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ABSTRACT

Defining the museum as a learning environment, this book analyzes devices that can be used to make the experience more meaningful for visitors in existing and new exhibits. Although the typical museum audience is heterogeneous and voluntary with no particular instructional objectives on which to base museum exploration, instructional technology can be used to arrange media and activities in order to facilitate specific learning outcomes. Elements of two experimental programs, which were initiated in the Milwaukee Public Museum, are described. Audiocassettes and portable visitor response devices can serve as adjuncts to already existing exhibits to give them interactive properties. For example, the visitor may carry and play the cassette as he examines an exhibit, and he can punch answers on a punchboard in response to audio-script questions. The devices can be wired so that the cassette stops playing until the correct response has been punched. Similar nonportable machines can be attractively programed for pre- and posttesting or self-testing. Other techniques for self-testing could involve latent image response cards, punchboards, and mechanical response devices. Statistics are included for several studies that use various techniques over different periods of time. (AV)

The Measurement and Facilitation of Learning in the Museum Environment: An Experimental Analysis

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Foreword

The introduction of a new series in the growing literature on museums and museum-related subjects might seem a bold step, since one could assume that most areas of concern to museum professionals, their patrons, or their visitors were already dealt with adequately. Yet, at least two areas remain virtually untouched: the measurement of visitor reaction to museum offerings and the study of means by which the totality of what is generally referred to as "the museum experience" can be enriched as well as gauged. It is to this field of inquiry that the volumes presented in this series will address themselves.

Psychological studies, as these subjects are often loosely referred to, have been undertaken sporadically for over the last half century. Significant contributions to learning have resulted, but these have lacked the underpinning of a continuum in research, testing, and application. It is to fill this gap and to demonstrate once and for all the validity of the discipline in the museum environment that the Smithsonian Institution, in 1972, formed a department within the Office of Museum Programs charged specifically with exploring, on a continued basis, the museum environment as an interactive *milieu*.

Our aim is not to analyze the visitor as such, but rather to analyze how the visitor learns, how the museum affects him, what devices can be used to make the experience more meaningful in existing exhibits, and how one can in new exhibitions incorporate within the basic script and the original research principles of learning which will lead to a more meaningful result. Paralleling this program is the development of means to disseminate this research, either that carried out by the staff of the Smithsonian or by specialists in the field.

It is appropriate that the first volume in the series be written by Dr. Chandler G. Screven, for it is in Milwaukee, under the leadership of the late Stephen F. de Borhegyi, Director of the Milwaukee Public Museum, that these studies received their earlier impetus. We are grateful to Professor Screven for sharing his long years of study and experimentation with us, and for allowing us to communicate the fruit of his research to a broad international audience.

The importance and the success of this series will depend entirely upon the interest that the subject will elicit, the minds that will be attracted to this new field of research, and the openness of the museum profession in accepting a new tool which, in time, may open new vistas of communication and understanding, and thereby foster the assimilation of museums into the educational fabric in the broadest sense.

Paul N. Perrot
Assistant Secretary for Museum Programs
Smithsonian Institution

October 17, 1974

Introduction

The Museum as a Learning Environment

The museum, in addition to its curatorial and scholarly functions, is also a learning environment. As a learning environment, museums provide an alternative place where something called "instruction," "education," "enrichment" can take place. While this idea is not at all new to most museum professionals (Cameron, 1968; Lee, 1968; Screven, 1969; Shettel, 1973; among others), there is serious question concerning the extent to which many public museums, as currently constituted, actually perform such functions. However, recent advances in "instructional design" and "communications technology" raise important new possibilities for utilizing the vast resources of public museums and art galleries (as well as zoos, parks, and other public access settings) as alternative sources for productive learning and educational enrichment.

The experimental studies reported in Chapters II, III, and IV concern some of these possibilities. These particular studies were conducted in cooperation with the Milwaukee Public Museum, under a grant to the University of Wisconsin-Milwaukee from the Bureau of Research of the Office of Education, and represent an exploratory effort to see if some principles of instructional design and human motivation might be helpful in facilitating learning within a public museum.[1]

A forthcoming bibliography of studies in museum visitor behavior (Elliot and Loomis) lists a surprisingly large number of papers concerned in one way or another with museum visitor behavior. But very few of these studies employed experimental procedures in which particular variables were systematically manipulated to examine their effects on visitor behavior or learning. Experimental research in museums is relatively rare. Examples include Abler (1968), Bechtel (1967), Bloomberg (1929), Fazzini (1972), Melton (1935, 1936a, 1936b), Parsons (1968), E. S. Robinson (1928), P. V. Robinson (1960), Screven (1974b), Shettel et al. (1968), and Weiss and Boutourline (1962). Even fewer of these have been concerned directly with examining the learning

[1] HEW Project 7-0138, Grant 3-7-070138-2882. Special recognition is due Robert Lakota, who served as Project Coordinator throughout most of the investigations, and to the late Dr. Stephen de Borhegyi, Director of the Milwaukee Public Museum until he was killed in an automobile accident. Dr. Borhegyi's interests in the objective measurement of museum visitor behaviors and the furthering of the educational functions of museums helped make these investigations possible.

process in the museum environment. It is not surprising, therefore, that little is known about the museum visitor, what happens to him, or how to go about helping him relate productively to museum resources. Museum professionals have strong beliefs that something *is* happening to their visitors, but there is great difficulty in defining what this is, much less measuring it.

Museums do generate a good deal of exploratory behavior, most of it probably random. "Contacts" with any one exhibit are brief, averaging between 20 and 40 seconds (Fazzini, 1972; Parsons, 1968; Shettel, 1968) hardly long enough for substantive learning. But some museum professionals in art and history museums would argue that substantive or "cognitive" learning often is not the point, that the objectives of many exhibits are more to change "beliefs," "aesthetic sensitivities," "attitudes," "perspectives," "interests," etc. This may or may not be so, but whether exhibit objectives are cognitive or not, little is known concerning the nature of whatever changes do take place, their direction, their retention, who is affected, or how frequently. What changes do take place, in any case, are frequently uncontrolled, more or less random, and, for the most part, unknown.

The museum as a place for instruction and education may have some unique advantages over more formalized public education for persons of all types and ages (Lee, 1968; Shettel, 1973). The museum, for example, is an *open* learning environment which, potentially at least, is an exciting alternative to the conventional, restrictive classroom. Museums have no classrooms, no coercive forces, and no grades. The museum visitor is in an exploratory situation, able to move about at his own pace and on his own terms.

But some of the features which give museums their appeal as open learning environments pose serious problems, both for measurement and for effective instructional communication. Thus, the typical museum audience:

(a) is *heterogeneous* in age, background, interests, and reasons for being in the museum;

(b) is *voluntary* (except for visiting school groups) and not necessarily ready to devote time and effort to educational ends;

(c) must be reached while freely moving (often hurrying) along hallways. While visitors are free to stop, look, and listen, they are also free to ignore the relevant and attend to the irrelevant;

(d) has no particular instructional objectives or goals on which to base its museum explorations (other than randomly explore).

Also, within any single display, it is difficult to control the *order* in which the visitor will view certain materials. Therefore, it is difficult to develop concepts which build upon one another. Another difficulty is that the visitor's relationship to an exhibit usually is a one-way, nonresponsive affair in which he receives no corrective feedback to whatever observing responses he is making. In most exhibit situations, "discriminative responses," which may be critical to learning (which is older? larger? faster? similar? different? etc.), are neither elicited (by questions or other means) nor selectively reinforced.

To complicate matters further, museum displays are put together by curators, artists, and other professional specialists with much attention to accuracy and eye appeal, but little (if any) attention to whether visitors actually learn anything from them. Worse yet, most museum exhibits are put together without predefined specific learning outcomes (teaching goals). Without pre-established goals, and some way of measuring whether or not they have been achieved, there is no scientific basis for evaluating existing displays or designing new ones.

Developments in recent years in the experimental psychology of learning and motivation (Skinner, 1959, 1968; Honig, 1966, Ulrich et al., 1970, 1974) and in instructional technology and design (Commission Reports, 1971; Gagne, 1969; Gerlach and Ely, 1971; Glaser, 1965; O'Day et al., 1971; Popham and Baker, 1970) have important implications for how museums might go about the measurement, design, and evaluation of museum exhibits. These methodologies already are being successfully applied to problems in curriculum design for the public schools, classroom management, industrial training, parent-child relationships, and many other applied fields (see, for example, Bijou and Baer, 1965; Ferster and Perrott, 1970; Ulrich et al., 1970, 1974).

In the remaining sections of this chapter, we shall consider a number of aspects of these methodologies of direct importance to the teaching functions of museums: the area of so-called "instructional technology," some principles for defining instructional goals for teaching exhibits, the problem of visitor motivation, the "interactive" exhibit, and some comments on audiovisual applications in museums.

Instructional Technology and Museum Education

Instructional technology involves a systematic process of arranging instructional media and activities to facilitate *specific learning outcomes.* Briefly, the following steps are involved.

(1) Characteristics of the population to be taught are identified (ages, interests, background, learning styles, etc.).

(2) Learning outcomes are formulated and performance tests are established which reflect these specific learning outcomes.

(3) An analysis is made of the specific learning tasks likely to be required.

(4) Instructional sequences are designed for producing the learning outcomes, utilizing whatever modes and media, human and nonhuman, seem most efficient for this purpose; in public museums, important media, of course, would be the artifact, simulated environments, etc.

(5) The tentative system is tried out with representative samples from the intended learner population, and these results are evaluated in terms of acceptance, efficiency, and its effectiveness in achieving the learning outcome.

(6) Based on these results, the instructional tasks and sequencing are reanalyzed and modified to improve results and again retested.

There are differing approaches and systems for carrying out task analyses and designing instructional sequencing. However, almost all systems utilize the performance of the intended learners as the final arbiter for evaluating the final instructional program, and it is this feature that must be applied to museum exhibit design if visitor learning of some sort is the primary goal of the exhibit.

The most extensive recent analysis of instructional technology is that of the U.S. Commission Reports on Instructional Technology (see Commission Reports, 1971). However, there are many good introductory treatments of the topic and its various facets written for teachers, curriculum designers, and specialists. The museum professional seriously interested in the teaching-learning functions of his museum exhibitions would do well to familiarize himself with some of this material. Some good introductory books include Baker and Schutz (1971), Banathy (1968), and Kemp (1971) on the systems approach to instruction, Popham and Baker (1970) on goal-referenced instructional design, Taber et al. (1965) and Espich and Williams (1967) on programmed instruction, and Gerlach and Ely (1971), a general text on teaching and media.

Applying this methodology to museums would require, first, the development of reliable methods for measuring visitor learning and performance. Given the availability of such measures, the "design" of a museum exhibition would include the following:

(1) specifying the instructional goals (learning outcomes) for the particular exhibition and establishing objective assessment procedures;

(2) breaking exhibition content into instructional elements related to these instructional goals;

(3) providing for some kind of visitor interaction with these instructional elements which would allow visitors to respond, receive feedback, etc.;

(4) providing specific learning goals for the visitor to achieve and, when needed, additional incentives for learning or achieving these goals;

(5) evaluating and revising exhibit characteristics during development until visitor performance meets original instructional goals (x-percent visitors achieving x-percent postexhibit mastery standard).

This final point concerning evaluation means that, whichever exhibition methods (designs) are finally employed, they are evolved *empirically* from visitor testing. In other words, the performance of the visitors themselves validates the exhibition methods-- *not* professional exhibit designers, educators, curators, or psychologists. The latter group establish content and goals, coordinate media and procedures, and evaluate testing procedures, but the visitors themselves establish whether or not these efforts have been successful or need to be modified.

This means, of course, that an exhibit should be changed (modified) when input from visitor testing indicates the need for this. The exhibit is adjusted until it produces the intended learning or behavior changes. But, as pointed out in an earlier paper by this writer (Screven, 1974a), this is almost impossible at present because of the way that most museum exhibit design, planning, and installations are now carried out. By the time exhibits are finally installed, their budgets have been exhausted, their labels are difficult to change, and so on.

Harris Shettel (1973) has suggested the use of mock-up exhibits during developmental phases of exhibit planning. Visitor responses to these mock-up exhibits can be measured and used as a basis for modifying specific components. Also, it would be helpful if exhibit budgets included reserves for making final adjustments, if labels and materials could be made for easier change, and so on.

If and when museum planners wish to take seriously the idea that museum exhibitions are essentially instructional (teaching learning) systems, it will be necessary to make provisions for exhibit modification based on visitor performance.

There are additional factors which need to be considered in evaluating the efficiency of any instructional system, in or out of museums, such as cost, mean learning time, and percentage of learners achieving a given instructional goal. For any instructional system there are trade-offs for each of these. However, discussion of these factors is beyond the scope of this monograph.

Specifying Instructional Goals for Exhibits

The applications of learning and instructional technologies depend upon the specification of instructional goals (learning outcomes, instructional objectives) and the reliable measurement of whether or not these instructional goals are achieved by the learners when the instructional system is applied. Applications to museums, therefore, require that exhibit planners learn how to specify instructional objectives for exhibits, measured in terms of tests of visitor performance.

Briefly, defining instructional objectives for an exhibit consists of stating exactly what the visitor should be able to *do* when he is presumed to have "learned" something from the exhibit. More precisely, defining instructional objectives (learning outcomes) includes:

(1) the specification of what the learner (museum visitor) is expected to *do* as the result of exposure to the exhibit in terms of *action verbs* such as: *name, arrange, compare, order, list, distinguish, identify, solve.*

(2) the specific conditions under which this behavior (listing, naming, etc.) is supposed to occur; and

(3) a statement of the minimum visitor performance that is acceptable; for example, the acceptable minimum percent of total test items correct.

For example, the general goal of an exhibit involving Greek and Roman pottery might be the ability of the visitor to distinguish between Greek and Roman pieces. The instructional objective might be written as follows:

Given six pairs of color slides of pottery, presented one pair at a time in a test machine, each pair containing an example of one Greek and one

Roman piece, the visitor will correctly identify the Greek (or Roman) example in five out of six pairs.

Note that this statement includes not only what the visitor does (identify pottery), but also the conditions for choosing the pottery ("given six pairs," etc.) and an acceptable performance level (five out of six pairs). Also, note that the statement is much more precise about what is expected of the visitor than the original general goal of simply "distinguishing between Greek and Roman pieces." Specifying exhibit objectives involves more than stating the purpose or goals of the exhibit in generalized terms. The statement "this exhibit will help visitors to understand the influence of Greek pottery design on Roman pottery" is *not* what is meant by an instructional objective or statement of learning outcome. From such a statement, how can one distinguish between visitors who have achieved this "understanding" and those who have not? The word "understanding" has not been specified in observable terms. Acts which cannot be seen or heard cannot be used in defining instructional objectives. Besides "understand," other vague terms that often creep into would-be statements of instructional objectives are "to grasp the meaning of," "discover," "know," etc. As stated earlier, instructional objectives use *action verbs* like *name, list, solve, reject, prefer,* because these force the instructional designer to deal with behaviors that can be directly observed.

This is not to say, however, that one might not *begin* with statements of some general goals or purposes for an exhibit. But it is important that one does not stop here. Once general instructional goals are established, they must then be translated into a form that tells us what the visitor is expected to *do* after exposure to the exhibit that is different than before his visit. This takes some practice and, perhaps, initial supervision by persons experienced in this process, but such efforts will be well rewarded in the long run when the exhibit designer is able to observe the results of his efforts directly in terms of improved visitor performance.

There are a number of good introductory discussions and how-to-do-it handbooks on the writing of instructional objectives. In addition to the aforementioned text by Gerlach and Ely (1971), the reader should consult Mager (1962), Drumheller (1972), Scott and Yelon (1971), and/or Vargas (1972). For a useful and rather amusing treatment of how to get from statements of generalized instructional goals to behavioral statements of objectives, see the recent book, *Goal Analysis*, by Robert Mager (1972).

It is often assumed by many beginners in this field that the statement of instructional objectives in precise, behavioral terms is necessarily limited to the teaching of cognitive matters—specific factual materials, scientific concepts, etc. This is not so. Objectives may be stated in behavioral form both for *cognitive* learning and for so-called *attitudinal* or *affective* learning. Cognitive objectives may include the teaching of simple information, being able to give new examples of a concept, applying rules to solve problems, learning to analyze problems into their components, etc. Attitudinal (affective) objectives would include observations of preference, avoidance behaviors, rejection, assignment of adjectives to specific stimulus conditions, rating scores. A number of writers have done extensive work in developing taxonomies of educational objectives—both cognitive and affective. The most well known of these are by Benjamin Bloom and his colleagues (Bloom, 1956; Krathwohl, Bloom et al., 1964) and Robert Gagne (1965). For introductory treatments and some modifications of these taxonomies, see Drumheller (1972), Gerlach and Ely (Part 2, 1971), and/or Popham and Baker (1970).

Visitor Motivation

An effective exhibit system includes not only content that is clearly related to its instructional objectives, but also certain "motivational" arrangements which will sustain productive attending and effort by the viewer and discourage nonproductive attending.

From the standpoint of learning, there are some kinds of "observing" or attending behaviors at an exhibit that are likely to be more productive than others. For example, such behaviors as searching, reading labels, answering questions, comparing characteristics, making distinctions, naming and noting examples of principles are *more* productive than random gazing at artifacts, guessing (at answers to exhibit questions), careless generalizations, ignoring important exhibit features, becoming distracted by other exhibits, etc. Exhibit motivational components should be designed to encourage productive attending behaviors and discourage nonproductive behaviors long enough for the viewer to be appropriately affected by the exhibit's message.

While there are many factors which influence visitor motivation in museums (for example, peer group interests, the "glamor" of certain artifacts, educational background, museum fatigue, crowding), probably the most important underlying factor is what happens to the viewer when he actually attends to something in the exhibit. When he attempts to read a label, does he become confused? If so, this bit of productive observing behavior is likely to be discouraged. When he looks for certain features in some vases, does he find them? If so, he is more likely to continue looking; if not, he is likely to quit looking.

An important principle in the experimental analysis of behavior is that maintaining any specific behavior over time (such as the particular attending behaviors listed earlier) depends on the *consequences* which are correlated with this behavior. Therefore, to "motivate" viewers to spend the necessary time and effort to learn from an exhibit, we must arrange things so that productive exhibit-attending behaviors are followed by consequences which encourage their repetition while nonproductive behaviors (guessing, sloppy comparisons, etc.) are followed by consequences which discourage their continuation.

In other words, if learning from exhibits is dependent on looking, reading, relating, comparing, etc., then it is necessary to motivate the casual museum visitor to "do" these things by "rewarding" him when he does them and *not* "rewarding" him when he doesn't. What might constitute effective "rewarding consequences" in public museums? Common rewarding consequences for humans in many learning situations include knowledge of results (feedback), the successful completion of a task or question, verbal praise, and progress toward a pre-established goal. The experimental studies described in this monograph have utilized some of these motivational contingencies in the museum exhibit environment.

Within the public-access, voluntary learning environment of the museum, the use of question-answer techniques, self-paced automatic-stop audio tapes, teaching machines, portable self-scoring devices tied to exhibit questions, built-in push buttons tied to differential feedback for correct-incorrect answers to exhibit questions, visitor goal-setting procedures, and computers are some of the ways that lend themselves to the kind of motivational controls we have been describing. There is still much to learn concerning how to motivate the productive observation of noncaptive, voluntary museum visitors given the practical and aesthetic considerations of the public museum environment. Hopefully, some of the examples described throughout this monograph, while tentative in many respects, will stimulate others to begin thinking about and experimenting with this important task.

Visitor-Exhibit Interaction Systems

One way of securing the cooperation, attention, and control of the visitor's attending behavior at exhibits is to provide for *interaction* between the exhibit and the viewer of the exhibit. To quote from an earlier paper by the author (Screven, 1974a):

> In an interactive system, the various elements depend upon one another in some way. An interactive museum exhibit would involve an interdependency between its two main elements: the exhibit and its viewers. Each acts upon the other in a series of interdependent events, via the media of artifacts, labels, audio, questions, response devices, slides, etc. To achieve this interaction, one must find ways to (1) direct and sequence viewer attention to names, distinctions, relationships, etc., (2) provide for selective responding by the viewer, and (3) provide for immediate feedback (preferably differential feedback) following viewer responses. Specific methods for achieving this include the use of punchboards, self-scoring cards, self-paced tape cassettes, computer terminals coordinated with exhibits, and so on. Regardless of the method used, the interactive sequence between the exhibit components (*E*) and the viewer (*V*) might look something like this:
>
> 1. *E* directs *V* to *do* something that requires "discriminative attention" (i.e., comparing, ordering, matching, applying examples, etc.) and asks *V* a question via slide, audio, question-sheet, moving panel, computer terminal, etc.;
> 2. *V* responds by carrying out instructions (reading label, comparing brush strokes, matching examples) and answering questions by pressing a button, marking an answer sheet, etc.;
> 3. *E* "responds" to *V*'s action by signifying correctness of *V*'s response through change of color on answer sheet, onset of slide or tape, etc., if answer was correct. In more complex interactive exhibits, incorrect responses may lead to corrective or remedial information and sequencing;
> 4. If *V* responded correctly to previous step, *E* directs *V* to next action and the above is repeated.

Some of the possibilities for providing for visitor interaction with the instructional elements of museum exhibits will be discussed in greater detail throughout this report. The specific applications reported in later chapters involve three types of interaction systems applied as adjunct systems to existing museum exhibits: the use of individual programmed audio tape cassettes, a portable punchboard response device, and a coin-operated visitor self-testing machine.

The use of visitor response devices in museums—especially in science and technology museums—is not new, although many of these visitor response systems, push buttons, etc., are not interactive as we have described this process. Of course, some are: such as electronic "robots" which move and orient themselves in relation to visitor vocal activity, electronic art exhibits which "respond" in relation to visitor movements or vocal activity, science exhibits which demonstrate principles by having visitors operate equipment that depends upon application of the principle, some perceptual exhibits, and so on. However, the availability of some active visitor response—such as pressing buttons—*does not necessarily* constitute an interaction system. Exhibits that contain buttons which simply light up a graph or turn on a motor are *not* interactive systems.

A note concerning push buttons: As usually applied in museums, push-button displays do not constitute an interactive system. Push-button displays frequently are used to start the display in motion, light lights, or begin a sequence. Unfortunately, few of these push-button applications constitute effective teaching-learning systems because the push buttons seldom are dependent on an understanding of the concepts presented in the exhibits. For example, the buttons usually do not require choices or comparisons between alternatives that discriminate between names, relations, properties, examples, rules, etc. But such choices are critical in establishing the discriminations that make up the concepts that are supposed to be communicated. Push buttons, of course, *can* be very useful in interpretive exhibitions when they require choices between alternatives, the *consequences of which* depend upon the visitor's correct use of the exhibit's information. But the availability of buttons, *per se*, is not necessarily of instructional or communicative value.

Harvey White (1967) developed several types of visitor response devices for use in the Lawrence Hall of Science which provided effective interaction between the visitor and the exhibits, and some of his efforts have shown up in museum exhibits in North America. However, too few museum professionals have given much attention to the pioneering efforts of Dr. White. The Boston Children's Museum has many noteworthy applications of interactive exhibits for teaching purposes, as do the Ontario Science Center, the current efforts of the Brooklyn Children's Museum, the Exploratorium, San Francisco, and others.

Some aspects involved in the design of effective interactive exhibits are discussed in Chapter V.

The Use of Audio in Museums

Theoretically, taped audio could be coordinated with exhibit instructional elements and visitor responding in such a way as to provide an interactive situation, or, at least, to simulate an interactive situation. Unfortunately, audio is seldom used in this way in present museum applications.

