to process information than the time periods used in studies of holding power.

Students' responses to the same exhibits vary widely, with some students finding them exciting and others finding them not at all interesting. Most positive comments are associated with games of skill such as puzzles, reaction time, or computer interactions, and these are exhibits with greater holding power (Peterson, 1976). Theoretically, holding power or time could be expected to be linked to learning but not to be a direct cause of learning. The amount of time spent looking at an exhibit may be a function of how distant it is from the viewer's experience, hence incomprehensible and difficult to process, rather than a function of the actual learning or information processing going on. Measures like time on task or holding power must therefore be used with caution: they serve as general measures of conditions for learning rather than measures of learning itself.

Knowledge Gain

As museum educators increasingly identify education as a primary objective, more are questioning what knowledge is gained from a museum exhibit. Some experts point to problems of gaining knowledge in a museum, noting difficulties of learning under crowded conditions or in novel environments (Kool, 1986). Given the short time museum visitors view exhibits, we must question how much knowledge they could gain. Cognitive science suggests that knowledge, if it is to be retained and retrieved, has to be stored in context. A series of exhibits may decontextualize, thus preventing development of a conceptual framework rather than providing the focus necessary for learning. In response to the constraints on learning imposed by lack of time and familiarity with the context, some museums have instituted programs of visits to the museum that take place over one or two days. For example, on the first day of a two-day visit, students take part in a guided tour in the morning, then are left free in the afternoon to solve puzzles and answer questionnaires requiring them to circulate through the museum to find the answers. The following day, the students participate in small workgroups on particular themes in the museum (Boucher & Allard, 1987). Students can be tested before and after the experience to determine how much they have learned.

Comparisons have been made between the amount learned during a museum visit and in a regular classroom (Wright, 1980) and between groups taking structured versus nonstructured visits to the museum (Stronck, 1983). Swan-Jones and Ott (1983) studied learning by means of self-study guides, which consist of questions, information, illustrations, and games. They looked for factual learning in responses to study guide questions and for

conceptual learning as measured by associations, comparisons, analyses, generalizations, syntheses, and evaluations students made in their guide books.

In a study comparing effects of a guided tour with a rally, where grade 5 students used self-study guides for half a day, student learning was tested by means of a questionnaire, and students' attitudes were tested on an attitude scale (Boucher & Allard, 1987). Students who used the self-study guides learned more than those who had a guided tour, and they had more positive attitudes toward the museum. The self-study guides provided a structure that made the learning meaningful for students but freed them to behave more independently, like adult visitors to the museum.

In comparison with the measurement of student learning, studies of adult knowledge gain in museums are less rigorous because pre- and post-tests can rarely be given. Evaluators can, however, get a sense of the extent to which intended learning objectives are achieved by visitors to exhibits. In an evaluation of learning about ecology in a Smithsonian exhibit entitled "Our Changing Land," over 200 visitors were asked in informal interviews what the exhibit was about, what they had learned, and what they would like to see or to learn about ecology (Wolf & Tymitz, 1979). The evaluators analyzed visitors' replies to articulate emerging themes, to identify consistencies and inconsistencies, and to develop a data categorization structure and tentative explanations for what the visitors had said. In the final report configurations of meaning in the data were illustrated and interpreted.

This kind of qualitative study shows museum staff what visitors have learned and, more importantly, provides general insight into what a wide range of visitors have gained from an exhibit. The study is thus useful for museum planning. The evaluative studies done at the Smithsonian Institution appear to have changed how other museum staff measure the success of exhibits. In Wolf and Tymitz's 1981 study of the "Dynamics of Evolution," curators asked for measures of what specific concepts were learned and what facts absorbed: content learning was a more important concern to them than numbers of people attending or the length of their visit. Points of interest or magnet areas, those which sustained visitors' attention and provoked protracted involvement like reading or conversing, were identified so visitors in these areas could be asked what specific kinds of things they learned there. Thus the measure of holding power showed where to ask more specific questions about learning.

Thinking and Problem Solving

The development of children's problem-solving abilities is receiving greater attention in schools today, and science museums were instituted to provide a milieu where children could develop these abilities by exploring, constructing, manipulating, and discovering (Donald, 1986; Fowles, 1986; Linn, 1976; Souque, 1986). At the Lawrence Hall of Science, for example,

measures of learning include observing how long students spend with materials, whether they complete the experience, in what order they carry out the activities, whether they leave and return, and whether they talk to other visitors. Linn points out that this information does not directly indicate learning, but it characterizes conditions for learning. Most frequently, visitors to Lawrence Hall are asked questions, but Linn suggests that if the students learn by doing activities they should also be evaluated by means of activities.

The Ontario Science Centre, in response to a request for science enrichment at the elementary school level, introduced a five-session course devoted to scientific processes rather than factual information (Fowles, 1986). On weekends and holidays there are hands-on workshops for children from 3 to 14 years old, and a Science School offers a one-semester experience in practical science with strong emphasis on communication skills. Fowles notes that programs for adults are of equal and growing importance. A guiding principle of the Centre is to stimulate curiosity, often by presenting counter-intuitive phenomena.