Audio-tape systems are, of course, rather common sights in many of the larger museums around the world. Some of these use transceiver headsets and transmitters hidden within exhibits or under floors to broadcast audio messages to visitors as they come near the exhibits. These systems transmit their messages independently of the individual listeners and, thus, remove any possibility of visitor control over the pacing of the taped messages. Another approach, in common use in museums, uses individual audio-cassette players which are carried by the visitor from display to display and manually stopped and started according to instructions. Such tape-cassette players, of course, *do* allow for visitor self-pacing, although few museum scripts written for tape cassettes have taken much advantage of this.

While these audio systems add a new dimension to museums, their applications, like the push buttons already mentioned, seldom utilize teaching-learning principles described earlier. Audio materials provide background sound effects, audio lectures, supplementary information, and/or help guide the visitor through a series of exhibits. In presenting content, the audio does all the talking, does not ask leading questions or in other ways require the user to make relevant discriminations within exhibits. Audio scripts are seldom (if ever) written around specific instructional goals or objectives, nor tested for their effectiveness in helping the visitor learn.

Nevertheless, the use of audio in museums—especially self-paced, individualized audio—has considerable potential for facilitating learning and communication in the public museum (and other public access environments). This potential, however, is not based on its use to present "audio lectures," but on the important functions of *guiding* visitor attention to those visual features or relationships we would like him to notice, *eliciting visitor involvement* via questions, and providing *feedback* and motivation.

There are many options as to how audio might be used, especially self-paced cassettes. Such cassettes are portable, they can be readily individualized, and users can proceed *at their own pace*. Audio scripts can be adapted, not just to language requirements but to the interests and needs of different age groups, ethnic groups, educational backgrounds, etc. Via audio, the same (fixed) exhibit may be treated, for example, through the eyes and voices of children, or scientists, or curators, or an ethnic group, and so on; or several knowledgeable persons may be conversing with each other about the exhibit, with the visitor "listening in." Tapes can "talk" a visitor through an exhibit area, automatically stopping to ask leading questions, direct attention, and so on.

In other words, self-paced audio is flexible and readily adaptable to the heterogeneous audiences of public museum settings. In addition to this flexibility, however, are a number of other features which have important teaching-learning functions. The most important of these functions include the ability of the audio to:

(1) direct attention to relevant exhibit information and control the *order* or sequence in which different exhibit components are viewed;

(2) relate various exhibit components to one another;

(3) fill information gaps important to the concept being developed (when these are missing in existing exhibit labels, etc.);

(4) ask leading (Socratic type) questions which involve the user in appropriate *actions*; and

(5) provide feedback and positive verbal comments and praise immediately following visitor responses to questions ("That's right!" "Good!" etc.) to motivate the visitor to continue.

In the application of the last two features, it may be desirable in many instances to use tape units which stop *automatically* when questions or directions are given. Automatic stops have a number of advantages, described by Screven (1974a) as follows:

They remove the need for the user to engage in the irrelevant and distracting task of operating a manual stop switch when he should be focused on the task, not the switch. Questions and stops can be used more frequently, allowing for shorter audio frames.

They assure that the tape will stop when it is supposed to, removing the possibility that the user may not stop it when required.

They allow instantaneous onset of the voice when the user presses start button, or has responded correctly on a response device with a stylus, etc. This is not possible with manual stops because considerable tape distance (up to 10 secs.) must be allowed at each stop point.

Automatic stops can be provided by recording a stop tone on the tape, which automatically stops forward movement of the tape. The user can restart the tape by pressing a start ("GO") button on the unit. (When used with a separate answering device, such as a punchboard, the answering device can be wired to the tape unit so that the tape restarts automatically when the visitor answers the punchboard question correctly.)

A number of factors have discouraged the use of automatic-stop audio cassettes in museums. Most currently available units require a separate channel for the stop tones, which increases their cost, size, and weight. Thus, it has been easier and cheaper to use low-cost monophonic cassette units which must be *manually stopped* by the user when he hears a signal. Reliable automatic stop tones, however, *can* be used with low-cost ($30) monophonic, portable cassette units. The author is currently testing such a unit for use in museums and other-public access settings, and it has proved reliable in several museum applications.

Another difficulty with the use of tape cassettes in museums is in situations of heavy visitor loads. It is obviously not possible to give out cassettes to individual visitors at particular exhibits where there is heavy and constant visitor traffic. One solution to this problem, when the addition of self-paced, programmed audio is desirable, is to install a bank of five or ten separate cassettes within the exhibit itself, with automatic-stop, endless-loop features. Corresponding plug-in stations in the front of each display could allow each visitor to plug in earphones and receive individualized, programmed audio from one of the bank of cassettes, with questions, automatic stops, etc. Such an arrangement would have many of the teaching-learning advantages of self-paced cassettes and still be able to handle larger crowds.

Automatic stops on individualized cassettes may not always be necessary for achieving effective results when the use of audio is appropriate. In asking questions which direct the viewer's attention to specific features in the exhibit, it is possible to simply provide a 5- or 10-second period of silence (while tape is still running), during which the viewer examines the exhibit and answers the question covertly. Following this silence, the tape provides appropriate feedback and reinforcement as in the case of the automatic stop tape. This provides less "control" over the viewer's behavior and assumes that he will cooperate by trying to answer to himself before the 5 or 10 seconds are up. Our own tests of this procedure have indicated that most visitors *do* cooperate (see, for example, Study 2 in Chapter III). However, in these successful applications, "answers" to the questions asked on the audio were quickly available by examination of the reference exhibit and the concepts involved were very simple. It seems likely that auto-stops may be more important in situations requiring more effort and time from the visitor in answering questions, and in which the need for self-pacing is greater.

Other Audiovisual Applications in Museums

Audiovisual displays, such as multiple-screen slides, continuous-loop 8mm movies, and closed-circuit TV, represent another inroad of modern communications technology within museums. Some of these media presentations are outstanding in their content, drama, and professional delivery; and they often can be shown to be effective in obtaining and holding the attention of passing visitors. But, again, many of these media presentations are poorly coordinated with the primary objectives of the exhibit area in which they are located.

Like audio, the potentials for slides, movies, and closed-circuit TV media for augmenting and facilitating exhibit teaching functions, both cognitive and affective, are probably immense. But their current applications within museums utilize, at best, only a small fraction of their instructional communication potential. Ideally, the unique properties of these media would be more carefully coordinated with the instructional and behavioral goals of particular exhibit applications and with the various exhibit elements such as artifacts, labels, panels, etc.

General Procedures: Skull and Animism Exhibits

The chief task of the present studies was to explore some possibilities for facilitating learning by the voluntary museum visitor at existing fixed exhibits, without major alteration of the exhibits themselves. Therefore, in the studies reported here, the exhibits, physically, were left as they were, and the guidance and feedback needed for facilitating attention and learning were provided through the use of audio cassettes and portable visitor response devices. The cassettes and response devices served as adjuncts to the pre-existing exhibits to give them interactive properties.

The principles applied in the use of these adjunctive devices are, of course, applicable in designing the original exhibits themselves. Discussion of some of these possibilities may be found in Chapter V. At the time that the initial investigations were conducted, it seemed more important (and less expensive) to see how the voluntary museum visitor would respond to interactive systems tied to existing exhibits from which predefined learning goals could be identified.

Basic Components of Exhibit Systems

The basic components of the system tested in the first series of studies are shown in Figure 1. The visitor first approached (voluntarily) a freestanding, gamelike test machine and, in the process of playing it, answered a set of criterion questions reflecting the instructional goals of the particular exhibit system. He then proceeded to the exhibit, where he was exposed to the exhibit learning procedure being evaluated. In this series of studies, the learning procedures consisted of from one to three components, shown in Figure 1,

(1) the physical exhibit itself (which in this series of studies was left unaltered);

(2) an individual audio tape cassette, worn by the visitor and used to direct his attention to relevant details and relations in the exhibit; and

(3) a portable punchboard question-answer device on which the visitor could respond to leading questions and obtain immediate feedback.

Following exposure to the exhibit learning procedure, the visitor returned to the test machine for a posttest involving the same set of criterion questions.

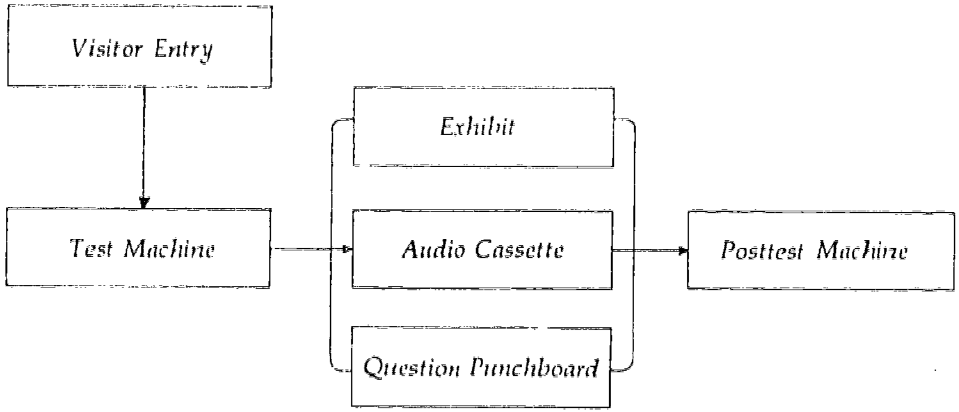

Figure 1. Schematic diagram of the basic components in skull and animism studies.

(These criterion questions were also available in booklet form, used in some studies to be described later.)

The audio was a Norelco cassette "Carrycorder," worn over the shoulder and used with earphones. A solid-state circuit, designed by project staff, enabled the tape to be stopped automatically by a 50-cps tone recorded on the voice channel of the cassette tape. Thus, when a question was asked, the tape stopped automatically. When plugged into the punchboard question unit, the tape restarted automatically after the visitor chose the correct answer. After incorrect answers, the tape remained silent.

The punchboard unit is shown, along with the cassette and earphones, in Figures 2a and 2b, with and without a question sheet. The punchboard was designed for use with the audio cassette powered by the cassette's 6-volt battery power supply.[2]

Figure 2a. The question punchboard device (without question sheet) and audio cassette used to provide guidance and feedback at the test exhibits.

Figure 2b. The question punchboard device and audio cassette with a question sheet on the skull display inserted on the punchboard.

[2] A more portable version of this punchboard is shown in Figure 23(B), Chapter IV. It can be used with or without an automatic-stop tape cassette.

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Question sheets were placed on the face of the punchboard as shown in Figure 2b. One or more 5" x 7" sheets of questions could be used. Questions were answered by punching holes with the attached stylus. The stylus made contact with one of the two underlying circuits providing the right-wrong logic of the device. A copper answer-key contained holes punched for the correct answer locations and was sandwiched between the upper punchboard and the lower "correct" circuit. Stylus contact through the answer-key to the "correct" circuit reactivated the tape cassette and punchboard light panel. Each answer also made a hole in the paper question sheet, thus providing a permanent record of all responses for later analysis.

Thus, correct answers automatically restarted the audio and briefly lit a small display of lights on the punchboard panel (see Figure 2b) as an added signal that a correct response had been made.

Figure 3 shows the cassette and punchboard devices being used by a visitor at a primitive skull exhibit, one of the test exhibits. The punchboard was small enough (2" x 6" x 9") to be held and carried about by the user. At the skull

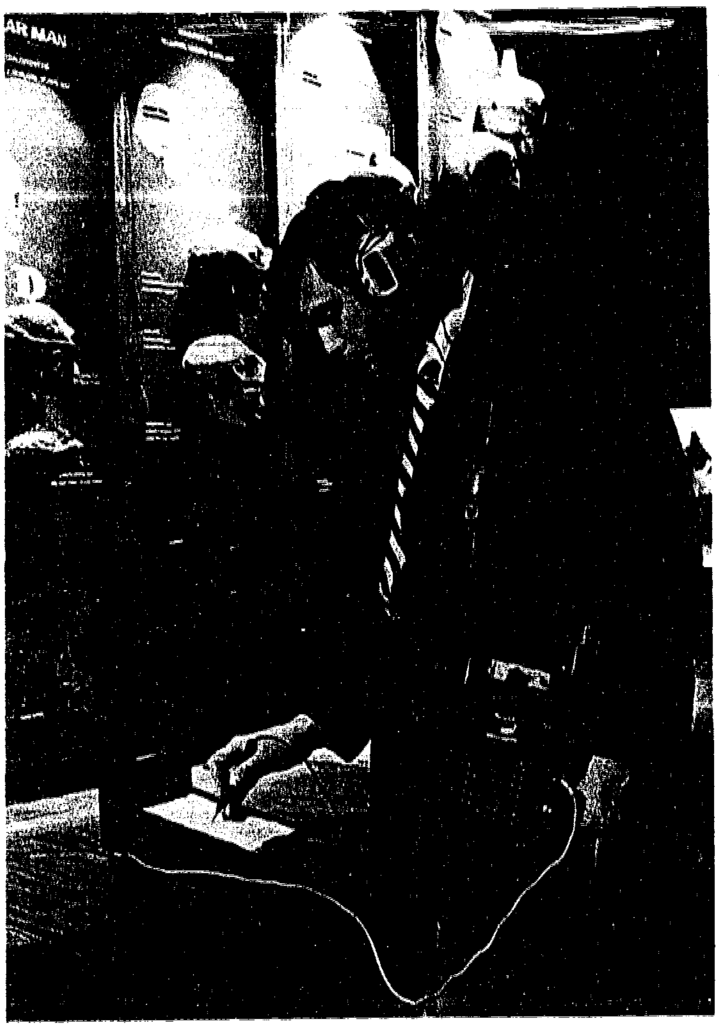


Figure 3. A visitor uses the cassette and punchboard device at the skull exhibit.

exhibit, many visitors took advantage of an open ledge in front of the display as the visitor in Figure 3 is doing.

In accordance with the considerations given earlier (Chapter I), the audio scripts used in the present studies included key exhibit relationships, directions for *where* to look (for names, shapes, etc.), commands to answer punchboard questions, etc. (See Appendixes B and E for some of the audio scripts used.) The audio immediately following each question included remarks such as "Good! The skull was Neanderthal," before continuing with the next segment of the script.

In earlier studies, some pilot audio scripts consisted of "conversations" between several persons with the visitor as a third party. In another script, the skulls in the test exhibit were given voices with appropriate accents and a conversational style. It was believed at the time that these script styles would provide more interest and help sustain attention. They proved unnecessary, however, even for the younger (10- to 11-year-old) participants. Visitors were more interested in answering the questions and getting the necessary directions. They preferred shorter scripts which dealt directly with directions, simple information, etc. Audio scripts were eventually simplified to include only a single (male) voice whose statements were confined to simple exposition, to directions needed to answer upcoming questions, and to confirming correct answers.

Punchboard Questions

Punchboard questions were designed to help the visitor notice those aspects of the exhibit related to the instructional objectives. Questions were developed through preliminary floor tryouts on the punchboard at the exhibits. Stylus holes provided a record of all responses. Each week's performance was analyzed for errors, etc. Questions on which errors were made, together with the accompanying audio exhibit labels and other features of the exhibit, were reviewed for possible ambiguities, errors, inconsistencies, etc., and were revised, retested, and further revised until at least 90 percent of the visitors over three of four-week tests obtained at least a 90 percent score with errors distributed across the questions.

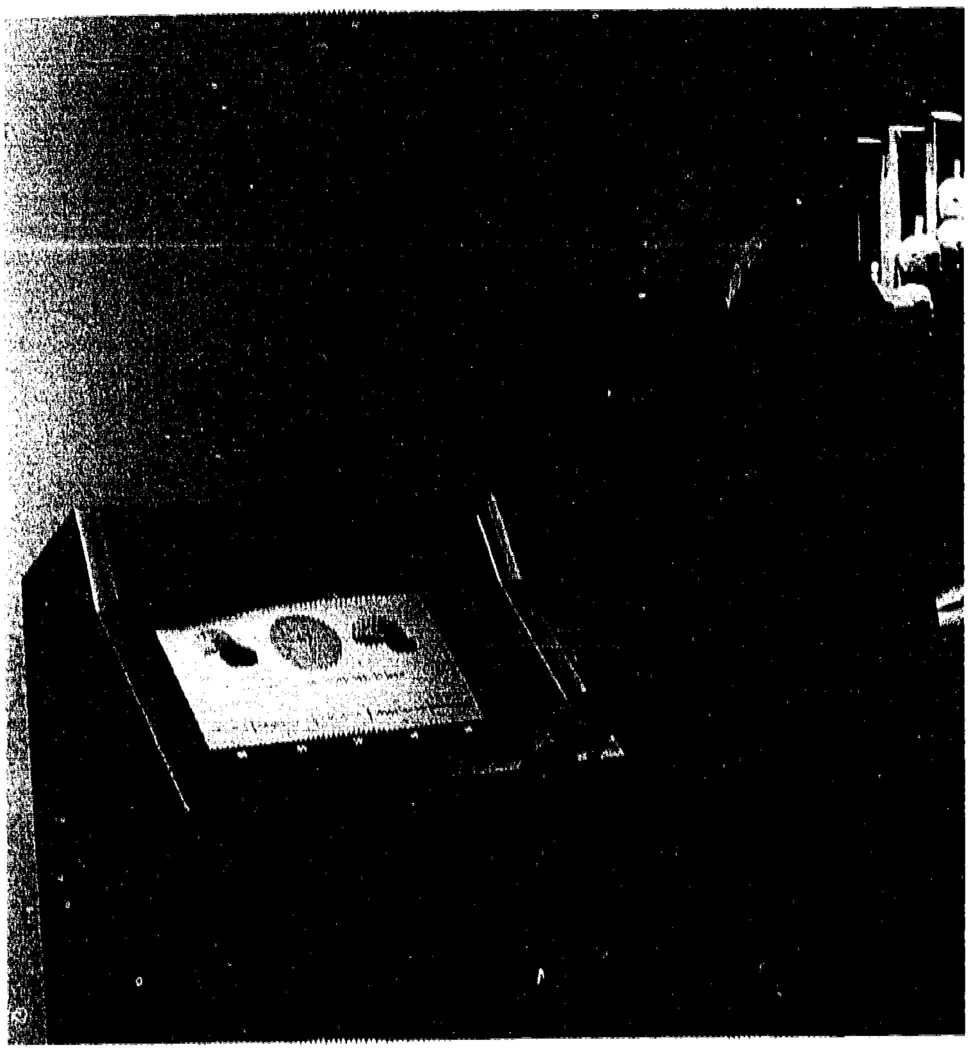
During developmental testing of the punchboard questions, little difficulty was experienced in obtaining the continued attention of most visitors to the question-answering activity. However, if it was possible to guess at answers without looking at the exhibit, or to reduce likely answers from the wording of the questions themselves, visitors tended to work with the punchboard with little or no attention to the physical exhibit in front of them. Thus, a question such as "Neanderthal's skull is (a) more pointed, (b) less pointed, (c) about the same shape as Cro-Magnon's skull" would often be answered without the visitor's having looked at the exhibit. To "force" exhibit-observing behavior, question formats were designed so that the exhibit and the audio were both necessary to determine what question was being asked.

Pre-Posttesting: Machines and General Procedures

A separate gamelike machine was used to test visitors prior to and following exposure to particular exhibit learning systems. Since visitors were expected to resist taking "tests" while visiting a museum on their own time, it seemed desirable to make the testing situation as attractive as possible. Observations of visitor behavior throughout the museum indicated that they were easily attracted to manipulate freestanding objects with buttons, etc. We therefore attempted to utilize this common curiosity and interest in "gadgets" in designing the pre-posttest situation.

Several pre-posttest machines were developed and tested. One such machine is shown in Figure 4, with a visitor answering one of the criterion questions on

Figure 4. A visitor answers one of the criterion questions, using an automated pre-posttest slide machine. Response buttons are located directly below answers along the base of the projection screen.



skulls. On this device, five-choice multiple-choice slides are automatically projected on a large (24" x 36") screen. Five answer buttons are arranged along the base of the screen directly under the choices for each question, as shown in Figure 4. In order to minimize the role of the pretesting situation as a learning situation, no feedback was given after an answer was chosen. After each choice, the next question was presented regardless of the correctness of the previous answer. Questions were prepared on 2" x 2" slides and projected by an Ectographic Kodak Carrousel (Model AV-303). Upon completion of the sequence of questions, the projector automatically advanced to the beginning of another test sequence and turned off. To discourage visitors from playing with the projector by stepping on and off the foot pad, a timer kept the projector on for about 40 seconds after the visitor stepped off the pad. This procedure effectively discouraged most persons from such actions. The system was housed in a cabinet manufactured by a Milwaukee coin-game company.

The test machine stood near the reference exhibit, but not in visual contact with it. A remote IBM card-punch machine recorded each answer along with the visitor's code number, age, and educational level.

A second type of pre-posttest machine is shown in Figure 5. This was an "MTA-400 Stimulus-Programmer," adapted for public-access operation.[3] Test

Figure 5. Pre-posttest machine presenting typed criterion questions on a paper roll. Response buttons are located at lower right on the face of the machine.

questions were printed on a continuous loop of paper indexed so that questions advanced and stopped one at a time in the viewing window shown in Figure 5. Questions were answered by pressing one of four response buttons shown at the lower left of the machine. As was the case for the slide machine, questions advanced regardless of correctness so that the visitor received no feedback on the correctness of his choices. A foot pad switch activated the system. The

[3] The original commercial unit was a paper-fed teaching machine with programmed materials, multiple choice questions, and response-recording devices.

visitor received instructions from a telephone mounted to the right of the machine. When the visitor picked up the receiver, the instructions were played from a Cousino continuous-loop tape player.

Pre-posttests were also prepared in booklet form for comparison with the machine mode of testing and for use with a retention study in which followup posttesting was done in the home. Each question was prepared on an $8^{1}/_{2}$" x 11" page (protected by acetate), in color, and in a format identical to that used for the same question on the test machines. Responses to booklet questions were made by circling the choice on a separate answer sheet provided by a project staff member.

Visitors who participated in the project's studies were not directly approached by project staff, but became involved in the system after they had approached the pretest machine or the nearby reception table (sometimes because they were interested in the punchboard devices seen being used by other visitors). A sign, "Try Our New Testing Machine," was located in the pre-posttest area.

Description of the posttest questions and the procedures used in their development and final selection will be given in later sections.

Over the total period of the project, more than 1400 persons voluntarily participated in floor tests of various experimental conditions. This figure excludes the 600 visitors whose responses were used to select criterion pre-posttest questions. Except for summer months and holiday periods, attendance at the museum was too poor during weekdays to justify the small number of subjects obtained. Therefore, much of the data to be reported were obtained on Saturdays and Sundays between 11 a.m. and 4 p.m.

The freestanding test machines shown in Figures 4 and 5, and the punchboard-cassette learning units, did well in attracting and holding the attention of younger visitors of intermediate and high school ages from a wide range of socio-economic backgrounds. Of the 1400 visitors, about 75 percent were between the ages of 11 and 17 with from 4 to 12 years of schooling. Approximately 30 percent were nonwhites. While participants included persons up to 52 years of age and persons with advanced degrees, the median age was about 14.5. Adult visitors would readily participate in playing freestanding question machines when they could do so in relative privacy, but were often reluctant to approach staff to obtain the punchboard or cassette units or to commit themselves to the time involved. Advertising special incentives, including cash awards for good test performances, did not improve adult participation.

Visitor participation took place under a wide range of crowd conditions, times of the year, distracting circumstances, and social pressures from peer groups or family.

Developmental and Exploratory Studies

Over the period of the project, the pre-posttest performance of visitors was compared under a variety of exhibit learning conditions with different types of audio, complexity and length of materials to be learned, and different motivational conditions. Tried in early exploratory work were different kinds of visitor response systems, prototype models of question-answer devices, different styles of audio, and a variety of programs based on different lists of instructional objectives.

In earlier pilot studies we underestimated the amount of interest visitors would have in devoting time and effort to the exhibit-learning materials simply to achieve correct answers on their punchboard questions. Earlier studies offered cash incentives for achieving high posttest scores. Incentives ranged from 25¢ to $4 if visitors could achieve six out of seven questions correct on the skull posttest (only seven criterion questions were used in posttests in these earlier studies). No significant differences were found among the various monetary levels. While posttest performance of those visitors who were offered money was somewhat better than that of visitors offered nothing, the improvement was of borderline significance statistically.

Our original concern over the need for extrinsic visitor motivation also led to the design and testing of a more elaborate punchboard, which contained a score panel. Incorrect responses were "punished" by subtracting from the accumulated score. This feature was intended to discourage careless guessing, which we expected would occur with many visitors. But comparisons of the use of this system with the simpler punchboard showed no differences in visitor performance, either in terms of errors made on the punchboard questions or on posttest questions.

It subsequently became clear that most visitors did not need special incentives or scoring devices to motivate the necessary attention to the exhibit materials. High posttest performance began to emerge as the programmed questions and audio materials improved and the criterion questions used in pre-posttesting were more carefully related to the exhibit learning system.

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Experimental Studies: Skull and Animism Exhibits

For the purposes of this report we shall consider in more detail the procedures and results of six investigations, which utilized the criterion test questions, audio scripts, and punchboard questions which finally evolved from the earlier exploratory investigations. These studies attempt to evaluate the role of the exhibit punchboard, audio, and the pretesting experience in facilitating learning from two experimental test exhibits: the skull display at the Age of Man exhibit and a display on animism and shamanism in the Hall of Religion. These will be considered in order of their occurrence, along with the primary results. Conclusions and discussion of these results as a whole will be given in Chapter V.

Criterion Questions: Skull Exhibit

Development of a final set of criterion questions for use on pre-posttests at the skull exhibit was based upon four kinds of behaviors related to the five primitive skull artifacts of the displays. These were:

(1) naming the skull;
(2) matching the proper skull to its name;
(3) ordering the skulls by age; and
(4) ordering the names of the skulls by age.

Two Kodak Carrousel trays of 160 colored slides were prepared, covering various combinations and formats of the above behaviors. The Slide-Test Machine described earlier (Figure 4) was set up in a hall area near (but not at) the skull exhibit. It was connected to a remote IBM card punch, which recorded each visitor's response to each question and whether or not the response was correct. No one was in attendance, so each visitor approached and operated the machine on his own. No feedback was given to the visitors on the correctness of their responses.

The machine remained on the floor for about six weeks. Baseline data were obtained from over 500 persons on each of the 160 slides. These data were analyzed by a SAP (Statistical Analysis Package) program, which provided a 5 x 160 matrix of choices by slides giving the number of responses on each choice to each slide and percentage of correct choices for each slide. On the basis of this analysis, all slides on which there were more than 30 percent correct responses were rejected. This reduced the total number of slides by more than 50 percent—to less than 80 slides.

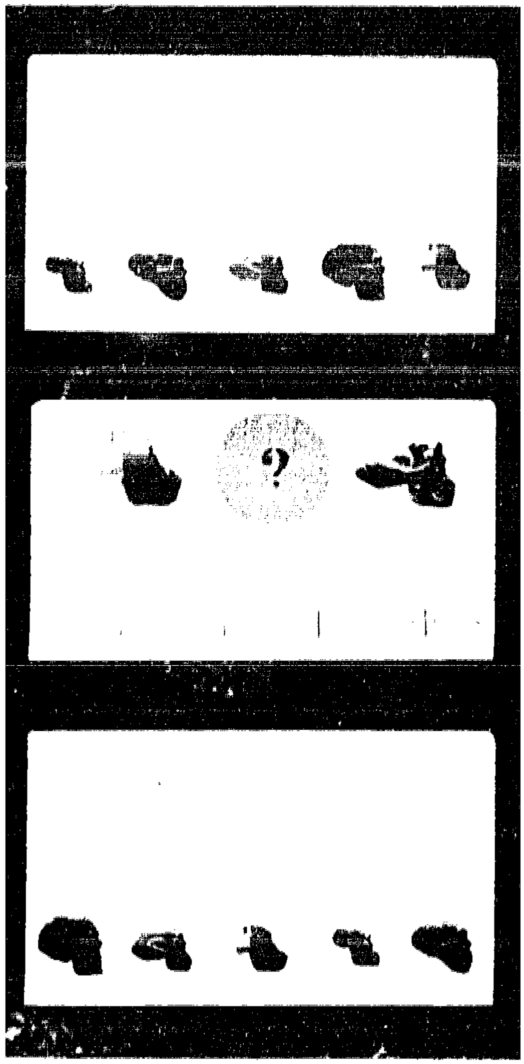

Figure 6. The 12 criterion questions on skul
of exhibit-learning systems at skull exhibit.

The remaining slides were then u
ner, with the additional procedure
by visitors about the slides and inter
understanding of particular slides, wi
an additional three weeks, during
the materials, the questions were re
unambiguous and still resulted in le
20 slides were then reduced to a tota
mum number of slides that sampl
earlier. These 12 criterion questions
they were presented. The skulls in
approximated the artifacts displayed i

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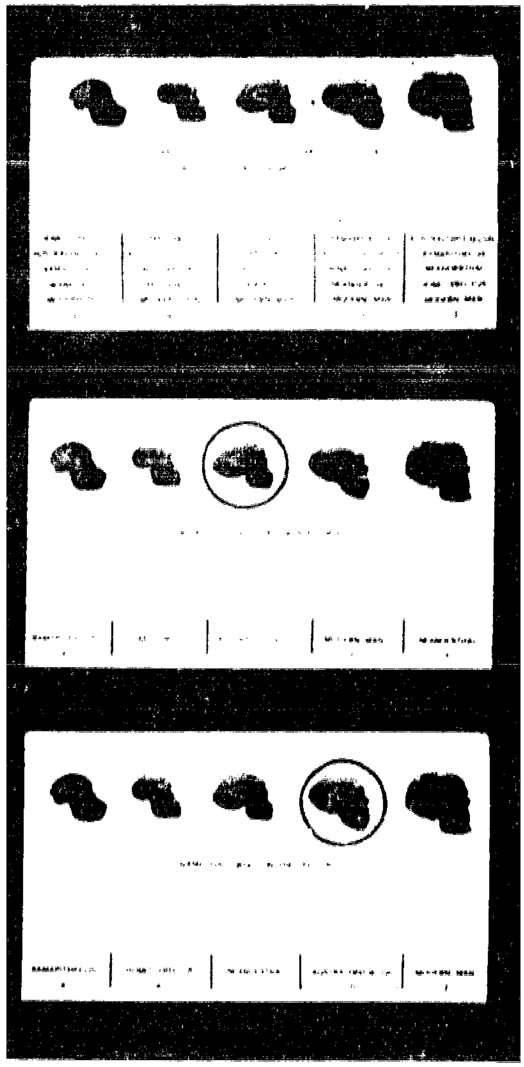
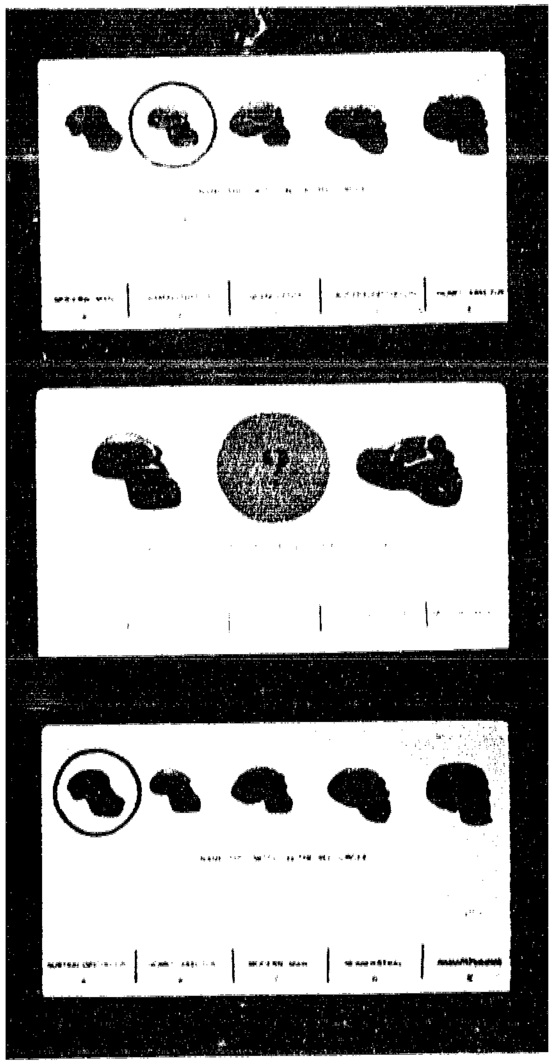


used to test the effects

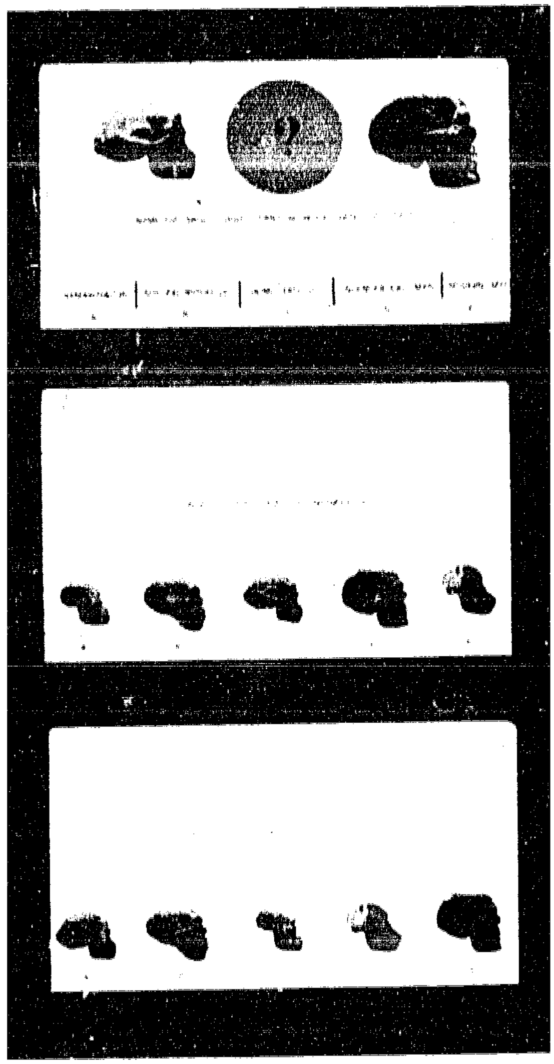
d in the same machine in the same man-
having observers record remarks made
ewing individual visitors concerning their
t they thought was ambiguous, etc. After
hich over 200 more persons completed
uced to a total of 20 slides, which were
than 30 percent correct answers. These
of 12 slides, which represented the mini-
the four criterion behaviors described
shown in Figure 6 in the order in which
e actual slides were in color and closely
the exhibit.



Punchboard Questions: Skull Exhil

While these criterion questions were being
grams were being tested for use at the exhi
described earlier for the five skulls.

Early programs attempted to teach the skulls and order them in terms of cranial eye ridges), and the shape of the backs. T questions printed on three separate sheet cessively). Together with the audio, this complete.



bit

; selected, audio and punchboard pro-
ibit for developing the four behaviors

visitors to discriminate between the
l area, muscle protrusions (including
The program included 24 punchboard
ts (placed onto the punchboard suc-
program took about 25 minutes to

After several revisions, this three-page program eventually yielded at least 90 percent correct answers for more than 90 percent of the participants.

The mean posttest score for this revised three-page program was better than 75 percent on the 12 criterion questions described earlier. However, interviews with participants after the posttest indicated visitor resistance to its 25-minute length. Nevertheless, no visitor ever quit before finishing it.

Because of its excessive length, it was decided to limit discussion to the *cranial area* as the basis for discriminations, eliminating shape of back of head and muscle protrusions. The audio script and questions were reduced to a single-page program of 16 questions requiring about 10 to 12 minutes to complete. Mean posttest score for this shortened program (n = 75) dropped to about 60 percent, which was lower than our objective of at least 70 percent posttest score. After minor revisions in wording, the shortened version finally yielded mean posttest scores of 75 percent over four weeks of testing. This version became the program used in the experimental studies described below. This final version is shown in Appendix A.

Skull Studies 1, 2, and 3

STUDY 1

This study involved a total of 201 visitors tested over a 10-month period on the 12 criterion questions on skulls described earlier (Figure 6), using the shortened single-page version of the teaching program. The subjects (*Ss*) ranged from 10 to 30 years of age (Mdn = 14), who were in the process of exploring the museum in the area of the skull exhibit. The majority of *Ss* (about 75 percent) were between 11 and 17 with 4 to 12 years of schooling. As in all of the work in the project, all socio-economic groups were represented and approximately 30 percent were nonwhites.

Four groups of *Ss* were tested under four exhibit learning conditions. Each of the conditions was run on successive testing days until no less than 48 *Ss* were obtained for that condition. The four experimental conditions were as follows:

> *M-Condition* (n = 50): Both the punchboard and cassette tape shown in Figure 2 were used to relate the visitor to the exhibit. Each *S* took the pretest on the test machine shown in Figure 4 without feedback. He was then given the cassette tape and punchboard and sent to the nearby exhibit where he worked on his own under the direction of the audio, as described earlier, and the punchboard questions. (See Appendix A for punchboard questions and Appendix B for audio scripts.) Upon completion of the programmed questions, *S* returned to the test machine and retook the 12 pretest questions, again without feedback.

> *AQ-Condition* (n = 51): Only the audio cassette was used, *without* the punchboard. The 16 questions formerly asked on the punchboard were inserted on the tape in appropriate spots. The *S* could answer the questions only to himself. Each audio-question was followed by a five-second silence

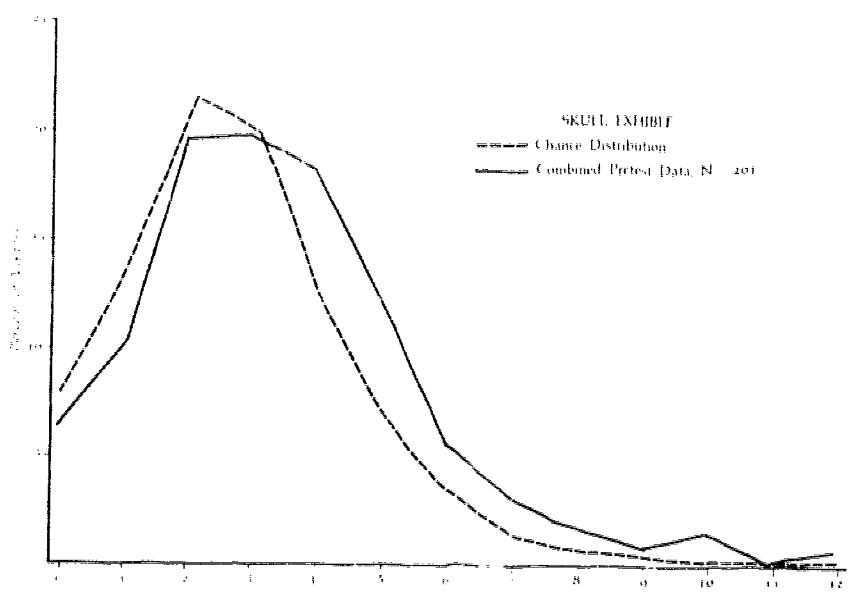
before audio confirmation of the correct answer and continuation of the program. Except for the questions, the audio script was identical to that used under the M-Condition.

E-Condition (n = 51): The exhibit itself was used without either the audio cassette or the punchboard. The *S* was left entirely on his own to process whatever information he could from the labels and physical layout of the exhibit, without guidance or feedback. Each *S* took the pretest as in the other conditions and was then told to go to the exhibit, study it, and return for a test on the machine.

E (NP)-Condition (n = 49): Identical to the E-Condition, except that the *S* was directed to the exhibit *before* taking the criterion test on the test machine. Thus, *S* was exposed to the exhibit without prior knowledge obtained through the pretest about what the instructional objectives might be. This represented the "normal" learning situation for most museum exhibits.

Pretest Results. A frequency distribution of pretest scores for the 201 *Ss* tested in Study 1 is shown in Figure 7 along with the theoretical distribution (dotted line) which would be expected based on chance alone. These curves show criterion test scores plotted against the percent-visitors obtaining these scores. As may be seen from Figure 7, the pretest distribution is very similar to the chance distribution, showing only a small pre-exhibit knowledge of the skull discriminations involved (skull naming, skull ordering, etc.). The mean pretest score for this group of 201 *Ss* was 25.2 percent, about 5 percent above the theoretical chance mean score. The pretest distribution curve shown here is very similar to the pretest distributions obtained from the more than 450 *Ss* tested prior to Study 1 during the development of the programmed materials.

Figure 7. Frequency distribution of pretest scores for the skull exhibit (n = 201) compared with expected chance distribution.



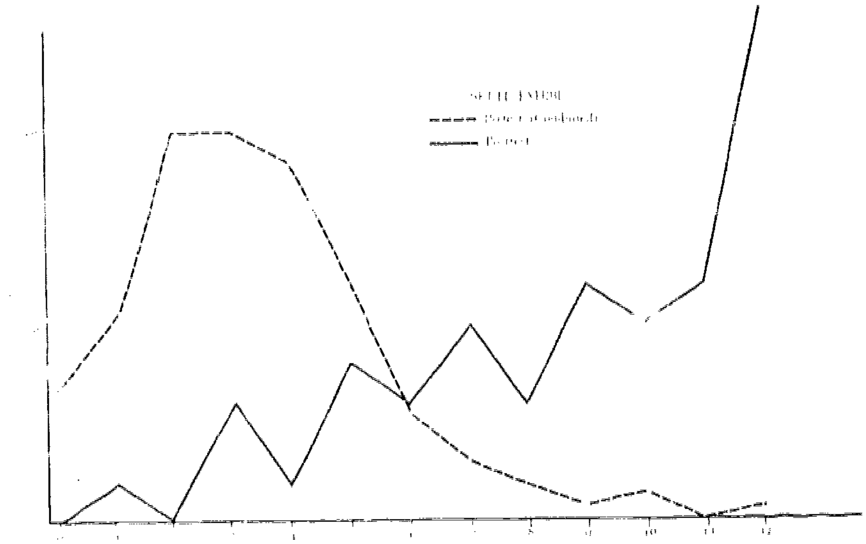


Figure 8. Frequency distribution of posttest scores for M-Condition (n = 50) at skull exhibit compared with pretest scores (n = 201).

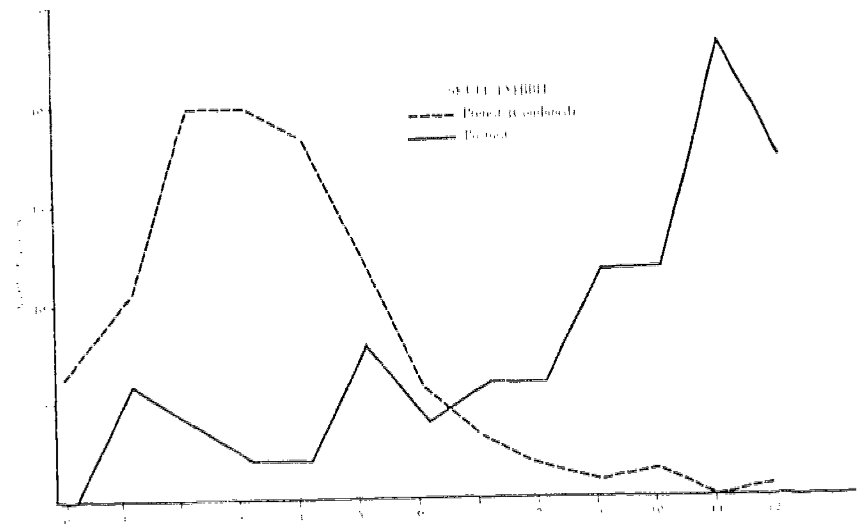


Figure 9. Frequency distribution of posttest scores for AQ-Condition at skull exhibit (n = 51) compared with pretest scores (n = 201).

This distribution and the mean and median scores proved highly stable across different times of the year, different days of the week, etc.

Posttest Results. Figures 8-11 compare the frequency distributions of each of the four conditions with the pretest performance for the combined group.

Figure 8 shows the distribution of posttest scores for *Ss* (n = 50) exposed to the exhibit under the M-Condition (punchboard and audio cassette). Performance increased sharply over pretest performance with over one-third (38 percent) achieving a 92-100 percent posttest score. Over one-fourth (26 percent) received a *perfect* score. Mean and median performance for the total group were 72.8 percent and 75 percent respectively.

Figure 9 shows results for *Ss* (n = 51) for the AQ-Condition (audio-cassette and audio questions only). Performance was similar to the M-Condition (Mean

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= 71 percent, Mdn = 79 percent). Apparently the availability of an overt response device, such as the punchboard, was not essential in achieving high posttest performance. About 40 percent of the *Ss* achieved a 92-100 percent score. It should be noted that the AQ-Condition consisted of the audio script and audio questions which had previously been tested with the punchboard and revised until able to yield a minimal error rate (5 percent or less).

Figure 10 shows the results for the E-Condition (n = 51), which involved the exhibit only, *without* audio or punchboard. After taking the pretest, the visitor studied the exhibit without benefit of either the punchboard or audio cassettes. Mean posttest score dropped to 57 percent (Mdn score dropped to 50 percent). Some visitors still showed considerable improvement, although not as dramatically as they did under the AQ and M conditions. About 19 percent of the visitors obtained the 92-100 percent level. Although these *Ss*, during pretesting,

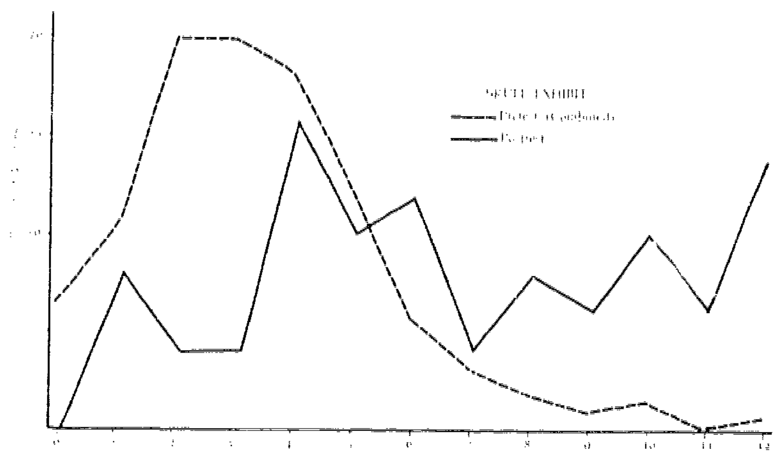


Figure 10. Frequency distribution of posttest scores at skull exhibit for E-Condition (n = 51) compared with pretest scores (n = 201).

received no feedback or other knowledge of how well they were doing, the pretest experience probably provided important advanced information *re* instructional objectives. Such advance knowledge may have helped some *Ss* to "process" effectively relevant exhibit information.

The importance of this pretesting experience in helping some *Ss* to learn from the exhibit was substantiated by the results obtained for 49 *Ss* who studied the exhibit without taking the pretest (E (NP)-Condition). Figure 11 shows the results for this group, and as may be seen, the distribution of scores closely approximates the distribution of pretest scores (dotted line), with mean and median performance at about 36 percent and 33 percent respectively.