When teachers consider the museum as a place of learning, their shopping list of learning objectives appears much longer than that of museum curators or educational officers, partly because of teachers' concern that a school day at the museum not become a holiday from learning. One dayplan for learning in the museum begins with the posing of a problem such as "Who were the Amerindians of the 17th century and how did they live?" (Lenoir & Laforest, 1986). More specific questions are asked, information is collected, and is then organized, classified, compared, and presented by the students, who interpret and communicate the results to other class members. The museum experience thus becomes a scientific exploration where students ask questions, find information to answer them, and synthesize their answers into a report for their peers.

But can a museum provoke this kind of learning for the adult visitor? Both museum personnel and educators believe so. For example, a visitor who recognizes something familiar in an art museum exhibit will make a comparison, which then leads to hypothesizing or conscious reflection about the observation (Lamarche, 1986). This conscious reflection may include elements of visual discrimination, a comprehension of the relationship between form and expression in the painting, and judgment of its expressive quality (Ecker, 1963). Dufresne-Tassé and Lefebvre observed a similar process in a natural history museum (Dufresne-Tassé, 1988). They found that museum visitors perceive an object, then actively imagine it, then ask questions about it, and then reason and verify their conclusions. The visitor attributes to the object a series of characteristics that integrate the object with what the person already knows and feels. Thus a museum visit can be a problem solving or reflective thinking experience for adults perhaps more readily than for children since adults have a greater background against which to hypothesize and test their new experiences. The measurement of

learning may be more complex, requiring interviews and protocol analysis; but this is not an insurmountable hurdle, as the studies by Wolf and Tymitz and by Dufresne-Tassé attest.

Motivation

Traditionally, attendance at museums has been by choice. Because visitors spend a relatively small amount of time at any one exhibit, Linn (1983) suggests exhibits might be designed to stimulate subsequent interest in the topic rather than to impart detailed knowledge during the visit. According to Linn, museum directors consider a museum's primary aim should be to stimulate interest in science or art rather than to teach science or art history. In her view, museums need to stimulate the desire to know; and exhibits, rather than teaching new science facts, may motivate visitors to buy astronomy books, watch TV programs on science, or have family discussions about computers.

This viewpoint is consistent with the most frequently used measure of the success of museum exhibits, attracting power, defined as the percentage of visitors who come to a complete stop and look at any part of an exhibit (Peart, 1984). Peart found that first-time visitors to the "Living Land, Living Sea" exhibit at the British Columbia Provincial Museum spent approximately 14 minutes in the gallery and that the exhibits' average attracting power was 36%, that is, just over one-third of the visitors stopped and looked at any one of the exhibits. More concrete exhibits—that is, larger, open exhibits that stimulated smell and sound as well as sight—were the most effective in both attracting and holding visitors. Attracting power correlated significantly ($r=.44$) with holding power in studies done by Kool (1986).

But does attracting power correlate with measures of learning? Kool (1986) reported that knowledge gain was no greater for visitors who said they came to the museum to learn than for visitors who said they came to enjoy themselves. He found, however, that knowledge gain was more likely with abstract exhibits than with concrete exhibits despite the fact that concrete exhibits both attracted and held visitors longer. Smaller, less complicated exhibits requiring shorter viewing time got the message across better. These studies suggest that the relationship between attracting power and learning is complex, and that measurement of motivation and its effect on learning are no easier in the museum than in any other learning milieu.

The learning of positive attitudes is a closely related phenomenon. In their study of the effect of a guided tour versus the use of self-study guides, Boucher and Allard (1987) found that although students who used the self-study guides had more positive attitudes toward the museum after their visit, neither group had more positive attitudes toward social science. Boucher and Allard explained their results by suggesting that a one-day experience could not be expected to change attitudes toward a field of study and that a longer learning period at the museum could be expected to produce different results.

As a measure of learning, motivation or attracting power suffers from being as global a measure as time on task or holding power. Since the index of its validity as a measure is knowledge gained, and the relationship between motivation and knowledge gained is complex, it is probably more reasonable to consider it a measure of a condition for learning rather than a measure of learning. Research suggests that visitor response to the questions of whether an exhibit was interesting and whether it would incline a visitor to explore further in the domain of the exhibit are more valid indicators of whether learning will occur than attracting power is.

Creativity or Intellectual Provocation

The extent to which museum experience stimulates creativity or is intellectually stimulating is another global and more difficult-to-use measure, but it is an important concept for both museum personnel and adult educators. Museum educators talk about evocative objects in the museum that are the starting point for learning, or about making the meaning of objects come alive for the viewer (Mackenzie, 1986; Vadeboncoeur, 1986). Providing an environment that stimulates curiosity and instilling respect for the environment and its inhabitants are objectives mentioned in conjunction with intellectual provocation (Baril, 1990; Fowles, 1986). Adult educators speak of the pleasure of playing with the known and creating something new from it, the pleasure of considering the unknown and coming to understand it, and the pleasure of mastering the unknown and integrating it with what one already knows (Dufresne-Tassé, 1986). These aesthetic or attitudinal outcomes are difficult to measure because they are sensed rather than seen, but they are important because they connect with the reality of our existence.