An analysis of variance of the four exhibit conditions yielded a between-treatment variance significant beyond the .001 level (F = 21.82, d.f. 3/197) as shown here:

Source	SS	d.f.	MS	F	P
Treatment	620.52	3	206.84	21.82	.001
Error	1867	197	9.48		

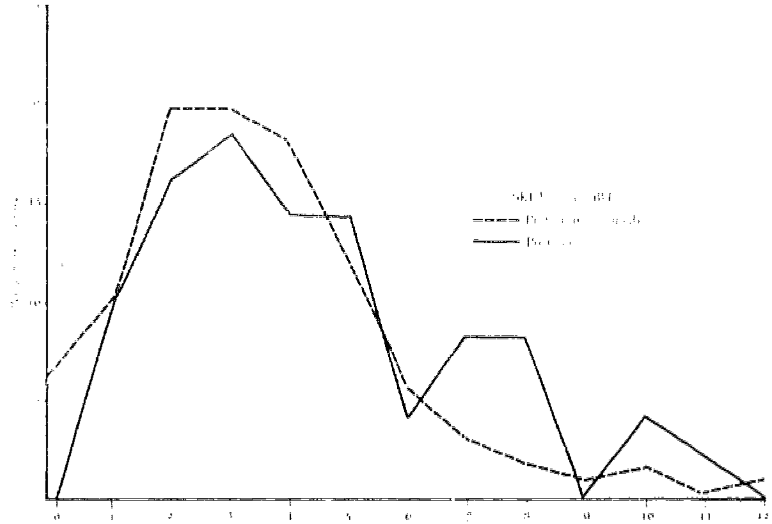


Figure 11. Frequency distribution of posttest scores for E(NP)-Condition at skull exhibit (n = 49) compared with pretest scores (n = 201).

Based on this result, a Newman-Keuls analysis of the differences between means (Table 1) showed that while there were no significant differences between the means of conditions M and AQ (as noted earlier), they were both greater than condition E ($p < .01$). Condition E, when compared with condition E (NP), was significantly greater than condition E (NP) ($p < .01$).

Treatments		E(NP)	E	AQ(w)	M
	Means	4.37	6.80	8.61	8.74
E(NP)	4.37	—	2.43**	4.24**	4.37**
E	6.80		—	1.81**	1.94**
AQ	8.61			—	.13
M	8.74				—

* = $p < .05$

** = $p < .01$

Table 1. Newman-Keuls analysis of differences between means of the E(NP), E, AQ, and M conditions at skull exhibit.

STUDY 2

The results of Study 1 indicated that the use of the audio cassette without the opportunity to overtly respond to questions on the punchboard was equally effective in producing significant improvement in learning for many of the visitors. The AQ-Condition included a five-second silence following each of the questions, intended to encourage *Ss* to take time to answer. This took additional time. One question was whether this five-second silence was necessary. Another question was the importance of the questions themselves. It was expected that the use of questions would facilitate performance. It seemed doubtful, however, that the five-second silence was necessary for *Ss* to respond to the questions.

Study 2 concerned a comparison of the AQ and E groups of Study 1, with two additional groups of *Ss* run under two additional audio conditions:

AQ(w)-Condition (n = 51): The same audio script was used as in the AQ-Condition, but *without* the five-second silence following questions.

AN-Condition (n = 49): The same audio script was used as in the AQ-Condition, but the questions were omitted. Thus, the audio material was presented here in essentially narrative form. (See Appendix B-4 for modifications of audio for AN-Condition.) In all other respects, all other conditions were the same.

Results. The data from these two additional groups were included in a four-group comparison with the AQ and E groups from Study 1; that is, three audio conditions with the no-audio condition. The mean posttest scores of the four groups, E, AN, AQ, and AQ(w) were 6.80, 7.73, 8.83, and 8.61 respectively. An analysis of variance yielded a between-treatments variance which was significant beyond the .05 level (F = 2.92, d.f. = 3/199). A Newman-Keuls analysis (Table 2) showed (as expected) that there were no differences between AQ and AQ(w) and that the E-Condition did not differ significantly from the AN-Condition, while the audio conditions involving questions (AQ and AQ(w)) were both significantly greater than no audio at all (E-Condition).

Treatments		E	E(N)	AQ	AQ(w)
	Means	6.80	7.73	8.33	8.61
E	6.80	—	.93	1.53*	1.81*
E(N)	7.73		—	.60	.87
AQ	8.83			—	.28
AQ(w)	8.61				—

* = $p < .05$
** = $p < .01$

Table 2. Newman-Keuls analysis of differences between means of the E, E(N), AQ, and AQ(w) conditions at skull exhibit.

STUDY 3

From Study 1, results indicated (groups E and E(NP)) that the pretesting experience played a role in helping some visitors achieve high posttest scores after studying the exhibit without audio or questions. Although no feedback was given during pretesting, the pretest experience for group E apparently helped some *Ss* to define the instructional objectives of the exhibit, which in turn helped them to process exhibit information relevant to the posttest.

Study 3 concerned whether this same result could be obtained by giving the visitor, prior to studying the exhibit, a printed statement of what to look for (rather than a pretest). Another question concerned the effects of taking the pretest in booklet form instead of by machine.

Study 3 compared *Ss* in the E(NP) and E conditions of Study 1 with two additional groups of *Ss* tested after they studied the exhibit on their own (without audio) under the following conditions:

> *E(1)-Condition* (n = 53): This was like the E-Condition, except that instead of taking a pretest, all *Ss* received a 5" x 7" card with a typed summary of what to look for in the exhibit.

The card read as follows:

> Notice the skulls in the exhibit with large white letters over their heads. Skull A is Modern Man and Skull B is Neanderthal Man. Look closely at the five skulls in the exhibit and try to do the following:
>
> 1. Find the *scientific* names of skulls C, D and E. The scientific names of each of these skulls is in small white letters near the top of the panel under "EARLIEST MAN," "NEAR MAN," and "EARLY MAN APE."
> 2. Name each of the five skulls when shown its picture.
> 3. Recognize the picture of each skull by name.
> 4. Know the *order* of the five skulls from oldest to most recent, both by pictures and by name.

Ss carried this card with them to the exhibit. Following the exhibit, they returned to take the regular posttest by machine.

E(B)-Condition (n = 51): Same as condition E in Study 1, except that *Ss* took the pretest from a *looseleaf booklet* in which each of the 12 criterion questions was presented in a format identical to the machine format. Questions were answered on a separate answer sheet and were administered by a project staff member. No feedback was given and no conversation took place between visitor and staff member during testing.

Results: The data from these two additional groups were included in a five-group comparison with the E and E(NP) groups from Study 1 and the pretest scores represented by these five groups.

An analysis of variance of these five groups yielded a between-treatment variance significant beyond the .01 level ($F = 11.25$, d.f. 4/250). A Newman-Keuls analysis of the differences between means (Table 3) indicated no significant differences among the three pretest conditions (E, E(I), and E(B)), but significant differences *between all* of these three conditions and the E(NP)-Condition, as well as the pretest baseline performance, as was expected.

Treatments		Pretest	E(NP)	E(I)	E	E(B)
	Means	3.72	4.37	5.92	6.80	7.29
Pretest	3.72	...	.65	2.20**	3.03**	3.57**
E(NP)	4.37		....	1.55*	2.43**	2.92**
E(I)	5.92			—	.83	1.37
E	6.80				—	.49
E(B)	7.29					—

* = $p < .05$
** = $p < .01$

Table 3. Newman-Keuls analysis of differences between means of the pretest, E(NP), E(I), E, and E(B) conditions at skull exhibit.

STUDY 4 *Retention*

The delay between exposure to the exhibit system and the start of the posttest averaged about two minutes. To obtain information concerning retention of the exhibit information over longer periods, Study 4 was conducted with a separate group of 67 *Ss*. This was a completely separate study, which replicated the procedures and the three exhibit learning conditions M, AQ(w), and E. The exhibit condition was followed by the usual machine posttest, followed by two *additional* test sessions, approximately 2 days and 16 days later. Addresses and phones were obtained at the end of the first posttest session when visitors were told that they would be given the questions again at their homes. For the second and third tests in the home, the booklet form of the test (described earlier) was used. As in the case of Study 1, no feedback or other knowledge of results was given to *Ss* during any of the three posttests.

Of the original 67 visitors who completed the initial programs at the museum, 43 completed both the second and third posttest sessions.

Figure 12 shows the mean pretest (combined) and posttest performance for each of the three posttest sessions for groups M ($n = 12$), AQ(w) ($n = 16$), and E ($n = 15$). As is apparent from these curves, visitor performance was maintained over the 2- and 16-day period at essentially the same levels as obtained on the initial posttest, regardless of the conditions under which the visitor had acquired the exhibit information. An analysis of variance yielded no significant between-sessions variance or treatments x sessions interaction. Differences between the groups were essentially the same as obtained in Study 1. Frequency distributions of the pretest and initial posttest scores for this replication were very similar in form to those obtained in Study 1. Therefore, as would be expected, there was a significant between-treatments variance beyond the .01 level ($F = 10.164$, d.f. $= 2/40$).

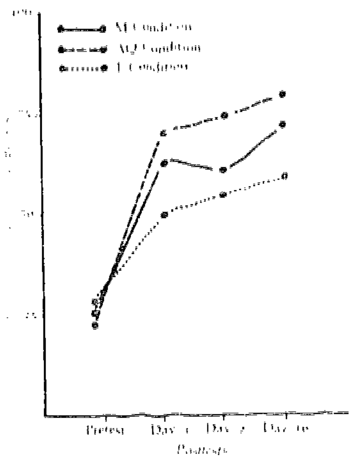


Figure 12. Pretest and successive posttest performance in terms of mean percent correct on days 1, 2, and 16 of retention study.

Animism—Shamanism Replication Studies 5 and 6

STUDY 5

In order to determine the replicability of the basic procedures and conditions used in the skull exhibit in producing visitor learning in a totally different museum location with different subject matter, the exhibit learning conditions M, AQ(w), E, and NP were replicated at a display on animism and shamanism in the Hall of Religion.

This, of course, required developing an entirely new set of criterion questions for use in pre- and posttesting, and a new set of programmed questions and accompanying audio for use with the exhibit.

A different pre-posttest machine, the MTA-400 shown in Figure 5, served as the testing device. Criterion questions were developed in a manner similar to that described for the development of the skull questions. However, on the MTA test machine the questions were not presented on slides, but on a continuous-loop paper roll, and involved four rather than five choices. Visitor responses were recorded on an Esterline-Angus Event Recorder within the machine, and the results were later analyzed by hand. An original pool of 45 questions, using a 40 percent rejection criterion,[1] along with individual interviews with visitors, was eventually reduced to 10 criterion questions plus two preliminary questions on age, and schooling (see Appendix C). The questions covered material found in two glass cases on the functions and methods of the shaman and animism among the Iroquois Indians.

[1] Due to the higher entering knowledge of visitors on the animism-shamanism topic, there were not 10 unambiguous questions on which there were less than 30 percent correct answers on pretesting. Therefore, the rejection criterion had to be raised to 40 percent.

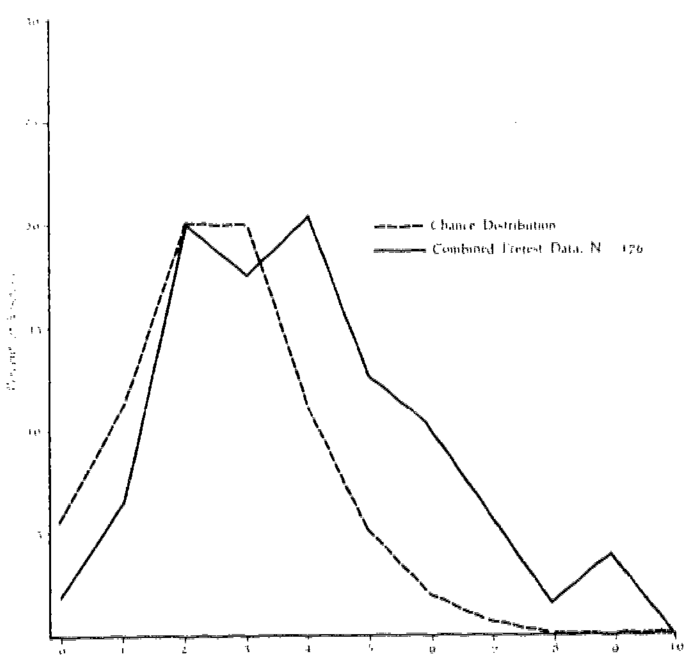
The punchboard questions and audio script were developed in the same manner as the skull program. The objective was a single sheet of questions and accompanying audio requiring from 10 to 12 minutes to complete and yielding better than 90 percent correct for at least 90 percent of the test *Ss* over several weeks of testing. Because of the experience already gained from the skull program, this process took much less time. A final set of punchboard questions and accompanying audio (Appendixes D and E) were completed after six weeks of testing with about 250 visitors.

The study to be described here involved a total of 226 visitors of about the same age range (10 to 39 years in this case) with a median age of 15.0 years and 4 to 14 years of education. The sequence of events was essentially the same as that already described for the skull exhibit procedure. Visitors who inquired about the test machine (or other visible apparatus) were invited to "play" the pretest machine, then were sent to the exhibit cases under one of the exhibit learning conditions. This was followed by a posttest on the MTA test machine. No feedback was available during pre- or posttests.

Four groups of visitors were exposed to the religion exhibit under one of the following four exhibit conditions: M, AQ(w), E, and E(NP), identical to the conditions previously described for these labels. The *n*'s for each group were 48, 48, 80, and 50 respectively.

Pretest Results. The frequency distribution of pretest scores for the 176 *Ss* who took the pretest is shown in Figure 13 along with the theoretical chance distribution (dotted line). (Only 176 of the 226 *Ss* are included in the pretest because the 50 *Ss* in the E(NP) group did not take a pretest.) As noted earlier, there was greater pre-exhibit knowledge of the animism-shamanism topic among visitors than there was of the skulls (mean = 39.3 or about 14 percent

Figure 13. Frequency distribution of pretest scores for animism exhibit (n = 176) compared with expected chance score.



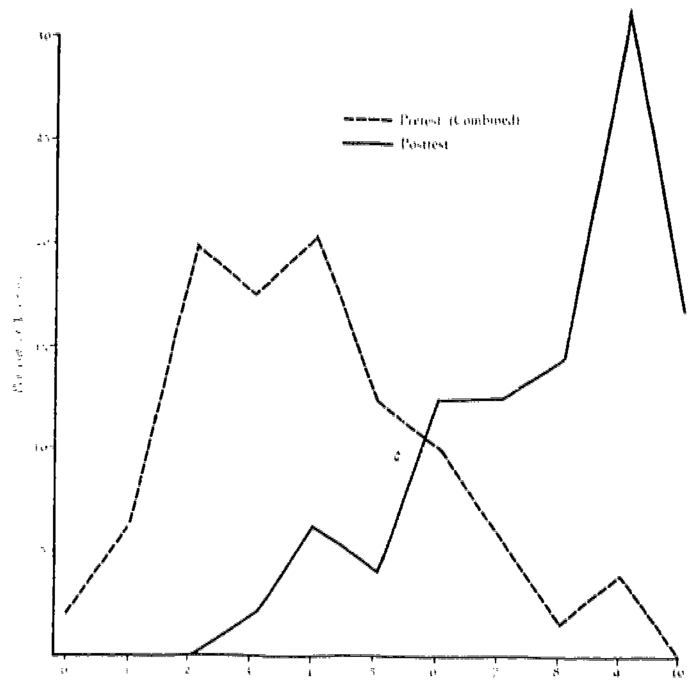


Figure 14. Frequency distribution of posttest scores for M-Condition at animism exhibit (n = 48) compared with pretest scores (n = 176).

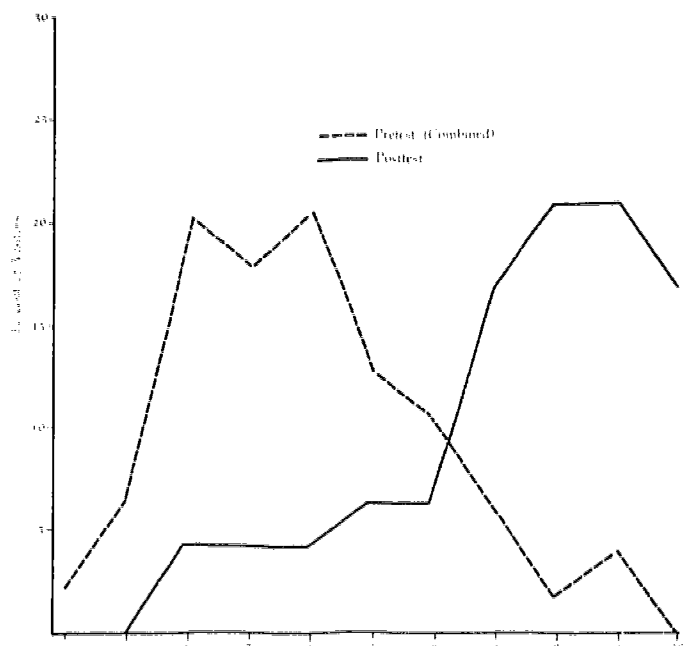


Figure 15. Frequency distribution of posttest scores for AQ-Condition at animism exhibit (n = 48) compared with pretest scores (n = 176).

above the 25 percent chance level). The pretest curve is very similar in shape to that obtained on the skull pretest.

Posttest Results. The frequency distributions for each of the four posttest conditions are shown in Figures 14, 15, 16, and 17. Each distribution is com-

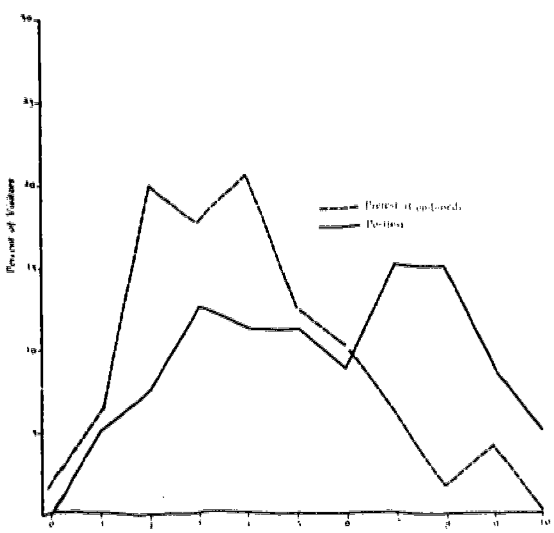


Figure 16. Frequency distribution of posttest scores for E-Condition at animism exhibit (n = 80) compared with pretest scores (n = 176).

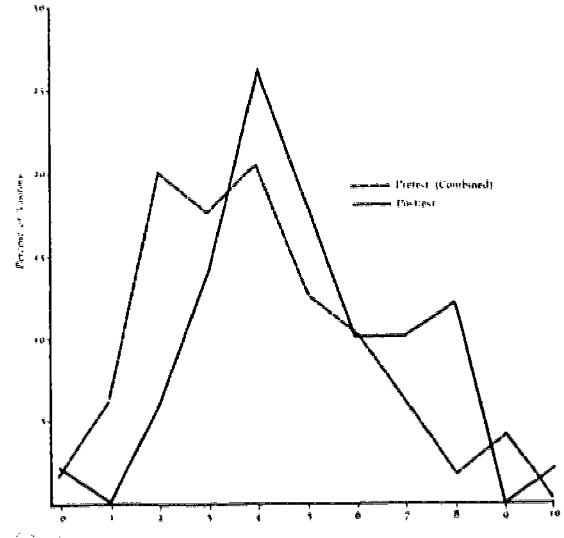


Figure 17. Frequency distribution of posttest scores for E(NP)-Condition at animism exhibit (n = 50) compared with pretest scores (n = 176).

pared with the combined pretest distribution. Results for the four conditions appear essentially the same for each of the conditions as obtained at the skull exhibit, with nearly 48 percent achieving a 92-100 percent posttest score under the M-Condition (n = 48) and nearly 38 percent achieving these levels under the AQ(w)-Condition (n = 48). Some visitors (16 percent of a total of 50) still achieved the 92-100 percent level under the E-Condition.

An analysis of variance yielded a significant between-treatment variance beyond the .001 level (F = 19.26, d.f. = 3/222). A Newman-Keuls analysis of the differences between means (Table 4) indicated no significant differences between the M and AQ(w) conditions, confirming the results with the skull program studies. Again, there were significant differences between the E-Condition and the M and AQ(w) conditions ($p < .01$). While less than the M and AQ conditions, the E-Condition was significantly better than the E(NP)-Condition where no pretest was given.

Treatments		E(NP)	E	AQ	M
	Means	4.94	5.86	7.79	7.83
E(NP)	4.94	—	.92*	2.85**	2.89**
E	5.86		—	1.93**	1.97**
AQ	7.79			—	.04
M	7.83				—

* = p<.05   ** = p<.01

Table 4. Newman-Keuls analysis of differences between means of the E(NP), E, AQ, and M conditions at the display on animism and shamanism.

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STUDY 6

As in the case of the skull exhibit, we wished to determine the effects on posttest performance, if any, of studying the exhibit alone without a pretest, and if the pretest conditions by machine (condition E) were any different from the pretest experience via the booklet (condition E(B)). Therefore, an additional group of *Ss* (n = 50) were tested with the pretest by booklet rather than by machine (E(B)).

The posttest performance of this E(B) group was then compared with the E and E(NP) groups of Study 5 and the original pretest scores of these three groups. An analysis of variance which included the pretest scores as a fourth condition yielded a significant between-treatments variance beyond the .001 level (F = 21.45, d.f. = 3/256). This was followed by a Newman-Keuls analysis (Table 5) of the differences among the means of the four conditions. As was found in Study 4, there were no significant differences between the booklet and machine forms of pretest administration. There *were* significant differences between the no-pretest E(NP)-Condition and the two pretest conditions, E and E(B), as may be seen in Table 5.

Treatments		Pretest	E(NP)	E	E(B)
	Means	3.80	4.94	5.86	6.56
Pretest	3.80	—	1.14	2.06	2.85
E(NP)	4.94		—	.92	1.62
E	5.86			—	.70
E(B)	6.56				—

* = $p<.05$ ** = $p<.01$

Table 5. Newman-Keuls analysis of the differences between means of the pretest, E(NP), E, and E(B) conditions at the display on animism and shamanism.

One result obtained in the analysis of exhibit-only conditions at the animism exhibit was the significantly better performance of the E(NP) group over baseline pretest performance. In other words, the performance of visitors was apparently improved by their having studied the animism-shaminism exhibit *without* benefit of pretest, although the results were not as good as when a pretest had first been experienced (group E).

This last result suggests that museum visitors do sometimes learn things simply from looking at an exhibit, reading the labels, etc. The fact that such a result was obtained on the animism topic and not at the skull exhibit may simply mean that the basis for skull discriminations was not as clear in the skull exhibit as were the functions and methods of animism and shamanism. In the latter case, reading one or two of the rather short labels in the religion exhibit could have provided some of the necessary information measured in the posttest. The labels in the skull exhibit, on the other hand, were more involved, longer, and more subtle. Also, the vocabulary required in the religion exhibit was simpler than that required for the skull exhibit. In any case, whether it was the better design of the exhibit cases or the greater pre-exhibit knowledge of the visitors, *some* learning apparently did occur for the E(NP) group at the animism-shamanism exhibit.

IV. Self-test, Recycling Systems

The self-test, "recycling" system evolved from our observations that in various replications of the E-Condition from 15 to 20 percent of the visitors who had taken the no-feedback pretest were able to achieve very high posttest scores (92-100 percent) without the use of any programmed systems at the exhibit. While these visitors received no feedback or other knowledge of what answers were correct or incorrect, the pretest experience probably helped define what had to be learned from the exhibit. Apparently some visitors utilized this pretest information to process effectively the exhibit information on their own without the help of audio or other programmed materials. The majority of persons in our visitor population, however, apparently needed the support of audio or other devices to select and organize exhibit information relevant to the concepts being tested.

Some cognitive approaches to learning have emphasized the importance of prelearning orientation (Ausebel, 1968). The facilitative effects of adjunct materials, such as instructions, questions, and "advance organizers," have been demonstrated in the learning and retention of prose (Frederick and Klausmeier, 1968, among others). Steinhorst (1968) reported that giving subjects the instructional objectives of an assignment resulted in significantly better learning and retention of information on a fictitious map than a free-study group achieved, and at least equal performance to that of a group receiving a programmed sequence on the same information.

In the context of these studies the pretest experience in the museum application constituted an "advance organizer" and pre-exhibit definition of objectives which could have influenced the way that visitors assimilated, stored, and retrieved exhibit information. In any case, the fact that some visitors were able to learn simply by having the pretest experience suggested the possibility that a pre-exhibit self-testing situation might be developed to facilitate later learning from the exhibit without the need for the more costly programming of the exhibit itself.

A difficulty with the use of the pretesting experience alone, however, is the fact that relatively poor results were obtained for over 80 percent of the Ss under this condition compared with the M and AQ groups. The use of a printed set of instructions (E(I)-Condition) did not help, and the use of the booklet pretest (E(B)) made no difference. The results might have been improved by the use of feedback during pretesting on matched criterion questions, although this was not investigated.

Another possibility would be not only to provide some feedback during testing but also to encourage the visitor to retest himself *between successive* exhibit visits. In the E-Condition the visitor had only one exposure to the test situation prior to visiting the exhibit. Additional exposures to the testing situation could provide additional help in processing exhibit information, each self-test further sensitizing the visitor to what he should look for in the exhibit.

The self-test, recycling system to be discussed here concerns this possibility. The purpose was to provide a means by which visitors could test themselves on criterion questions, study the exhibit in terms of the framework provided by these questions, return again to the exhibit, retest themselves, and so on. Hence, the terms *self-test, recycling* system. If visitors could learn from such repeated self-testing, this would eliminate costly programming of the exhibit itself and substitute the visitor's own information-processing skills to reach the same end. Through successive self-testing, slower and less skilled persons might thus be able to "discover" those characteristics of the exhibit which were relevant to good test performance. This assumes, of course, that visitors would or could be motivated enough for the goal of performing well that they would repeatedly test themselves.

Experimental Studies

To evaluate such an approach, a coin-operated, self-test machine was developed and tested, with several variations, in a series of studies in the Milwaukee Public Museum and, more recently, in the Milwaukee Art Center (Silberglitt, 1972; Lakota, Screven, and Reis, in preparation). Figure 18 shows a recent model of the device, as used in testing at the Milwaukee Art Center.[5]

The self-test procedures found to be most effective to date using this machine may be summarized as follows:

(a) The test machine is placed near (but not at) the reference exhibit area, where visitors may freely approach it as part of their normal exploratory activity. If they touch the machine, a projector turns on and a "come-on" frame invites them to insert 10 cents to test themselves on the nearby exhibit's topic. An "expert medal" (a gold-colored token with "MUSEUM EXPERT" printed on it) is promised for a perfect score.

(b) Inserting 10 cents provides seven multiple-choice questions (from a pool of 50 to 100 questions), which are interspersed with nonquestion frames emphasizing that visitors can improve their scores by studying the exhibit. The game ends with a final frame inviting the players to study the exhibit and return to better their scores.

(c) Questions advance after each answer (regardless of correctness of choice). A counter (upper right-hand corner) registers 100 points for each correct answer.

[5] Modified from a coin-operated commercial quiz game. This machine has since been discontinued by the manufacturer. However, other systems designed to perform similar functions in museums are currently in development. For information, write to the author.

(d) The machine dispenses a silver token (regardless of total score) with the message: "ONE FREE PLAY, STUDY THE EXHIBIT AND TRY AGAIN." This free-play token, on all later games, is contingent on a score above chance.

(e) If, in any one game, the player answers all seven questions correctly, the machine dispenses the gold "expert medal," which may be kept or used for replay.

The gamelike appearance and the touch-activated "come-on" frame attracts the attention of passing visitors and encourages them to play. During play, advance of the counter provides feedback concerning correctness of answers as well as the final game score. The free-play token encourages the player to return for replays between exhibit visits. The gold "expert medal," received for a perfect score, is intended to encourage repeated efforts to achieve mastery. It is not expected that all players will achieve mastery before terminating the process. But it is expected that many players will *try* and, in the process, will achieve a higher terminal score than would otherwise be the case.

The initial prototype model (not shown) was similar in shape and operation to the test machine shown in Figure 18. However, the earlier model and self-test procedure differed in the following major respects: (a) there was no touch-activated "come-on" frame or other interspersed nonquestion frames, (b) an advance-on-correct mode was used in which questions could not be advanced until a correct answer was made, (c) there were four topic selection buttons which the player could use to select one of four question categories, and (d) additional feedback signals accompanied correct answers (a green light and a bell) and incorrect answers resulted in a red light, a buzzer, and a lowering of points obtainable for the next choice. The extra feedback was assumed to be necessary to sustain visitor cooperation and to provide corrective information.

Initial tests of the system utilized this prototype model at a general exhibit area in the Milwaukee Public Museum covering the topics of evolution, heredity, seed dispersal mechanisms, and animal age and movement. Four sets of 40 multiple-choice test questions were filmed for use in the prototype machine. Each pool of 40 questions was organized into successive five-question games. The player could select one of the four topics on which he wished to test himself by pressing the appropriate category button on the machine.

The test machine was placed about 20 feet from the reference area containing information about the four topics. Preliminary unobtrusive observations of visitor reactions, replays, and recycling were made over two-hour periods. These initial informal observations indicated the following: the machine attracted both younger and older persons to stop and examine it (or watch others play it); about 30 percent of the passing visitors in the two-hour samples stopped; about 25 percent of these played it; more younger than older persons played it, but the average age level appeared higher than the 14- to 15-year level of the programmed systems described earlier; family and peer groups often played the machine as a group. It was difficult to obtain exact data on individual recycling activity or resulting performance on questions. However, persons were observed going to the exhibit area and returning with the free-play token to replay. Some persons continued to replay without going to the exhibit. Use of the four category buttons posed difficulties. Changing categories from one play to the next was common and some persons changed categories *during* games.

These initial observations were followed by a more systematic study. The category buttons were removed. The machine was preset to present questions over a single topic: heredity. A picture of the reference exhibit was prominently displayed on the machine with the instructions: "STUDY THIS DISPLAY AT THE EXHIBIT AND WIN AN EXPERT MEDAL!" Sample questions used in this study are shown in Appendix F.

All data were collected as unobtrusively as possible by a single observer, who stood near the area observing the movements of players who approached and played the machine and recorded their game scores, etc. Not all persons who played in succession were selected for observation. Since it was very difficult to follow the actions of family and peer groups, these were excluded. Also excluded were children below about 12 years of age. Some players who had been initially observed were lost track of in subsequent plays and, therefore, information about them has been omitted from the data to be presented. Persons who replayed with 10 cents were also omitted. Observations took place over approximately two-hour periods under relatively crowded conditions on Saturdays and Sundays. The test machine remained on the floor when no observations were being made, but was unplugged.

A total of 32 persons were observed through to the point at which they either left the situation or achieved mastery. The results of these observations are summarized in Table 6. Of the 32 persons, 15 (about 47 percent) achieved

Type of Play	Total Avail. for Play	Did Not Return to Replay	Replayed Without Returning to Exhibit	Returned to Exhibit	Scores Achieved: Below 250	250-400	450-500	Mean Score
10¢ Play	32	—	—	—	12	19	1	225
Token #1	31	0	11	19	8	16	7	315
Token #2	16	3	5	8	1	8	4	365
Token #3	8	2	5	1	0	4	2	383
Token #4	4	1	3	0	1	0	2	

Table 6. Number of plays, replays, and scores obtained by 32 visitors at the self-quiz recycling machine on the topic of heredity.

mastery over four replays. One person achieved mastery on his initial (10 cent) test. Six persons ultimately achieved mastery by taking successive retests without visiting the exhibits. There was an increasing tendency during later replays to replay without returning to the exhibit. Of the 31 persons who did not achieve mastery on their first test, about 61 percent went to the exhibit prior to taking their first retest. Everyone replayed the test machine with their first free-play token. Six persons (8½ percent) eventually quit with a free-play token.

Because of the small sample, these results were tentative. But they were sufficiently encouraging for a decision to move ahead with further testing of the self-test system. This study was difficult to evaluate and pointed up a number of difficulties in achieving the objective of facilitating learning from exhibits through repeated self-testing. The questions used were not as dependent as they should have been on studying the exhibit, were too easy, and often trivial. By taking the initial five-question test, it was possible to learn enough to do better on the next five-question test which, in turn, taught more, and so on. It seemed reasonable that the advance-on-correct procedure contributed to this result since it provided feedback on wrong as well as correct answers. In fact, the feedback and advance-on-correct features made the machine into a rather effective teaching machine capable of teaching *independently* of the exhibit. Visitors gradually discovered this and, as may be seen in Table 6, an increasing proportion stopped visiting the exhibit between games and simply played the machine with successive replay tokens. It is difficult to say how much of the score improvement that did take place was due to the actual exhibit and how much to the teaching properties of the machine.

In a later series of investigations with more than 600 visitors in the Milwaukee Public Museum, Fazzini (1972) examined the effects of feedback, expert medal, free-play tokens, and other variables on visitor performance in the self-testing situation. These studies were conducted at the same primitive skull exhibit used in earlier investigations. A pool of 70 questions utilizing the formats and objectives of the earlier studies was prepared for use in a modified form of the self-test machine shown in Figure 18. Each game consisted of seven criterion questions matched for each of the original objectives listed in Chapter III (page 29). There also was added a touch-activated "come-on" frame and an end-frame suggesting that the player visit the exhibit to improve his score.

There is insufficient space here for a thorough treatment of the results of this series of investigations, which also included demographic data on visitor populations, viewing time data, a comparison of solicited and unsolicited groups, and other observations. The reader is referred to Fazzini (1972) for a more complete treatment of these investigations. We shall summarize here some of the results pertaining to the self-test machine variables and their relation to visitor persistence, recycling, and learning.

(1) As *Ss* continued to replay the test machine, the percent recycling (visits to exhibit between plays) gradually decreased from about 32 percent after the first play to about one percent ($n = 31$) after the tenth play. Table 7 shows the mean percent recycling for the first 10 plays. Neither feedback, free-play tokens, nor the gold medal incentive significantly affected the 32 percent recycling figure. The remaining two-thirds of the visitors continued to play the machine without visiting the exhibit. Playing the self-test machine apparently was reinforcing in its own right.

(2) There was a small but significant positive correlation ($r_{xy} = .30$, $p < .02$) between the amount of recycling and the score obtained on the last game before quitting (terminal score or *TS*) only for group MIN, which received no feedback after answering questions, and no score. The only knowledge they had as to how they were doing was whether or not they received a free-play token (which required three questions correct) or a

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Play	No. of Players	Returned to Exhibit	Percent Recycling	Mean Score
1	500	170	34	285.2
2	331	106	32	302.3
3	183	43	23.5	343.7
4	128	31	24.2	369.5
5	95	17	17.9	409.5
6	75	14	18.7	433.3
7	60	11	18.3	451.7
8	48	7	14.6	465.6
9	36	6	16.7	481.9
10	31	1	3.2	530.6

Table 7. Mean score and percent recycling for first 10 plays at self-test machine at skull exhibit (adapted from Fazzini, 1972).

gold expert medal (which required all seven questions correct). For this MIN group, the more visits to the exhibit between games, the higher the *TS* (terminal score). The amount of recycling did not correlate with the *TS* of those *Ss* who received any form of feedback from the machine (counter scores, green light on correct, etc.). However, feedback did significantly improve *TS* (see below), apparently because feedback was being effectively used by the players to learn the required information from the machine. The no-feedback players had no such advantage and *had* to utilize the exhibit. Although not discussed by Fazzini, it seems worth noting that the improvement in visitor performance resulting from the feedback conditions may have masked possible effects of the exhibit visits on the *TS*. In any case, the exhibit visits (recycling) added no more to the ability of *Ss* to perform than did the information they received via feedback while playing the test machine.

(3) Feedback conditions consisted of a "maximum" feedback (MAX) condition (bell, lights, buzzer, counter score for correct), an advance-on-correct (AOC) condition (no bells, lights, or buzzers but question advanced only after correct answer), and an advance-on-initial response (AOI) condition (feedback provided by advance of counter score on correct only). All of these feedback conditions resulted in higher *TS*. Figure 19 shows the decrease in *TS* as a function of decreasing feedback conditions, including the so-called MIN condition in which no direct feedback was available. Shown are both *TS* and initial game scores (IS). Figure 20 shows frequency distributions of *TS* for the three feedback conditions and the no-feedback group.[6] Note that for feedback groups, there was a sharp rise in the num-

[6] In the original Fazzini studies an additional feedback condition was run which placed the self-test machine *directly in front* of the exhibit. There were no significant differences in *TS* between this group and the regular AOC-Condition. For simplicity, this group was, therefore, omitted from the present discussions and is not shown in Figures 19 and 20.

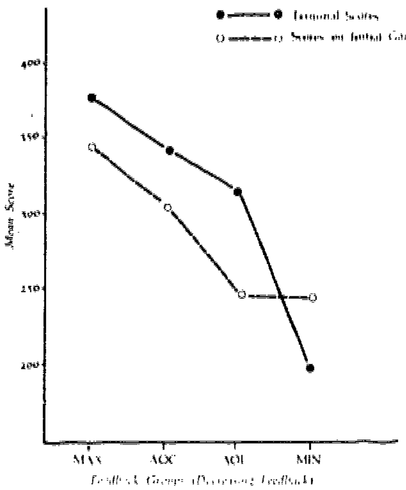

Figure 19. Initial game scores and terminal scores for each of four feedback conditions on self-test machine.

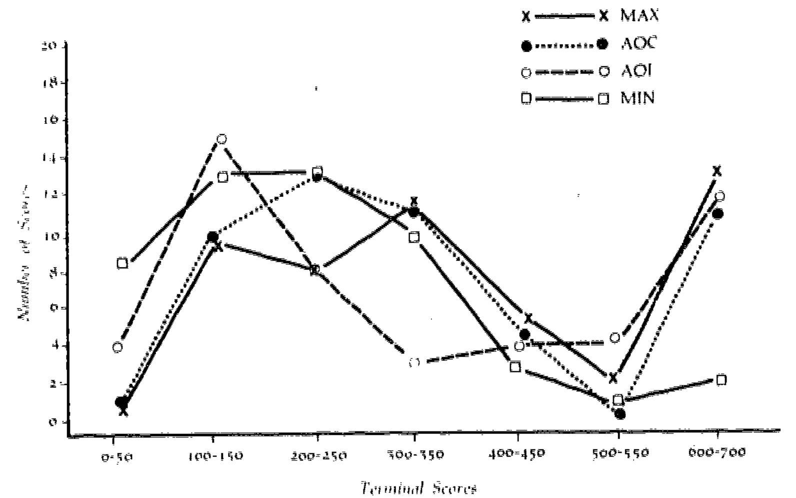

Figure 20. Frequency distributions of terminal scores for each of the four feedback conditions on self-test machine (adapted from Fazzini, 1972).

ber of mastery level *TS* (600-700) and no such rise for MIN. Only two *Ss* (four percent) in MIN reached the 600-700 level, while 11, 12, and 13 *Ss* in MAX, AOC, and AOI (22-26 percent) reached these levels. As noted earlier, *TS* performance of the MIN *Ss* depended upon the effective utilization of the exhibit during recycling. But only about one-third or less of the MIN *Ss* actually recycled. This might account for the lower mean *TS* of the MIN group because at least two-thirds of these *Ss* were trying to answer the questions with no relevant input either from the exhibit or from feedback.

(4) The use of feedback appeared to reinforce replaying the machine. All feedback conditions correlated significantly with the number of replays. The no-feedback condition did not. The number of replays did *not* correlate with *TS*.

(5) Use of the free-play token was significantly correlated with replays and with higher *TS*, which is not surprising. When tokens were omitted, replays were few and *TS* was the same as *IS*. Fazzini investigated the effects of lowering the criterion score required to obtain a free-play token from 300 to 200 points (two questions correct). This did increase recycling (from 16 to 26 percent), but unproductively, since there was no improvement in *TS*. Since the no-token group had to spend 10 cents for all replays, the replays for this group were, of course, sharply lower (mean = 1.5 plays). However, in spite of cost, about one-third of the 50 non-token *Ss* replayed at least once, one-third of these replayed a second time, and a third of these played a third time. One *S* replayed five times (without achieving "expert" medal).

(6) Use of the gold "expert" medal as an incentive for achieving a high score significantly increased *TS*, as well as the number of mastery-level (600-700) scores (Figures 21 and 22). These effects appeared to be inde-

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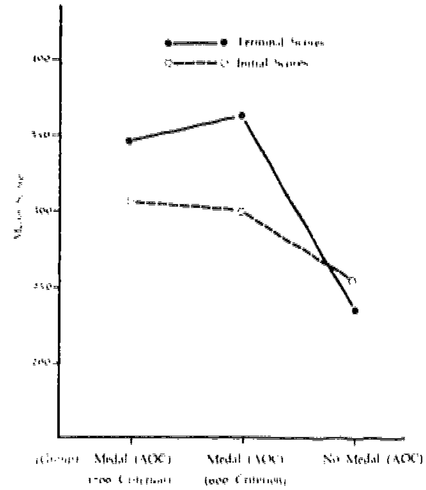

Figure 21. Initial game scores and terminal scores for the medal and no-medal groups on self-test machine (adapted from Fazzini, 1972).

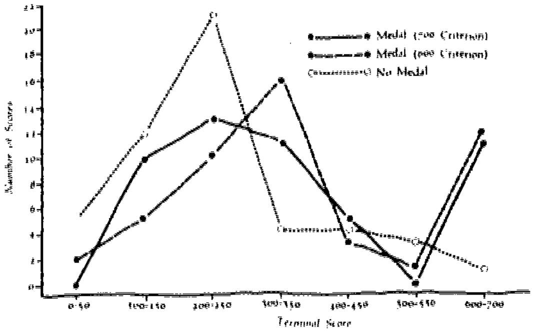

Figure 22. Frequency distributions of terminal scores for the medal and no-medal groups on self-test, machine (adapted from Fazzini, 1972).

pendent of number of replays or recycling. Fazzini investigated the effects of lowering the difficulty of obtaining the expert medal from 700 (all questions correct) to 600 (one question incorrect), but obtained no significant effects on *TS*. However, a breakdown of the 600- and 700-level scores for the two groups showed that the 600 criterion produced twice the number of 600-level scores and the 700 criterion produced nine (out of ten) 700-level scores. Thus, making the mastery score more (or less) difficult did not significantly alter the number of persons who attained it, but it did appear to alter how much the players learned in order to achieve it. Apparently the presence of a specific goal at some level was important. Thus, for the no-medal group, only two *Ss* (four percent) achieved a *TS* above 500, while 11 and 13 *Ss* (22 and 26 percent) working for the medal achieved scores above 500. The *TS* (and *IS*) for the 600 and 700 criterion groups and the no-medal group (n = 50 each) are shown in Figure 21. The frequency distributions of *TS* for the three groups (Figure 22) again show few 500-level scores and a sharp increase in 600- to 700-level scores only for the expert medal conditions.

(7) Fazzini reported that 14.6 percent of the unsolicited *Ss* in his studies achieved an expert medal and required from 1 to 28 plays to do this (mean = 6 plays). About 61 percent of these winners continued playing *after* receiving the medal. It was reported that some *Ss* actually had to be stopped or they might have continued indefinitely. The motivating properties of the test machine contingencies seemed clear throughout Fazzini's investigations. It is noteworthy that the "slower learners" in the various feedback and token groups who required 10 to 15 games to obtain the medal spent from 45 to 60 minutes at the task with no apparent loss of enthusiasm.

(8) While the self-test machine was inoperative, mean viewing time in a

predefined area of the skull exhibit (n = 66) was 19 seconds. Another study (n = 60) involved only visitors who first made eye contact with the exhibit (about 60 percent of those passing during observation periods). Mean eye contact time was 29.6 seconds. As Fazzini noted, it is doubtful if 20-30 seconds is sufficient to "learn" *any* concepts presented by the exhibit. Comparable exhibit time or viewing data for the self-test machine *Ss* were not reported. However, Fazzini did report up to 72 minutes spent at the exhibit (excluding machine time). From 1½ to 3 minutes were spent at the machine per game. Total exhibit times were estimated to be from 20 to 40 times the viewing time when the machine was inoperative.

In subsequent applications of the self-test machine at the Milwaukee Public Museum and the Milwaukee Art Center, modifications have included more nonquestion frames encouraging use of the exhibit, an advance-on-first response mode, and other procedures listed at the beginning of this chapter. Applications of the self-testing procedures in the Milwaukee Art Center by Silberglitt (1972) yielded posttest scores comparable to the use of programmed audio. However, this study provided no data on percent recycling. More detailed comparisons of the self-test recycling machine with other exhibit systems (audio, labels) have been carried out in more recent investigations at the Milwaukee Art Center by Lakota, Screven, and Reis (1974).

While these procedures resulted in the predicted recycling, the percentage of persons recycling was disappointing. Other approaches to the basic self-testing concept need to be investigated. Improvement in the machine procedures may be possible through additional modifications. For example:

(a) removal of all feedback on individual questions, providing only a total score at the end of each game;

(b) free-play tokens exchanged *at the exhibit* (from vendor) for replay tokens usable at the machine, thus requiring return to the exhibit area; and

(c) more interspersed frames which encourage the use of the exhibit and require answering questions concerning the recycling procedure.

Self-testing Without Machines

Use of the self-testing strategy may not require coin-operated quiz machines at all. Exhibit self-test questions could be printed on 3" x 5" or 5" x 7" cards with self-scoring and feedback capabilities. There are available commercially a number of simple, self-scoring materials which could be adapted for self-testing purposes in museums. For example:

(a) *Latent Image Response Cards*: Questions can be printed on these cards along with invisible markings for correct answers. Responses to each question consist of marking over the appropriate answer space with a special pen containing a nontoxic latent image developer. The pen leaves an indelible colored mark for scoring purposes which *changes color* if answer is correct, thus providing immediate feedback. Latent image processes are available from several manufacturers.[7] Hendershot (1973) provides an updated list of such systems.