Dufresne-Tassé suggests that adult educators have concentrated so hard on the acquisition of knowledge and abilities in order to resolve problems of existence that their austere description of learning has no place for pleasure or wonder. She recommends that museums study the functions of observation, imagination, and wonder as well as the capacity to analyze and synthesize in viewers' contact with exhibits. Lamarche (1986) also talks about the educational potential of a museum in the development of expressive style and values. Both authors suggest models in which new measures more suitable to these objectives must be developed, measures of a more qualitative nature (Dufresne-Tassé, 1988). As has been noted above, measurement of thinking or problem solving requires these more complex methods as well.

THE APPLICABILITY OF THE MEASURES OF LEARNING

The measures of learning we have investigated can be divided into global and specific. The global or broad measures of learning include those of time (holding power and time on task), of the direction of attention (motivation

and attracting power), and of intellectual stimulation (creativity or intellectual provocation). Specific measures of learning include knowledge gained, both factual and conceptual, and thinking and problem solving. The broader measures are used more often with adult visitors, the more specific with school-aged visitors.

This difference is explained primarily by the assumption that adults are at a different level of cognitive development and have different levels of knowledge compared to elementary and secondary school students, that is, that adults have achieved a level of cognitive development students are still acquiring. The focus of the specific learning measures is cognitive development, while the focus of the broad measures could be described as environmental influences on learning. In addition to the difference in level of cognitive development assumed, different levels of control over the learning process are assumed for adults and children, and there are different expectations of learning. Teachers, for instance, point out that museums serve students well when they illustrate topics in the school curriculum (Lenoir & Laforest, 1986). The museum rally, on the other hand, emphasizes cognitive development while at the same time providing students with the motivation and intellectual stimulation more frequently used to gauge the success of museum displays with adults.

Two worldwide changes in expectations of learning may affect the role of museums. The first change is the view that learning is a lifelong phenomenon, and the second is the shift in our view of learning as the acquisition of knowledge to learning as the acquisition of thinking skills and the utilization of knowledge. Both changes should affect how museums prepare and measure learning experiences for children and adults. We could hypothesize that in future measures of learning used in museums will be less differentiated according to visitor age.

LEARNING IN DIFFERENT KINDS OF MUSEUMS

Do different kinds of learning occur and are different measures used in different kinds of museums? The four major kinds of museums referred to in this study are fine arts museums, natural history museums, science museums, and park museums or centres of interpretation. Analysis of the references used in this study, which were selected on the basis of their dealing with learning in the museum, shows that of 29 references, 4 are concerned with learning generally, that is, their approach is not based on a particular kind of museum. More of the articles examined natural history museums (13) than any other type; science museums were next most frequently discussed (7 articles), while fine arts museums and centres of interpretation were least mentioned (3 and 2 references, respectively). We could hypothesize from this that natural history and science museums are more concerned with questions about learning.

We might suppose that science museums would be most concerned with thinking and problem solving, since those were a major part of their original mandate. Would emphasis on knowledge gain parallel or complement emphasis on thinking? Knowledge gain was the most frequently discussed kind of learning (9 articles), and it was discussed in articles about each kind of museum, but most of these articles were concerned with natural history museums (4) and science museums (3). Thinking and problem solving were next most frequently discussed (8 articles), and they were discussed in articles about each kind of museum; but as expected, there were more such articles about science museums (3) than natural history and fine arts museums (2 articles each). Thus the more specific measures of learning were more frequently discussed in the articles, and they were more frequently discussed with respect to natural history and science museums (6 each).

Of more global measures, holding power was discussed in articles about all kinds of museums. Would motivation be considered more in some museums than in others? Of the 4 articles dealing with motivation or attracting power, 3 referred to natural history museums and 1 to science museums. Attracting power was also dealt with in 2 general articles. Would creativity be a particular concern of fine arts museums? Creativity or intellectual provocation was discussed in 6 articles, 3 on natural history museums and 1 on each other kind of museum.

These results suggest that the specific measures of learning, knowledge gain and thinking and problem solving, are being attended to in all kinds of museums, as are creativity and intellectual provocation. Measures of motivation or attitudes seem most concentrated in the natural history and science museums, but there were substantially more articles on these two kinds of museums. The analysis also reveals that, although the kinds of learning measures may be differentiated according to whether they are used with adults or students, all measures of learning except motivation were considered in articles on each kind of museum.

A visit to any kind of museum could thus be expected to result in learning according to several of these measures. Although from this analysis we might expect to reap a greater knowledge gain in a museum of natural history, or to think and problem solve more in a science museum, we can expect a potential gain in knowledge, in thinking, and in intellectual provocation from any museum experience.

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