(b) *Overlay Cards* (Figure 23A): These have overlays over answer spaces. Responses consist of erasing the overlay over the chosen answer; printed numbers or symbols appear which then indicate whether the answer is

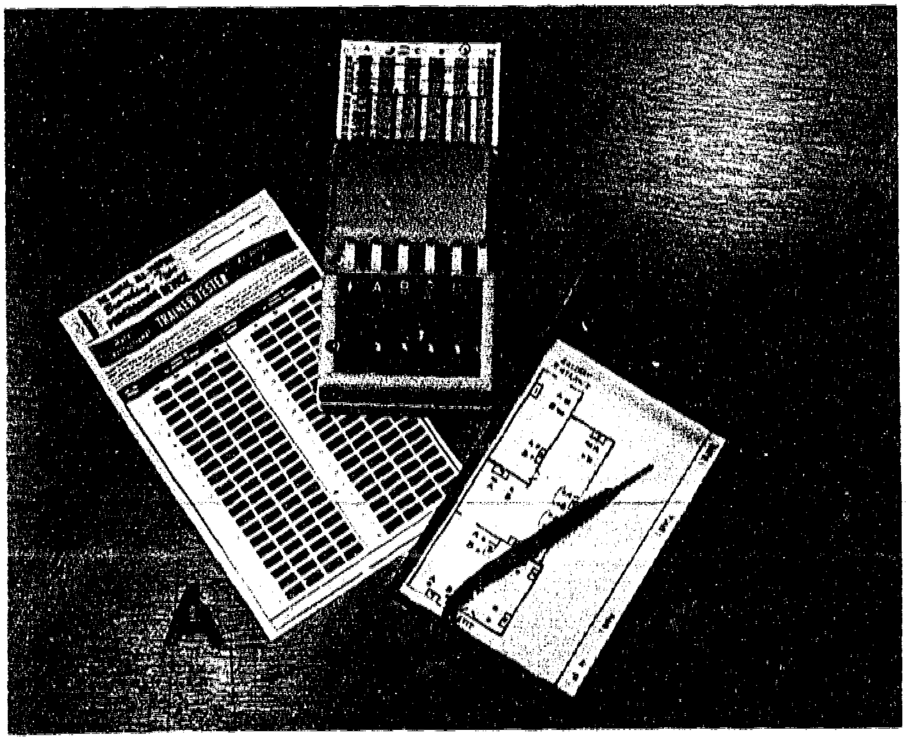

Figure 23. Self-scoring response devices: Trainer-Tester Card (A), Punchboard (B), and QRS Responder (C).

correct. Other feedback cards provide small tabs for each answer; tabs are pulled out to answer and colors reveal whether answer is correct.[8]

(c) *Punchboards and Mechanical Response Devices* (Figure 23B and C): Some systems utilize a stylus, pencil, or simple push buttons to punch answers in precoded cards inserted in simple mechanical devices. These systems are self-scoring. The small punchboard (Figure 23B) accepts a 4" x 6" card which contains answer choices that can be selected by punching them with a stylus. The stylus activates a light if choice is correct, or will restart an attached start-stop audio cassette. In this example, the answer card is coordinated with a "map" of an art gallery. Figure 23C

[7] For example, A. B. Dick Corporation Central Scientific Company (CENCO), Docent Corp., among others.

[8] See Hendershot (1973).

uses a prepunched IBM card which is inserted into the push-button holder. Pressing a button punches a hole in the card and advances the card if answer is correct. This device can also be coordinated with a start-stop audio cassette.[9]

For purposes of implementing a recycling strategy, such self-scoring systems could guide the visitor, via appropriate questions, to specific exhibit information and, through the immediate feedback and scoring, encourage the visitor to make productive use of this exhibit information.

For example, latent image quiz cards (with attached answer pens) could be dispensed from coin-operated vendors located at exhibits, or provided in packets to be taken along on exhibit tours. Each card would contain five to seven questions covering particular topics, answers to which had to be obtained from the exhibit, or series of exhibits. Unlike the self-testing recycling machine situation, users could directly match their possible answers to the exhibit's information before answering. Thus, the questions would require recognition rather than recall.

Following each answer, color changes or other feedback on the card would indicate if the chosen answer was correct. If not, further choices would be made. In order to encourage *repeated* efforts to produce an errorless card, an "expert medal" or other suitable incentive could be made available by museum staff for a given number of errorless cards obtained from the same or from a variety of exhibits.

Unfortunately, the feedback feature of these quiz cards might also produce the same effect as the feedback on the recycling machine, *viz.*, encouraging learning from successive quiz cards rather than from the exhibit! If the use of such quiz cards is to facilitate productive self-study of the exhibit, then, ideally, the exhibit should be the *only* source of information for achieving the high score which the user is seeking.

One way of achieving this would be to use a *different* set of questions and test different exhibit information on separate quiz cards. This would reduce the chances of the repeat user obtaining successive cards on similar information, thus removing the advantage of accumulating related information from card to card. Thus, the exhibit would become the *only* available reliable source for the information necessary to avoid errors. If the visitor is adequately motivated to avoid errors on any single card (in order to obtain mastery token, etc.), he must "search" the exhibit for the necessary information, make comparisons, identify relationships, draw conclusions, and so on. This is the kind of activity which is likely to lead to more effective utilization of the exhibit and to productive learning.

It is interesting to note that such a system imposes a contingency which would distinguish between adequate and inadequate observing behaviors. Thus, the immediate feedback after a *correct* answer to a question would reinforce the *adequate* observing behavior that just preceded it, while the feedback following errors would encourage changing the *inadequate* observing behavior that preceded these errors. Since the subsequent card consists of an entirely

[9] See Hendershot (1973).

new set of questions, there would be little benefit from the previous card's feedback, except possibly an improved skill in observing and processing exhibit information. These possibilities are currently under investigation by the writer.

Another way of avoiding the cumulative effects of repeated question feedback would be to use quiz cards which do not provide feedback on individual questions. For motivational purposes, a total score would still be needed. This would require some means of scoring completed cards, such as card readers or print-out systems, which would impose some expensive mechanical complexities. Also, no feedback response devices would mean that adequate and inadequate exhibit observing behaviors could not be discriminated immediately after they had occurred.

In summary, work still needs to be done to determine how best to aid visitors to utilize *unprogrammed, fixed* exhibit information productively. Possibilities include self-testing systems via automated, coin-operated question machines, self-scoring quiz cards, punchboards, and visitor orientation and goal-setting systems (discussed below).

The self-test recycling machine studies clarified the importance of feedback and achievement incentives such as the "expert medal" for learning. Many visitors were readily motivated to repeatedly test themselves on exhibit criterion questions and invest considerable time and effort to achieve specific learning goals. However, many visitors preferred learning the necessary material from the machine rather than from the noninteractive exhibit. More systematic investigation is needed to determine how this can be overcome for purposes of obtaining visitor-exhibit interaction, and to establish more clearly the effects of various self-testing systems on visitor performance and their practicability and cost-effectiveness in comparison with alternative approaches.

Visitor Orientation and Goal Setting

Additional approaches for helping the visitor make productive use of exhibits include: (a) pre- or postexhibit orientation areas which provide important background concepts and perspectives and (b) goal-setting systems for helping the visitor to establish specific learning goals prior to entering an exhibit.

Orientation areas, adjacent or parallel to major exhibits or galleries, could contain interactive audiovisual teaching machines, computer-based displays and response terminals, sound-slide presentations, single-concept super-8 cartridge film presentations, films, etc. As stated earlier, the recycling studies indicated that the recycling self-test machine was highly effective in holding visitor attention, often at the expense of the reference exhibit. In orientation areas these attention-holding features of responsive machines, including computer-based displays and response terminals, could be put to good use in securing the attention of visitors to self-contained 5-15-minute self-instructional units presenting overviews, important principles or historical perspectives, developing technical or scientific procedures, perceptual sensitivities of importance in viewing art objects, attitudinal shifts, and so forth. When visitors are exposed to such materials either before or after visiting a major exhibit or gallery presentation, this background could help them organize, reorganize, and process what they have seen or are about to see. Further discussion of some of these possibilities will be found in Chapter V.

Goal setting may provide another important element in helping visitors organize and process exhibit or gallery information more effectively. Results of condition E comparisons in the earlier skull studies suggested that pre-exhibit tests and lists of instructional objectives added to the ability of some visitors to achieve high posttest scores. If goal setting is important, the task is to determine how visitors can identify specific (learning) goals around which they can productively organize their exhibit explorations.

Some would say that identifying specific learning goals *for* the visitor would necessarily restrict his activities. But this need not be so, nor should it be. As noted in Chapter I, an attractive feature of the museum is its lack of coercive, structured systems. The ability of the visitor to explore freely and to personalize his activities should be kept intact so far as is possible.

But the task also is to help the visitor to make his explorations productive. As has been indicated, this is less likely without some "purpose" for such explorations; that is, without some kind of learning goal. Such goals can be made available to the visitor in various ways. The self-test recycling machine was one way of doing this, although, in this case, the visitor could not choose among alternative goals. Research is needed to establish some of the effective conditions and limitations of various possible visitor goal-setting procedures. The following are offered as examples of some of the possible approaches:

(a) Visitors could explore among visually presented topic "previews" (cafeteria style) in museum lobby areas. From these he could select whichever one he wishes for more detailed examination at the appropriate exhibits. After selecting a topic-goal he would receive a map, a list of learning objectives, and, perhaps, some self-scoring quiz cards to help him make productive use of the exhibit materials.

(b) Visitors could be provided a "decision-tree," via a small computer, which would allow the visitor to narrow down topic areas for possible investigation. The computer presents a series of successively narrowing, branched choices, each ending with some specific objective (learning tasks) in the selected topic area along with necessary guidance materials. For example, Figure 24 shows a successively branching series of choices (decision tree) involving Indian paintings before 1900. The visitor eventually selects an objective at the level of detail he desires. Having selected the desired level, he is then given several choices at this level. After his final choice, he receives a map, along with other learning aides. In the case of controversial or alternative approaches and viewpoints on the handling of specific topics, the branches could allow choices among these alternative approaches.

(c) The physical design of "exhibit spaces," arranged in mazelike fashion, could also provide a decision tree for the visitor to establish learning goals. Upon entering the "maze," the visitor would move through a sequence of branching rooms, each of which would present him with decisions concerning topics, goals, level of generality, difficulty, etc., in much the same manner as the computer method described earlier.

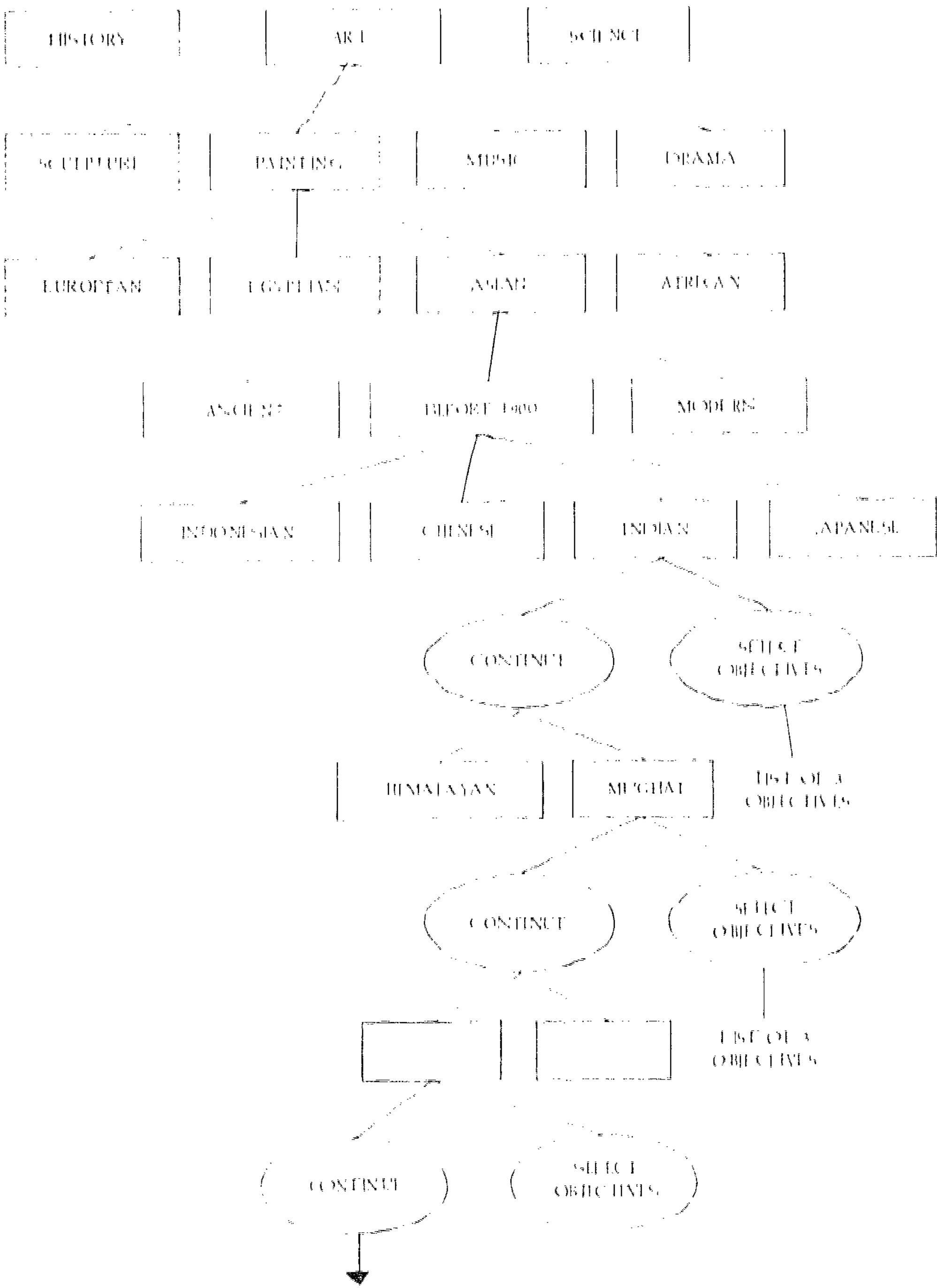

Figure 24. Decision tree for successively branching visitor choices in establishing "goals."

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Discussion and Conclusions

Progress in recent years in the use of programmed learning, responsive teaching machines, and computers for instruction in more formal educational and training situations has led to the general acceptance of such technologies as a basis, at least in principle, for improving the efficiency of instruction. The present project has raised the question as to whether such systems might also be utilized for educational and communication purposes in public access environments such as museums, zoos, botanical parks, shopping centers.

The results of the studies reported here have indicated that substantive learning *can* occur in the public museum (one type of public access environment) through the use of responsive systems such as audio cassettes and question-answer devices at exhibits.

A responsive exhibit is one in which the viewer, as he proceeds through each conceptual step, does not simply "look" at something, but is required to respond in some specific manner to what he thinks he sees or understands, receiving correctional feedback about his response. A response of some sort is important because the actions necessary to answer a well-designed question *direct* the viewer to those features of the exhibit (size, shape, color, order, etc.) which are important links in the new learning to be developed.

Through the use of pre-posttests our experimental results suggest that a museum exhibit, or exhibit system, can be subjected to the same kind of evaluation in terms of terminal visitor performance as any would-be instructional or communication procedure. Data from the many museum visitors who participated under various exhibit conditions suggest that the effectiveness of any exhibit probably depends upon the same considerations that determine the effectiveness of any instructional procedure; *viz.*, careful definition of the desired learning outcomes of the exhibit, communication of these goals to both the exhibit designer and the would-be visitor-learner, two-way interaction between the learner (visitor) and the exhibit, frequent feedback to define progress toward a goal, testing and revision of the exhibit system based on actual visitor performance, and so on.

In Chapter I we described the museum as an attractive, open learning environment, but one with some inherent problems which lower the likelihood that effective communication and learning will take place within it. Among these were heterogeneity of the museum audience, the absence of any particular learning goal on which the visitor can base his exploration, the essentially passive, one-way nature of most exhibits, which are not, or cannot, be responsive in any way to their viewers. The methods employed in this project have attempted to deal with these difficulties in three ways:

(1) employing interactive or *responsive* systems (punchboard and audio) which focus the visitor's attention through successive steps toward a specific learning outcome;

(2) employing pre-posttesting devices to measure the outcome of the visitor's exhibit experience in relation to predefined instructional objectives; and

(3) use of a recycling procedure, described in Chapter IV, in which a self-testing device measured the learning that occurred, provided visitors feedback and motivation to devote the effort necessary for learning, and (theoretically at least) encouraged visitors to process the exhibit information on their own.

Audio and Punchboard Studies

The studies using the punchboard-audio system to focus and control the attention of the visitor indicated that the system was most effective in attracting the younger (below 18) person and holding his attention. The system produced significant learning in at least half of the participants and was able to bring approximately 40 percent of the participants to a mastery level (92-100 percent) of posttest achievement.

It would not be correct to conclude that it did this with a representative sample of all museum visitors. Only about 25 percent were adults and the data were based only on those persons who were attracted by the test machine, punchboards, signs, etc. Therefore, our population was, perhaps, a more "motivated" group, more ready to cooperate and more ready to learn. But whatever their characteristics, they represented a large proportion of the younger persons who passed near the exhibit areas.

The use of overt responses to questions, via the punchboard, with immediate audio and visual feedback to correct answers, was initially believed to be necessary to obtain the sustained attention and cooperation of noncaptive, voluntary visitors. However, from comparisons of the so-called M and AQ conditions in both the skull exhibit and the animism exhibit, this proved not to be so. The use of the audio cassettes without the punchboard and with the questions asked vocally worked as well in producing high level posttest performance as having the questions answered on the punchboard (Figures 8 and 9). Further investigation is needed to determine if some kind of response device coordinated with audio may be more effective in some situations. The present application involved only a single exhibit and a simple set of objectives. Overt responding may be needed for more complex discriminations, more difficult questions, or when a series of exhibits are involved over a longer time span.

The role of the questions themselves, when presented on the audio cassette, also requires further study, although the results obtained in these studies favored better performance when questions were used. Much needs to be done in establishing *which* specific properties of audio (re Chapter I discussion of audio on page 17) have facilitative effects, with and without the use of attention-controlling questions. The audio scripts used in the skull study were not well suited to do this.

Most visitors exhibited little, if any, learning from the exhibit when they had no guidance devices and no pre-exhibit test or other knowledge of what was expected of them (the E(NP) situation, Figures 11 and 17). This result does not augur well for those museum educators who believe that the static museum display, if carefully designed and artistically arranged, will "communicate" the ideas contained therein to the interested visitor. There were no differences between the normal pretest performance and the posttest performance of those who had studied the skull exhibit without aides or a prior pretest.

On the other hand, some learning *did* occur under these conditions (Study 6) at the animism exhibit, although the results were significantly poorer than under other exhibit conditions. The animism exhibit was more clearly related to the requirements of the posttest questions, its labels were shorter and to the point, etc.

The latter result points up the important role of the physical design of the exhibit and its pertinence to specific instructional goals. Obviously, the physical design, the simplicity of an exhibit's instructional goals, the clarity of its labels, etc. can influence whether some particular instructional goal will be communicated (i.e., result in a measurable learning outcome). But, at best, the use of a static display without predefined goals, discrimination responses, feedback, orienting pretests, or the like will greatly limit the subtlety of the instructional material which can be communicated and the number of persons who are likely to profit from it. On the other hand, a well designed display, carefully tied to instructional objectives, is likely to greatly simplify the systems for helping the visitor to process its contents.

Concerning the retention of the learning provided by the experimental learning systems, Study 4 attempted to determine if the learning that took place under the M, AQ, and E conditions at the skull exhibit would be retained after 2 to 16 days. The results supported our expectation that the learning would be retained. Each group maintained its previous level of posttest performance over the 16-day period.

In Study 3 the amount of learning that occurred while visitors looked at the exhibit *without* the audio or the punchboard was significantly facilitated by taking a pretest (E and E(B) conditions). This was the case even though no feedback or other knowledge was given on pretests. From 15 to 20 percent of the visitors who took the no-feedback pretest prior to studying the animism or the skull exhibits on their own achieved 92-100 percent posttest performance.

Although the overall effectiveness of the pretest was less than when the audio or punchboard devices were used (Figures 10 and 16), the pretest experience apparently helped some visitors to process effectively relevant information from the exhibit on their own without benefit of programmed materials, audio, etc. The pretest may have helped provide for these persons a specific instructional goal which then became the basis for studying the exhibit. For example, having seen questions about ordering the skulls according to age, some visitors subsequently examined the skull orders, and so on. However, it should be pointed out that the exhibit itself may not have played a role in these results. No control group was run in which visitors took the pretest and then (after a comparable interval of neutral activity) took the posttest without visiting the exhibit. It is possible that the improvement in posttest performance was the result of the pretest and not the exhibit visit, although the lack of pretest feedback makes this unlikely.

Providing visitors with an idea of what they were supposed to learn, what to organize, etc. might also be accomplished by means other than a pretest. Our substitution of a simple statement of objectives on a card in place of the pretest (condition E(I)) is one such approach. This method also resulted in significant improvement over normal pretest performance.

These and other methods for providing exhibit "previews," pretests, and instructional objectives and goals need to be carefully investigated. The "recycling" self-testing procedures discussed in Chapter IV are but some of many possibilities here.

In general, the results of these studies support the position that to reach the majority of casual visitors to large public museums, and to extend the complexity and depth of the exhibit information to this group, some sort of "control" over visitor "observing behaviors" is necessary so that productive attending is "rewarded" and nonproductive attending is discouraged (Chapter I). Individualized programmed audio-cassette tapes with or without a response device is one way of achieving such control and a high level of terminal performance in the majority of visitors who participate.

Other possibilities for controlling such activities include the "recycling" systems described in Chapter IV, the use of portable response and self-testing devices such as those described in Chapter IV, public access "teaching machines" in orientation centers adjacent to main exhibit areas, interactive electronic exhibits, computer terminals at or near exhibits, and visitor goal-setting systems.

Portable Response Devices

In Chapter IV the use of self-scoring quiz cards with built-in feedback was suggested as a simple, nonmechanical means of facilitating learning through repeated self-testing. Such self-scoring cards (see Chapter IV for descriptions) also could be used to present a short series of *teaching* frames to shape exhibit discriminations around predefined concepts. Each frame could pinpoint visible exhibit features (shapes, colors, ages, sizes, structures, names) and ask the user to compare, relate, identify, name, choose between, or make some other specific response.

Following the example given in Chapter IV, 5" x 7" cards could be dispensed at exhibits, perhaps from coin-operated vendors, or given out as part of exhibit tours. Each card could contain a series of question frames for a single conceptual objective in the exhibit. Or a pack of such cards could develop more complex concepts utilizing a series of exhibits.

Another simple way of providing for responding and feedback would be to use, without audio, simple electromechanical question-answer devices, such as the punchboard of the present studies, or devices such as used by White (1967) at the Lawrence Hall of Science. While we accompanied our punchboard with coordinated audio to provide a simple means for attention control, we did not investigate the possible effectiveness of the punchboard alone. Theoretically, at least, printed programmed response materials, without audio, should be able to yield good visitor performance when carefully integrated with exhibit information.

There are, on the educational and training devices market, an increasing number of low-cost, portable response devices which provide feedback and automatic scoring capability. A continuously updated list of such devices (as well as nonmechanical response and testing devices) may be found in Carl Hendershot, *Programmed Learning: A Bibliography of Programs and Presentation Devices* (1973). (See also Intelek, 1969.) Some of these devices would be readily adaptable to applications in public museum and gallery settings.

In Chapter IV a number of simple, self-scoring response devices were described and Figure 23 shows examples of three of them. Some of these response devices (e.g., the QRS Responder in Figure 23C) serve only as an answering and feedback-scoring unit for questions which must be provided at or in the exhibits themselves or in some other source. Other devices can include the questions themselves, such as the punchboard (Figure 23B) and others.[16]

It is important to distinguish between response devices that simply provide feedback as to whether or not an answer to a question is correct and devices that also provide a record of right and wrong answers. The former (feedback only) devices simply give the user right-wrong signals (green light, tone, etc.); the latter (self-scoring) devices, in addition to providing feedback, also record every response by punching a hole, making an ink mark, advancing a score, etc.

A permanent record of visitor responses is important, not only for program evaluation purposes but also to motivate the user to attempt as high a score as possible. Incentives for high performance could be similar to those used in our recycling studies. For example, visitors obtaining a high score on the IBM card of the QRS Responder could, if they wished, turn it in for an "expert" token or other reinforcer found to be effective. Comparisons of the medal and no-medal groups in the recycling studies indicated the importance of such incentives in encouraging persistence and high-level performance (see Figure 22).

Public Access Teaching Machines

The results of the recycling studies indicated that learning from the machine itself was more popular than utilizing the exhibit for learning. Two-thirds or more of the participants remained at the self-test machine for repeated replays. Over 14 percent managed to achieve a mastery token without visiting the exhibit. While this posed a problem when the purpose was to encourage learning from the exhibit rather than the machine, it suggests that responsive audio-visual machines might be useful information resources in their own right. In history and science museums, for example, they could teach important back-

[16] See Hendershot (1973).

ground concepts for exhibits, provide supplementary information, fill conceptual gaps in the exhibit's resources, add indepth treatments, present overviews of museum collections, and so on. In an art gallery, they could help develop perceptual sensitivities, develop social and historical perspectives in art, teach how art objects are made, and so on.

Unlike the recycling machine, teaching machines could provide a self-contained instructional package, relating to nearby exhibits but operating independently of them. Of course, they would have to be located so that they would not interfere or compete with the normal viewing of museum exhibits, perhaps adjacent to main exhibit areas, serving simply as another area for museum exploration.

The teaching machines could, and probably should, incorporate many of the features of the recycling machine—frequent questions, self-paced responding, feedback, scoring, free-play tokens and, if needed, special "expert" tokens for high performance. Many of the questions, however, would be leading questions designed to elicit discriminations, provide practice and step by step guidance toward a specific learning objective. Learning objectives, of course, would be limited to those which could be reasonably achieved by short instructional programs of from 5 to 20 minutes.

To discourage random playing and help meet operating costs, the machines could be coin-operated on the first play while free replay tokens or free games could be earned for moderate scores to encourage replays for those who need them. Mastery "expert" tokens for high performance might be necessary for the longer and more difficult programs.

The costs of such devices, modified for public access, would not be prohibitive, and probably could be justified in terms of the contributions which they could make. A number of responsive audiovisual devices now on the market could be adapted for public access use in museums (see Hendershot, 1973). The costs of custom-programmed materials for use in such machines, however, would be high and perhaps beyond the current budgets of most museums. Some off-the-shelf programs, or sections of programs, currently available from publishers, concern topics which could relate to various museum exhibits. Programmed materials are available on hundreds of topics (Hendershot, 1973) from art history to atomic physics. Many of these are in booklet format, but could be adapted for use in responsive audiovisual teaching machines. The costs of adapting such off-the-shelf materials would be far less than custom-developed materials.

Programmed Interactive Exhibits

The studies reported here were limited to audiovisual materials and adjunctive testing situations for use with fixed, unprogrammed, unresponsive exhibits. Visitor attention, questioning, responding, and feedback were all provided independently of the exhibit itself.

Another possibility is to incorporate interactive teaching-learning principles into the physical exhibits themselves. To do so, it would still be necessary to define instructional objectives, analyze and arrange tentative sequences of instructional elements, provide for visitor responses, and arrange for step progression and feedback, testing visitors at each stage.

Sequencing, responding, and feedback could be built into the physical exhibit itself, with electronic programming circuits providing the appropriate sequencing of lights, slides, panel movements, etc. Possibilities for presentation and sequencing of questions include rotating question panels, slides, spotlighted questions, audio, TV monitors, etc. Multiple-choice push buttons, when activated, would require a correct choice in order to advance the exhibit to the next stage. Various parts of the exhibit could be coordinated with questions and visitor responding via spotlights, moving panels, audio, color-coded areas, etc. The exhibit and viewer might be linked together by means of small computer terminals located at or near main exhibit areas from which visitors could obtain instructions, answer questions, *ask* questions, test themselves, etc. Interactive exhibits obviously would be expensive to build and to maintain.

As pointed out in Chapter I, push buttons, panel questions, or elaborate moving exhibit elements operated by visitors do *not* necessarily constitute an effective exhibit in which learning is likely to occur. Most museum people are familiar with the frequent use of buttons and manipulative gadgets as part of exhibits in science museums and technical exhibitions. Unfortunately, in interacting with these buttons and gadgets, visitors seldom are required to discriminate between important elements in the display, much less receive differential feedback correlated with correct and incorrect responding. In fact, the visitor behaviors generated by these buttons seldom go much beyond the generation of more button pushing and statistics showing that visitors are spending more "time" at the exhibits.

We would warn exhibit planners against the careless use of buttons and gadgets simply to provide responses for visitors. Responding is of no value unless the response is in some way related to understanding the exhibit's message; that is, to the ability to compare or discriminate between objects, statements, actions, etc. which relate to the exhibit message. Buttons and other forms of responding are helpful when they require the visitor to use exhibit information correctly in order to determine which of several buttons to press. The button should then produce different results (feedback) for a "correct" choice (for example, advance of tape, a green light, a changing exhibit panel) than for "incorrect" choices. In other words, the visitor should not be able to "play" gadgets without appropriate attention to and understanding of the exhibit. To be sure that a visitor "sees" what you want him to "see," it is a great help to ask him to *do* something, *the effect of which* requires that he has in fact seen it! Buttons are sometimes a convenient means of doing this. But, if the purpose is some kind of instructional communication, we would discourage their use unless they do perform this function.

An interactive exhibit need not involve electronic gadgets. Interactive properties could be built into the arrangement of physical spaces. As an example of such a possibility, the author in a recent paper (Screven, 1974a) described an interactive exhibit designed as a series of multiple "T-mazes." To quote from this paper:

Consider a one-way interpretive exhibition arranged as a series of small "halls" separated by "choice points." *Display information is presented in th[illegible], each of* which leads to a choice point. At *each* choice point, a "teaching q[illegible] is clearly spotlighted on the wall, along with *two* alternative "answers." Ch[illegible]; the correct answer requires the visitor to effectively integrate the facts, labels, artifacts, concepts, etc. presented in the hall. If he chooses answer 1, he goes down the path to his left; if he chooses answer 2, he goes down the path to his right. Correct paths lead to the next hall and a new 2-choice question building upon the information in the previous hall. Incorrect paths lead to "dead ends," which contain additional display materials designed to "explain" and to correct the error. The "dead end" would return the visitor via a separate path back to the original hall where he could again look at the display materials and the question that he missed. Another possibility for handling his return from this "dead end" would be to provide at the "dead end" area a second 2-choice, remedial question which, if answered correctly, would lead the visitor back to the original hall, or if answered incorrectly, would lead back again to the "dead end" area.

There are many interesting possibilities for designing exhibit spaces so that the path taken by the visitor will depend on his "understanding" and effective use of the display materials. Such methods would provide similar kinds of "control" over visitor attention and learning as provided by responsive electronic exhibits.

The Potential Role of Computers in Museums

The possibility of providing programmed, interactive exhibits raises the topic of computers and the possibilities of going beyond the concept of programming the communication of single concepts in a single display. The vast capabilities of the computer raises the possibility not only for developing individualized learning systems around individual exhibits, but for harnessing the entire museum as an open, responsive, learning environment. With its vast memory potential, its capabilities for high-speed information retrieval and data processing, and for problem solving and simulation, the computer has immense implications for realizing the full potential of the museum as an open learning environment.

To date the computer's role in museums has been almost nonexistent. Where it has been even considered, discussion has centered on the computer's role for record keeping and administrative functions. But the real potential of the computer's capabilities is as an *instructional* device. Thus, the computer could mobilize all of the resources of the museum to meet the individual learning needs of the visitor; it could converse with him, challenge him, test and evaluate him, relate his interests to exhibits, and help him explore their implications.

The computer could not only provide direct instruction on particular topics but could also develop the visitor's abilities for inquiry and investigation, using the museum's exhibits as the framework for such activities. It could challenge the visitor to explore the museum environment to achieve specific learning goals and manage his movements and exploratory activities so as to maximize the chances of his achieving his goals. The computer could provide learning experiences in its own right that could develop new perspectives, new skills and interests. The computer could simulate a political or social system or a historical event, requiring the visitor to ask a series of questions, organize facts, apply principles, predict consequences, discover defects, evaluate decisions, and so forth. It could even referee problem-solving activity in simulated social, political, economic, and other situations. Thus, the computer goes beyond the "teaching machine" or programmed exhibit system because, unlike the ordinary programmed learning situation, the computer is not limited to a set of finite "correct" responses, but can provide for "open-ended" responses, carry out dialogues, and so forth.

Conclusions

In conclusion, these experimental investigations provide some support to the idea that substantive, productive learning *can* occur in the public museum and that museum exhibits probably are subject to the same kind of evaluation as any would-be instructional or communication system. We would *not* wish to conclude that the specific procedures employed in these studies, such as auto-stop audio cassettes, punchboards, or self-testing machines, are *the* answer to better museum communication. Some sort of control over visitor attending behaviors apparently is needed along with better visitor motivation and opportunities for goal setting. But much investigation—hopefully experimental—still needs to be done on the uses of audio, visitor response systems, testing systems, and the many other possibilities for facilitating learning in public museums. The possibilities abound in the literature on museum behavior, but little has been done to systematically implement and experimentally evaluate these many possibilities. (See Goldman, 1970, for a variety of possibilities reported at a conference on museum science education.)

The critical need at this stage is that experimental research *is* done. The highest priority should be given to the development of practical means for objectively monitoring the museum visitor and what is being communicated to him. Some of these objective measurements will necessarily have to intrude on the visitor's normal movements within the museum at various times. Visitor measurement may include structured interviews, rating systems, and objective testing formats with multiple-choice and matching questions. But also, hopefully, reliable and useful methods can be developed which are unobtrusive (see Anderson, 1968, and Webb et al., 1966).

But if this is to be done, museum administrators must find ways of encouraging their staffs—particularly those who work at planning and preparing exhibits for the public—to practice a more directly empirical and experimental approach as part of their regular efforts to find out what visitors actually *do*, or can do, after they have been exposed to their exhibitions and displays. An important first step in this direction would be for museum planners to become more familiar with the existing facts and principles on human learning, human motivation, and instructional systems design. The reference section includes some basic introductory materials which may be helpful to the reader who wishes to make a beginning in some of these areas.

One final word. Throughout this monograph, we have used the term "technology" in connection with facilitating teaching-learning functions in museums. For many museum professionals, especially in art museums, the term "technology" is out of place. There is concern that technology and gadgetry, for example, might overshadow the "self-discovery" process presumed to be going on for many museum visitors. And might not technology change the emphasis of many museums from "educational enrichment" to simply high-class amusement centers? The answer is that, indeed, it might (and in some cases already has). But it is important to note that the "technology" of which we have been speaking was *not* intended to mean a technology of gadgets, but a technology of *analysis*; that is, a way of defining and implementing the instructional process. If effective communication in museums is accepted as an important goal of museums, then this "technology" of analysis can be of help in providing a systematic, empirical basis for analyzing and coordinating museum resources *and* media to assure that these resources *do* communicate worthwhile messages to a reasonable proportion of visitors.

VI. Appendixes

Appendix A

PUNCHBOARD QUESTIONS: SKULL EXHIBIT

The 16 questions on the skull program were used as a single sheet on the punchboard. Each question was accompanied by the audio script for the M-Condition (see Appendix B).

1.	THE PART OF THE SKULL THAT CONTAINS THE BRAIN IS CALLED THE ________ AREA OF THE SKULL. ○ BACK	○ CRANIAL	○ CEREAL	○ TOP
2.	○ EARLY MAN	○ NEANDERTHAL MAN	○ NEO MAN	
3.	○ TRUE	○ FALSE		
4.	○ MORE POINTED	○ LESS POINTED		
5.	○ EARLIEST MAN	○ CRO MAGNON	○ HOMO ERECTUS	
6.	○ SAME SIZE	○ LARGER	○ SMALLER	
7.	○ AUSTRALOPITHECUS	○ HOMO ERECTUS	○ EARLY MAN-APE	
8.	○ SMALLER	○ LARGER	○ SAME SIZE	
9.	○ JAVA MAN	○ RAMAPITHECUS	○ AUSTRALOPITHECUS	
10.	○ LARGER	○ EVEN SMALLER		
11.	○ SMALLER	○ LARGER		
12.	○ NO PARTICULAR ORDER ○ THE OLDEST ON YOUR LEFT TO THE MOST MODERN ON YOUR RIGHT ○ THE OLDEST ON YOUR RIGHT TO THE MOST MODERN ON YOUR LEFT			
13.	○ RAMAPITHECUS	○ NEANDERTHAL MAN	○ AUSTRALOPITHECUS	
14.	○ HOMO ERECTUS	○ MODERN MAN	○ RAMAPITHECUS	
15.	○ NEANDERTHAL MAN	○ AUSTRALOPITHECUS	○ MODERN MAN	
16.	○ AUSTRALOPITHECUS RAMAPITHECUS HOMO ERECTUS NEANDERTHAL MAN MODERN MAN	○ RAMAPITHECUS AUSTRALOPITHECUS NEANDERTHAL MAN HOMO ERECTUS MODERN MAN	○ RAMAPITHECUS AUSTRALOPITHECUS HOMO ERECTUS NEANDERTHAL MAN MODERN MAN	

Appendix B

AUDIO SCRIPTS FOR SKULL STUDIES

1. *Audio Script, M-Condition.*

We're going to find out about the Age of Man Exhibit. Look at the panels in front of you. There are many skulls on the panels and they aren't all the same! Some are different from others. The skulls have large white letters above their heads. Look at the panel farthest to your right. The skull on that panel has the large white letter A above it. That's the skull of Modern Man, the kind of skull that people have today. Take a close look at Modern Man's skull. The back of his skull and the part that is above the jawbone, and in back of the eyes, is the part that contains the brain. That is called the cranial area of the skull. Now answer question 1 on your answer sheet.

Good! The part of the skull that holds the brain is called the cranial area of the skull. That's the back of the skull and the part that's above the jawbone and behind the eyes. Take a good look at Modern Man's skull. The cranial area of Modern Man's skull is large and makes up a big part of the skull. Now look at the panel just to the left of Modern Man. That panel has a skull with a large white letter B above it. The name of this skull is in large white letters at the top of the panel. What is its name? In question 2, name skull B.

Right! This is the skull of Neanderthal Man, Modern Man's most recent ancestor. Neanderthal Man was the first form of man to have a brain of modern size. Since his brain was the same size as that of Modern Man, what does that tell you about his cranial area? Compare the skull of Neanderthal Man with that of Modern Man. Do their cranial areas differ very greatly in size? Look closely at these skulls and listen very carefully because here comes question number 3. Is this statement true or false? Since Neanderthal Man's brain was about the same size as that of Modern Man, his cranial area must also be almost as large as that of Modern Man.

You're right! The cranial areas of Neanderthal man and Modern Man are about the same size. Their cranial areas are the same size because Neanderthal Man's brain was about the same size as that of Modern Man. Even though Neanderthal Man's skull is almost as large as that of Modern Man, it is shaped a little differently. Take a close look at the shape of Neanderthal Man's cranial area. Compare it with that of Modern Man.

Do you notice any difference in the way the backs of their skulls are shaped? Look at the skulls of Neanderthal Man and Modern Man carefully and answer question 4. Is the back of Neanderthal Man's skull more pointed or less pointed than that of Modern Man?

Right! It is more pointed. Knowing that the cranial area of Neanderthal Man's skull is both pointed in back as well as large in size are good ways to tell his skull apart from the others. Now look at the panel to the left of Neanderthal Man. That is the one that has the skull with the large white letter C over it. The name of that skull is in large white letters at the top of the panel. That is the skull of Earliest Man. But there is a better, more scientific name for this skull in small white letters under Earliest Man. To answer question 5, find his scientific name.

Good! The scientific name for Skull C is Homo Erectus. Homo Erectus was an older form of man than Neanderthal Man and his brain was smaller than that of Neanderthal Man. Compare the skulls of Homo Erectus and Neanderthal Man. Look closely at their cranial areas. Do they differ in size? Compare the skulls and answer question 6. Is the cranial area of Homo Erectus the same as that of Neanderthal Man, larger, or smaller than that of Neanderthal Man?

That's right. Since Homo Erectus is an older form of man with a smaller brain than that of Neanderthal Man, his cranial area is smaller than that of Neanderthal Man. Take another look at the skulls of Homo Erectus and Neanderthal Man. Look closely at the shapes of their cranial areas. Do you see the way the backs of their skulls are shaped? Notice that the back of the skull of Homo Erectus is even more pointed than that of Neanderthal. Now we know that the skull of Homo Erectus is both smaller in size and a little more pointed in back than Neanderthal Man's. Look at the panel to the left of Homo Erectus. The skull on that panel has a large white letter D above it. The larger white letters at the top of the panel tell you that this is the skull of Near Man. But just like the skull of Homo Erectus, there is a better, more scientific name for Skull D than Near Man. To answer question 7, find the scientific name for Skull D.

Good! The scientific name for skull D is Australopithecus. Try to pronounce that. Australopithecus. Australopithecus is a very old ancestor of man who lived even before Homo Erectus. Look at the exhibit. We're going to compare two skulls again. This time we will compare the cranial area of Australopithecus, the older skull, with that of Homo Erectus, the more recent skull. Look closely at the skulls of Australopithecus and Homo Erectus in the exhibit. In question 8, is the cranial area of Australopithecus smaller than that of Homo Erectus, larger, or the same size as that of Homo Erectus?

Great! You got it right. Australopithecus is older than Homo Erectus; therefore, his brain was smaller, and Australopithecus had a smaller cranial area than that of the more recent Homo Erectus.

Now let's look at the panel to the left of the skull of Australopithecus. This is the panel farthest to the left in the exhibit. Notice that there is no actual skull on that panel, just the outline of a skull with the large letter E above it. In question 9, find the *scientific* name for skull E.

Good! The scientific name of skull E is Ramapithecus. Ramapithecus is the oldest ancestor of man in the exhibit. He lived over 14 million years ago, and his skull would be older than the skull of Australopithecus, but he lived so long ago that only a few bone fragments of Ramapithecus have ever been found. The drawing of the skull on the panel is what we think he looked like. Compare the drawing of Ramapithecus with the skull of his closest but more recent relative, Australopithecus. If we actually had a skull of Ramapithecus to compare with that of Australopithecus, how do you think their cranial areas

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would differ? In question 10, *should* the cranial area of Ramapithecus be larger or even smaller than that of Australopithecus?

Right! Ramapithecus is older than Australopithecus and, therefore, his cranial area should be smaller. Look at all the skulls in the exhibit and listen carefully, because here comes question 11. In general, does a *more recent* skull have a smaller or a larger cranial area than an older skull?

Very good! More recent forms of man had large brains and, therefore, larger cranial areas than older ancestors of man. Look carefully at all the skulls in the exhibit. Do you see how they are arranged? In question 12, find the order in which the skulls are arranged.

That's right! The skulls in the exhibit are arranged in order from the oldest on your left to the most modern on your right. For the next few questions, try to remember the scientific names of the skulls without looking up at the names on the panels. In question 13, name the skull that is older than Modern Man, but more recent than Homo Erectus.

Good! Neanderthal Man came between Homo Erectus and Modern Man. Look closely at the exhibit. Find the skulls of both Australopithecus and Neanderthal Man. In question 14, name the skull that is older than Neanderthal Man, but more recent than Australopithecus.

You're right. The answer is Homo Erectus. You can tell Homo Erectus is older than Neanderthal Man and more recent than Australopithecus because he has a smaller cranial area than Neanderthal Man, but a larger cranial area than Australopithecus. This time, in question 15, name the skull that comes between Ramapithecus and Homo Erectus.

That's right. Australopithecus comes between Ramapithecus and Homo Erectus. Now for one final question, see if you can remember both the names of the skulls and their ages. To answer question 16, poke the hole *over* the list that correctly names the skulls in order from the oldest at the top of the list to the most modern at the bottom.

Great! You did very well. Now take your machine and answer sheet back to the attendant. Thank you for taking the program.

2. *Audio Script: AQ-Condition. (With five-second pauses (dots) following each question. The punchboard was not used.)*

We're going to find out about the Age of Man Exhibit. Look at the panels in front of you. There are many skulls on the panels and they aren't all the same. Some are different from others. The skulls that we're going to talk about have large white letters above their heads. Look at the panel farthest to your right. The skull on that panel has the large white letter A above it. That's the skull of Modern Man, the kind of skull that people have today. Take a close look at Modern Man's skull. The back of his skull and the part that is above the jawbone, and in back of the eyes, is the part that contains the brain.

That is called the cranial area of the skull. Now answer this question: what is the name of the part of the skull that contains the brain? *(5-sec. pause.)*

The part of the skull that holds the brain is called the cranial area of the skull. That's the back of the skull and the part that's above the jawbone and behind the eyes. Take a good look at Modern Man's skull. The cranial area of Modern Man's skull is large and makes up a big part of the skull. Now look at the panel just to the left of Modern Man. That panel has a skull with a large white letter B above it. The name of this skull is in large white letters at the top of the panel. What is its name? Name skull B. *(5-sec. pause.)*

This is the skull of Neanderthal Man, Modern Man's most recent ancestor. Neanderthal Man was the first form of man to have a brain of Modern size. Since his brain was the same size as that of Modern Man, what does that tell you about his cranial area? *(5-sec. pause.)* Compare the skull of Neanderthal Man with that of Modern Man. Do their cranial areas differ very greatly in size? *(5-sec. pause.)* Look closely at these skulls and listen very carefully because here comes another question. Is this statement true or false? Since Neanderthal Man's brain was about the same size as that of Modern Man, his cranial area must also be almost as large as that of Modern Man. *(5-sec. pause.)*

The cranial areas of Neanderthal Man and Modern Man are about the same size. Their cranial areas are the same size because Neanderthal Man's brain was about the same size as that of Modern Man. Even though Neanderthal Man's skull is almost as large as that of Modern Man, it is shaped a little differently. Take a close look at the shape of Neanderthal Man's cranial area. Compare it with that of Modern Man. Do you notice any difference in the way the backs of their skulls are shaped? Look at the skulls of Neanderthal Man and Modern Man carefully and answer this question: Is the back of Neanderthal Man's skull more pointed or less pointed than that of Modern Man? *(5-sec. pause.)*

It is more pointed. Knowing that the cranial area of Neanderthal Man's skull is both pointed in back as well as large in size is a good way to tell his skull apart from the others. Now look at the panel to the left of Neanderthal Man. That is the one that has the skull with the larger white letter C over it. The name of that skull is in large white letters at the top of the panel. That is the skull of Earliest Man. But there is a better, more scientific name for this skull in small white letters under Earliest Man. Find his scientific name. *(5-sec. pause.)*

The scientific name for skull C is Homo Erectus. Homo Erectus is an older form of man than Neanderthal Man and his brain was smaller than that of Neanderthal Man. Compare the skulls of Homo Erectus and Neanderthal Man. Look closely at their cranial areas. Do they differ in size? Compare the skulls and answer this question. Is the cranial area of Homo Erectus the same as Neanderthal Man's, larger, or smaller than that of Neanderthal Man? *(5-sec. pause.)*

Since Homo Erectus is an older form of man with a smaller brain than that of Neanderthal Man, his cranial area is smaller than that of Neanderthal Man. Take another look at the skulls of Homo Erectus and Neanderthal Man. Look closely at the shapes of their cranial areas. Do you see the way the backs of their skulls are shaped? . . . Notice that the back of the skull of Homo Erectus is even more pointed than that of Neanderthal. Now we know that the skull of Homo Erectus is both smaller in size and a little more pointed in back than that of Neanderthal Man. Look at the panel to the left of Homo Erectus. The skull on that panel has a large white letter D above it. The large white letters at the top of the panel tell you that this is the skull of Near Man. But just like the skull of Homo Erectus, there is a better, more scientific name for skull D than Near Man. Find the scientific name for D. *(5-sec. pause.)*

The scientific name for skull D is Australopithecus. Try to pronounce that. Australopithecus. Australopithecus is a very old ancestor of man who lived even before Homo Erectus. Look at the exhibit. We're going to compare two skulls again. This time we will compare the cranial area of Australopithecus, the older skull, with that of Homo Erectus, the more recent skull. Look closely at the skulls of Australopithecus and Homo Erectus in the exhibit. Is the cranial area of Australopithecus smaller than that of Homo Erectus, larger, or the same size as that of Homo Erectus? *(5-sec. pause.)*

Australopithecus is older than Homo Erectus, therefore his brain was smaller, and Australopithecus had a smaller cranial area than that of the more recent skull, Homo Erectus. *(5-sec. pause.)*

Now let's look at the panel to the left of the skull of Australopithecus. This is the panel farthest to the left in the exhibit. Notice that there is no actual skull on that panel, just the outline of a skull with the large letter E above it. Find the *scientific name* for skull E. *(5-sec. pause.)*

The scientific name of skull E is Ramapithecus. Ramapithecus is the oldest ancestor of man in the exhibit. He lived over 14 million years ago, and his skull would be older than the skull of Australopithecus. But he lived so long ago that only a few bone fragments of Ramapithecus have been found. The drawing of the skull on the panel is what we think he looked like. Compare the drawing of Ramapithecus with the skull of his closest but more recent relative, Australopithecus. If we actually had a skull of Ramapithecus to compare with that of Australopithecus, how do you think their cranial areas would differ? *Should* the cranial area of Ramapithecus be larger or even smaller than that of Australopithecus? *(5-sec. pause.)*

Ramapithecus is older than Australopithecus and therefore his cranial area should be smaller. Look at all of the skulls in the exhibit and listen carefully, because here comes another question. In general, does a *more recent* skull have a smaller or a larger cranial area than that of an older skull? *(5-sec. pause.)*

More recent forms of man had large brains and therefore larger cranial areas than older ancestors of man. Look carefully at all the skulls in the exhibit. Do you see how they are arranged? Find the order in which the skulls are arranged. *(5-sec. pause.)*

The skulls in the exhibit are arranged in order from the oldest on your left to the most modern on your right. For the next few questions, try to remember the scientific names of the skulls without looking up at the names on the panels. Name the skull that is older than Modern Man but more recent than Homo Erectus. *(5-sec. pause.)*

Neanderthal Man came between Homo Erectus and Modern Man. Name the skull that is older than Neanderthal Man's, but more recent than that of Australopithecus. *(5-sec. pause.)*

The answer is Homo Erectus. You can tell Homo Erectus is older than Neanderthal Man and more recent than Australopithecus because he has a smaller cranial area than Neanderthal Man but a larger cranial area than Australopithecus. This time, name the skull that comes between Ramapithecus and Homo Erectus. *(5-sec. pause.)*

Australopithecus comes between Ramapithecus and Homo Erectus. Now for one final question. See if you can remember both the names of the skulls and their ages. Try to name them in order starting with the oldest. *(5-sec. pause.)*

Ramapithecus, the skull farthest to your left, is the oldest. Then comes Australopithecus, Homo Erectus, Neanderthal Man, and finally Modern Man, the most recent skull. This concludes our program on the Age of Man Exhibit. Please take your machine back to the attendant. Thank you for taking our program.

3. *Audio script: AQ(w)-Condition. (Same as above, except that there were no pauses between questions.)*

4. *Audio-Narration: AN-Condition. (Questions were removed.)*

We're going to find out about the Age of Man Exhibit. Look at the panels in front of you. There are many skulls on the panels and they aren't all the same! Some are different from others. The skulls that we're going to talk about have large white letters above their heads. Look at the panel farthest to your right. The skull on that panel has the large white letter A above it. That's the skull of Modern Man, the kind of skull that people have today. Take a close look at Modern Man's skull. The back of his skull and the part that is above the jawbone, and in back of the eyes, is the part that contains the brain. That is called the cranial area of the skull.

Remember, the part of the skull that holds the brain is called the *cranial area* of the skull. Take a good look at Modern Man's skull. The cranial area of Modern Man's skull is large and makes up a big part of the skull. Now look at the panel just to the left of Modern Man. That panel has a skull with a large white letter B above it. The name of this skull is in large white letters at the top of the panel.

This is the skull of Neanderthal Man, Modern Man's most recent ancestor. Neanderthal Man was the first form of man to have a brain of Modern size. Since his brain was the same size as that of Modern Man, what does that tell you about his cranial area? Compare the skull of Neanderthal Man with that of Modern Man. Do their cranial areas differ very greatly in size? Look closely at these skulls and listen very carefully.

The cranial areas of Neanderthal Man and Modern Man are about the same size. Their cranial areas are the same size because Neanderthal Man's brain was about the same size as that of Modern Man. Even though Neanderthal Man's skull is almost as large as that of Modern Man, it is shaped a little differently. Take a close look at the shape of Neanderthal Man's cranial area. Compare it with that of Modern Man. Do you notice any difference in the way the backs of their skulls are shaped? Look at the skulls of Neanderthal Man and Modern Man carefully. The back of Neanderthal Man's skull is more pointed. Knowing that the cranial area of Neanderthal Man's skull is both pointed in back as well as large in size is a good way of telling his skull apart from the others. Now look at the panel to the left of Neanderthal Man. That is the one that has the skull with the large white letter C over it. The name of that skull is in large white letters at the top of the panel. That is the skull of Earliest Man. But there is a better, more scientific name for this skull in small white letters under Earliest Man.

The scientific name for skull C is Homo Erectus. Homo Erectus is an older form of man than Neanderthal Man and his brain was smaller than that of Neanderthal Man. Look closely at the size of their cranial areas.

Since Homo Erectus is an older form of man with a smaller brain than that of Neanderthal Man, his cranial area is smaller than that of Neanderthal Man. Look closely at the shapes of their cranial areas. Do you see the way the backs of their skulls are shaped? Notice that the back of the skull of Homo Erectus is even more pointed than that of Neanderthal. Now we know that the skull of Homo Erectus is both smaller in size and little more pointed in back than that of Neanderthal Man. Look at the panel to the left of Homo Erectus. The skull on that panel has a large white letter D above it. The large white letters at the top of the panel tell you that this is the skull of Near Man. But just like the skull of Homo Erectus, there is a better, more scientific name for skull D than Near Man.

The scientific name for skull D is Australopithecus. Try to pronounce that. Australopithecus. Australopithecus is a very old ancestor of man who lived even before Homo Erectus. Look at the exhibit. We're going to compare two skulls again. This time we will compare the cranial area of Australopithecus, the older skull, with that of Homo Erectus, the more recent skull. Look closely at the size of the skulls of Australopithecus and Homo Erectus in the exhibit.

Australopithecus is older than Homo Erectus; therefore, his brain was smaller, and Australopithecus had a smaller cranial area than that of the more recent skull, Homo Erectus.

Now let's look at the panel to the left of the skull of Australopithecus. This is the panel farthest to the left in the exhibit. Notice that there is no actual skull on that panel, just the outline of a skull with the large letter E above it.

The scientific name of skull E is Ramapithecus. Ramapithecus is the oldest ancestor of man in the exhibit. He lived over 14 million years ago, and his skull would be older than the skull of Australopithecus. But he lived so long ago that only a few bone fragments of Ramapithecus have ever been found. The drawing of the skull on the panel is what we *think* he looked like. Compare the drawing of Ramapithecus with the skull of his closest but more recent relative, Australopithecus. If we actually had a skull of Ramapithecus to compare with that of Australopithecus, how do you think the size of their cranial areas would differ?

Ramapithecus is older than Australopithecus and therefore the cranial area of Ramapithecus should be smaller. Look at all of the skulls in the exhibit.

In general, more recent forms of man had larger brains and therefore they had larger cranial areas than older ancestors of man. Look carefully at all the skulls in the exhibit. Do you see how they are arranged?

The skulls in the exhibit are arranged in order from the oldest on your left to the most modern on your right. Try to remember the scientific names of the skulls without looking up at the names on the panels. Which skull is older than Modern Man but more recent than Homo Erectus?

Neanderthal Man came between Homo Erectus and Modern Man. Now, which skull is older than Neanderthal Man but more recent than Australopithecus?

Homo Erectus came between Australopithecus and Neanderthal Man. You can tell Homo Erectus is older than Neanderthal Man and more recent than Australopithecus because he has a smaller cranial area than Neanderthal Man but a larger cranial area than that of Australopithecus. Which skull comes between Ramapithecus and Homo Erectus?

Australopithecus comes between Ramapithecus and Homo Erectus. Can you remember the names of the skulls and their ages in order starting with the oldest?

Ramapithecus, the skull farthest to your left, is the oldest. Then came Australopithecus, Homo Erectus, Neanderthal Man, and finally Modern Man, the most recent skull. This concludes our program on the Age of Man Exhibit. Please take your machine back to the attendant. Thank you for taking our program.

Appendix C

PRE-POSTTEST QUESTIONS: ANIMISM-SHAMANISM

Following are criterion pre-posttest questions and other instructions as they appeared on the MTA Pre-Posttest Machine in the animism exhibit. Questions appeared, one at a time, in the viewing window of the test machine (Figure 6). A floor pad switch in front of the machine activated a circuit so that picking up the phone would initiate the audio instructions and subsequent events (see text). The statement "Please pick up the phone for quiz instructions" remained in the viewing window when machine was not in use. Leaving the machine, after a short delay, reset the program to its beginning (to the instructions to pick up the phone).

Please Pick Up the Phone for Quiz Instructions

What is your age?

A. 10 years or less
B. 11-13
C. 14-18
D. 19 years or over

How many grades of schooling have you completed?

A. 6 grades or less
B. 7-9
C. 10-12
D. 1 or more years of college

An example of animism would be:

A. The belief that the sun and the moon have spirit power
B. Belief in a single supreme being
C. Denial of the spirit world
D. Obeying the rules of the church

What is a function of a shaman?

A. Weave ceremonial robes
B. Bury the dead
C. Prepare medicinal herbs
D. Contro' the spirits

Astrology is:

A. Astronomy made simple
B. A new means of communicating with the spirits
C. A corruption of religious beliefs
D. A form of divining the future

Divination techniques are:

A. No longer in existence
B. Almost extinct except for some primitive tribes
C. Still popular in many areas
D. A new fad

Members of the False Face Society are:

A. Monotheistic
B. Animistic
C. Atheistic
D. Anti-theistic

Which of the following can be used as a means of divination?

A. Tea leaves
B. Playing cards
C. Shells
D. All of the above

The False Face Society is part of the religious tradition of the:

A. Hopi Indians
B. Pueblo Indians
C. Iroquois Indians
D. Menominie Indians

Indian "How and Why" stories told about:

A. Hunting and fishing
B. Relationships between nature, wildlife, and people
C. Arts and crafts
D. The heroics of the Chief

What is the leader of spirit workshop ceremonies called?

A. Chief
B. Head Man
C. Shaman
4. Spiritual Leader

The relationship between Animism and Shaminism is such that:

A. Shamanism is necessary for animism
B. Animism is necessary for shamanism
C. One always goes with the other
D. There is no relationship between the two

You've finished the quiz now.

Thank you.

Appendix D

PUNCHBOARD QUESTIONS: ANIMISM-SHAMANISM

The 11-question sheet used with the punchboard on the animism-shamanism program. (For audio script, see Appendix E.)

1.	◯ A SIMPLIFIED FORM OF ASTRONOMY ◯ A NEW MEANS OF COMMUNICATING WITH SPIRITS ◯ A CORRUPTION OF RELIGIOUS BELIEFS ◯ A FORM OF DIVINING THE FUTURE
2.	◯ AN INNOVATION OF THE 20th CENTURY ◯ PRACTICED THOUSANDS OF YEARS AGO ◯ A NEW FAD
3.	◯ NO LONGER IN EXISTENCE ◯ ALMOST EXTINCT ◯ STILL MODERATELY POPULAR
4.	◯ RATTLE ◯ SPOON ◯ BOWL
5.	◯ FAIRY STORIES ◯ OLD WIVES' TALES ◯ HOW AND WHY STORIES
6.	◯ MEDICINE MASKS ◯ FALSE FACES ◯ VOODOO FACES
7.	◯ CHIEF OR HEAD MAN ◯ SHAMAN, MEDICINE MAN, OR PRIEST ◯ FAVORED BRAVE
8.	◯ ANIMISTIC POWERS ◯ SUPERSTITIOUS POWERS ◯ LEGENDARY POWERS
9.	◯ BELIEF IN ANIMALS ◯ BELIEF THAT ALL OBJECTS POSSESS SPIRITS ◯ MEDICINE CULT
10.	◯ STRENGTH ◯ FERTILITY ◯ DEATH
11.	◯ TELL THE PEOPLE TO PLEASE THE SPIRITS ◯ SETTLE FIGHTS BETWEEN TRIBES ◯ ENTERTAIN THE CHIEF

Appendix E

AUDIO SCRIPTS FOR ANIMISM-SHAMANISM

1. *Audio script used with the punchboard (M-Condition).*

50 secs. of music—"Age of Aquarius."

I'm sure you've heard those lines before. And you probably know that they're referring to astrology. But do you know what astrology is? Look at the astrology magazines in case 2. They're in the middle and near the front. Notice that label beneath them. The label says astrology is a form of divining the future. What is astrology? Answer question 1 by poking the hole in front of the answer that best describes astrology.

That's right. Astrology is a form of divining the future. That means it is a way to *predict* the future—it's a type of fortune telling. But how long ago was it developed? Is it an innovation of the 20th century? Or was it practiced thousands of years ago? Or is it a new fad? For question 2, poke the phrase that tells how long ago astrology was developed.

Right. Astrology is thousands of years old. It was first developed by the Chaldeans in 2000 B.C. and has continued to exist up to the present time. Are there some other familiar divination or fortune telling techniques in this case? Look to the left of the astrology magazines. Playing cards, a crystal ball, and tea leaves are all items that are still used today to predict the future. Are divination techniques no longer in existence? Or are they practically extinct except for some primitive tribes? Or are they still moderately popular in many areas? In question 3, find to what extent divination techniques are used today.

Yes, many of the objects in this case are still used today to predict the future. In fact, those small wooden symbols on your right in the front of the case are quite popular as divining tokens in Southeast Asia today. There are also a lot of Ind[illegible]n items in this case that you might not be familiar with. Look at those Kw[illegible]llop shells in the middle of the case and read the label carefully. Q[illegible]: What are these shells used for?

They're used as a rattle by the Kwakiutl Indians in spirit worship ceremonies. Look at the top picture on the right side of the back wall. Like all other people the Indians were concerned with the relationship between nature, wildlife, and people; the relationship of human characteristics to living things. They told stories about these things they didn't understand. What are these stories called? Are they fairy stories, old wives' stories, or "how and why" stories? That's question 5—what are these stories called?

Right. They are called "how and why" stories because they explained the how and the why of things the Indians didn't really understand like rain, thunder, sickness, and death. They believed that spirits controlled all these things. Look at the rest of the pictures on the right side of the back wall. They show how the spirits were called upon for rain by the Hopi Indians as well as for prosperity and advice in war. Now look to the left of the pictures. See those red and orange wooden masks? The Iroquois Indians carved these masks from a living tree as a part of their religious custom. Look at the label next to these masks and see if you can find what they are called. In question 6, poke the hole in front of the correct name for these Iroquois masks.

They are called False Faces and they are worn by the Iroquois Indians in ceremonies to drive away evil spirits. Every adult male Iroquois Indian was a member of the False Face Society. Each member of the False Face Society went alone into the forest and fasted until he had a vision of a spirit. He then carved the face of this spirit in a living tree, and later made a mask out of it. But even though every member of the False Face Society wore a mask and took part in the ceremonies, only one member of the tribe was the leader of the ceremonies to drive away evil spirits. This was also true of other Indian tribes. Only one person was the leader of these ceremonies, and it was his job to control the spirits. Look at the exhibit title on the right side of the back wall. What is this leader called? Is he the Chief or head man? Is he the shaman, medicine man or priest? Or is he the favored brave? In question 7, find the name of the leader of the ceremonies.

The leader is the medicine man, priest, or shaman, and his job is to control the power of the spirits. This form of religion, in which one person has the power to communicate with the spirits and tell his people what the wishes of these spirits are, is known as *shamanism*. And the leaders are shamans. So far we've been calling the powers that the shamans controlled spirit powers, but they have a fancier name. Look at the exhibit title again. Do you know what these powers are called? Are they called animistic powers, superstitious powers, or legendary powers? Answer question 8 by poking the answer that tells what these powers are called.

Animistic powers are what they are called. And the shamans controlled these animistic powers so that the people didn't feel quite so helpless or frightened by them. But what exactly are these animistic powers and what does animism mean? Look at case 1 on your left. This tells us about the form of religion known as animism. What is animism? Is it a belief in animals, a belief that all objects possess spirits, or a medicine cult? Question 9 is: What is animism?

Animism is the belief that all substances, objects and phenomena possess spirits. Look at the objects in the upper right of this case. Can you see some of the things believed to have spiritual powers? Some of the best examples shown here of objects having spiritual qualities are the sun, the moon, the wind, and thunder. According to animistic beliefs everything is spiritual, even mountains. Look at the Japanese shrine on the upper left. It shows a mountain which the people believed was a spirit mountain. Remember the Iroquois False Face Society? Like many other Indian tribes, the Iroquois believed in many spirits, especially spirits of the forest like trees and animals, and spirits of nature like wind and thunder. The Iroquois religion, therefore, is based on the belief that all substances, objects, and phenomena possess spirits. What is this form of religion called? Answer question 10 by finding the correct name for the belief that all substances, objects and phenomena possess spirits.

The belief that all substances, objects, and phenomena possess spirits is known as animism. Therefore, the Iroquois False Face Society is animistic. According to animistic beliefs, there are spirits in everything—both in good things like the ... strength, and in bad things like death. With all these spirits life could be pretty threatening and *at times* the people turned to shamans. How did the shamans help the people? Did they tell the people how to please the spirits, did they settle fights between tribes, or did they entertain the chief? Answer question 11 by picking the choice that tells how the shamans helped the people?

The shamans told the people how to please the spirits. If the people pleased the spirits, the spirits would send rain or drive away sickness or grant other wishes of the people. In this way, animism helped the people to understand things in nature like rain and thunder, and shamanism helped make them feel they had some control over these natural phenomena. They knew that if they were obedient and pleased the spirits, the spirits would be good to them.

This concludes our program on the Hall of Religion. Take your machine back to the attendant. Thank you very much for taking the program.

2. *Audio script used* without *the punchboard but with questions (AQ(w)-Condition). No pauses were used with the script. Therefore, no spaces are provided following questions.*

50 secs. of music—"Age of Aquarius."

I'm sure you've heard those lines before. And you probably know that they're referring to astrology. But do you know what astrology is? Look at the astrology magazines in case 2. They're in the middle and near the front. Notice that label beneath them. The label says astrology is a form of divining the future. What is astrology? Astrology is a form of divining the future. That means it is a way to *predict* the future—it's a type of fortune telling. But how long ago was it developed? Astrology is thousands of years old. It was first developed by the Chaldeans in 2000 B.C. and it has continued to exist up to present time. Are there some other familiar divination or fortune telling techniques in this case? Look to the left of the astrology magazines. Playing cards, a crystal ball, and tea leaves are all items that are still used today to predict the future. Are divination techniques no longer in existence? Or are they still moderately popular in many areas? Yes, many of the objects in this case are still used today to predict the future. In fact, those small wooden symbols on your right in the front of the case are quite popular as divining tokens in Southeast Asia today. There are, also, a lot of Indian items in this case that you might not be familiar with. Look at those Kwakiutl scallop shells in the middle of the case and read the label carefully. What are these shells used for? They're used as a rattle by the Kwakiutl Indians in spirit worship ceremonies. Look at the top picture on the right side of the back wall. Like all other people the Indians were concerned with the relationship between nature, wildlife, and people; the relationship of human characteristics to living th[illegible]. They told stories about these things they didn't understand. What are these stories called? They are called "how and why" stories because they explained the how and the why of things the Indians didn't really understand, like [illegible], thunder, sadness, and death. They believed that spirits controlled all these things. Look at the rest of the pictures on the right side of the back wall. They show how the spirits were called upon for rain by the Hopi Indians as well as for prosperity and advice in war. Now look to the left of the pictures. See those red and orange wooden masks? The Iroquois Indians carved these masks from a living tree as a part of their religious custom. Look at the label next to these masks and see if you can find what they are called. They are called False Faces and they are worn by the Iroquois Indians in ceremonies to drive away evil spirits. Every adult male Iroquois Indian was a member of the False Face Society. Each member of the False Face Society went alone into the forest and fasted until he had a vision of a spirit. He then carved the face of this spirit in a living tree, and later made a mask out of it. But even though every member of the False Face Society wore a mask and took part in the ceremonies, only one member of the tribe was [illegible] of the ceremonies to drive away evil spirits. This was also true of other [illegible] tribes. Only one person was the leader of these ceremonies and it was [illegible] to [illegible] the spirits. Look at the exhibit title on the right side of the [illegible] wall. What is the leader called? The leader is the medicine man, priest, or shaman, and his job is to control the power of the spirits. This form of religion, in which one person has the power to communicate with the spirits and tell his pe[illegible] what the wishes [illegible] spirits are, is known as *shamanism*. And the leaders are shamans. So [illegible] been calling the powers that the shamans controlled spirit powers, but they have a fancier name. Look at the exhibit title again. Do you know what these powers are called? Animistic powers are what they are called. And the shamans controlled these animistic powers so that the people didn't feel quite so helpless or frightened by them. But what exactly are these animistic powers and what does animism mean? Look at case 1 on your left. This tells us about the form of religion known as animism. What is animism? Animism is the belief that all substances, objects, and phenomena possess spirits. Look at the objects in the upper right of this case. Can you see some of the things believed to have spiritual powers? Some of the [illegible] examples shown here of objects having spiritual qualities are the sun, the [illegible]n, the wind, and thunder.

According to animistic beliefs everything is spiritual, even mountains. Look at the Japanese shrine on the upper left. It shows a mountain which the people believed was a spirit mountain. Remember the Iroquois False Face Society? Like many other Indian tribes, the Iroquois believed in many spirits, especially spirits of the forest like trees and animals, and spirits of nature like wind and thunder. The Iroquois religion, therefore, is based on the belief that all substances, objects, and phenomena possess spirits. What is this form of religion called? This belief that all substances, objects, and phenomena possess spirits is known as *animism*. Therefore, the Iroquois False Face Society is animistic. According to animistic beliefs, there are spirits in everything both in good things like the sun and strength, and in bad things like death. With all these spirits, life could be pretty threatening and *at times* the people turned to shamans. How did the shamans help these people? The shamans told the people how to please the spirits. If the people pleased the spirits, the spirits would send rain or drive away sickness, or grant other wishes of the people. In this way animism helped the people to understand things in nature like rain, and thunder and shamanism helped make them feel they had some control over these natural phenomena. They knew that if they were obedient and pleased the spirits, the spirits would be good to them.

This concludes your program on the Hall of Religion [illegible] your machine back to the attendant. Thank you very much for taking the program.

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Appendix I

[illegible] MACHINE QUESTIONS ON HEREDITY

Sample set of recycling self-test questions on heredity. There were 10 se[illegible] ets.

Heredity

Chromosomes:

A. Contain genes
B. Were discovered by Darwin
C. Are always dominant
D. Are always recessive

According to Darwin, all domestic chickens came from.

A. Two basic strains
B. The red jungle fowl
C. Siberia
D. United States

The exhibit uses which plant and animal forms to illustrate heredity?

A. Witch hazel shrub and Irish Elk
B. Roses and chickens
C. Roses and dogs
D. Flowering peas and cats

Mendel only discovered genes after he had:

A. Studied the Yokohama cock
B. Studied eye color
C. Crossbred flowering peas
D. Noticed blending of characteristics of roses

Genes were recently found:

A. To be absent in patients with cancer
B. To contain nucleic acid
C. To be lacking in the tobacco plant
D. To be made up of chromosomes

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