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Visitor Self-Report Behavior Mapping as a Tool for Recording Exhibition Circulation

by Gretchen Nurse Rainbolt,[1] Jacob A. Benfield,[2] and Ross J. Loomis[3]

[1]*University of Arizona, Tucson, Arizona, USA*
[2]*Penn State University, Abington, Pennsylvania, USA*
[3]*Colorado State University, Fort Collins, Colorado, USA*

ABSTRACT

The evaluation of visitor flow within a museum or exhibition has been a topic of interest for decades with several research approaches taken over the years. Direct observation or visitor tracking during museum occupancy is the most popular technique, but it generally requires substantial amounts of time and financial resources. An alternative approach to direct observation—visitor self-mapping—is presented using data obtained from 2 short-term, small-budget evaluations of a world-class collection museum. Results show that self-mapping provides usable data with more than 90% of maps having tracking data for the entire museum. Maps varied in the amount of detail, but more than 60% of visitors provided details beyond what was required. In Study 1, movement patterns, sweep rate indices, and timing data suggest that the mapping data accurately reflected the visitor experience. Study 2 directly paired the self-mapping method used in Study 1 with unobtrusive behavioral observations to address the reliability and validity of the new approach. A discussion compares the relative costs and benefits of the new approach with more conventional direct observation techniques and provides directions for future research.

Observing visitors moving through museums or exhibitions is one of the oldest methods for understanding the effectiveness of installations and interpretation. The classic observation study was done by Melton (1935, 1973) at an art museum. Understanding that visitors needed to move through different spaces to experience and learn about objects, Melton used the then-innovative method of unobtrusive observation to understand how visitors reacted to the architectural design of museums, installations of artifacts, and interpretive resources like labels. Melton's work also captured curatorial concerns such as density of object installation and object placement in the museum.

Since that first visitor observation study, the issue of tracking within museums, exhibitions, or exhibits has continued to be of interest to curators and evaluators for several reasons (Yalowitz & Bronnenkant, 2009). First, visitor tracking is useful for providing insights about potential problems (or success stories) in museum circulation and orientation design (Bitgood & Cota, 1995; Klein, 1993). For example, a tracking study conducted inside a 2,500 square ft exhibition celebrating major scientific discoveries showed that visitor circulation could be summarized as one of three movement patterns with nearly half of the visitors following a single path (Serrell & Associates, 2009). Melton's (1935) work pinpointed similar sets of movement patterns, including groups of visitors who viewed only the right or left wall. Such information is valuable to museum staff who want to be sure that the space is being used to its maximum potential, that expensive or key exhibition elements are being displayed effectively, or that problems in orientation and wayfinding are not occurring.

Beyond circulation and orientation, visitor tracking allows for the collection of data concerning time in museum and use of specific objects or displays (Serrell, 1998; Yalowitz & Bronnenkant, 2009). Together those two measures offer a rich picture of visitor engagement and exhibition retention or holding time, which are often central to evaluating the overall effectiveness of an installation. Time in museum has been related to visitor willingness to pay for admission, visitor satisfaction, and visitor learning (Borun, Chambers, & Cleghorn, 1996; Falk, 1993; Haeseler, 1990; Raphling & Serrell, 1993). The use of a sweep rate index, dividing the square footage of the space by the time spent in the museum, facilitates the direct comparison of visitation times across museums, exhibitions, and other types of informal learning environments (Serrell, 1998). However, time spent in a museum is not the only, or even most agreed upon, measure of museum success (Doering & Pekarik, 1997; Shettel, 1997).

Understanding more specific usage rates and retention or holding power for particular displays or interactives helps inform decision making with regard to any object in a visitor setting. Therefore, tracking visitor usage rates and holding power help highlight the relative costs and benefits of individual elements within an exhibition. If a particular piece of art is on loan at a very high cost, understanding visitor appeal and holding power for that object can help institutions justify the expense or their desire to renegotiate the loan agreement. Usage rates and holding power also determine how frequently a particular interactive will likely need maintenance or if a second unit is needed to meet demand. For example, the Oregon Museum of Science and Industry created a 6,000 square ft exhibition intended to teach mathematics and economics to elementary school children, but also had to create a downsized version that could travel to different locations. An evaluation of usage rates and holding power helped staff to provide clear recommendations about which exhibit pieces would be best received and, therefore, best to include in the traveling version (Fuller et al., 2004).

Because of the benefits provided by visitor tracking data, several approaches and amendments to the basic observational method used by Melton (1935) have been used to provide insight into visitor behavior. Some have not strayed from purely unobtrusive observation (e.g., Ross & Lukas, 2005) whereas others have added an intercept interview or questionnaire at the conclusion (e.g., Jakubowski, Benfield, Szlemko, Loomis, & Pickering, 2007). Some of the more creative adaptations have used electronic counting devices underneath the flooring of the exhibition (e.g., Bechtel, 1967) or sophisticated computer counting programs attached to exhibition interactives that allow for inference about high and low usage areas (e.g., Black, 1989). Yalowitz and Bronnenkant (2009) suggested that such uses of technology are likely the future of tracking and timing studies with cameras and other monitoring equipment helping to make data collection more efficient and accurate. Advancements such as smart phone applications, wi-fi, and radio frequency identification provide the potential for low intrusion, high efficiency tracking. However, these technologies often include a substantial initial cost investment that may not be feasible for most institutions.

The variability in tracking methods used over the years arises, in part, from an inherent challenge to all research projects: how to best gather useful data in a reasonable amount of time given the resources available. Tracking is not the most efficient of data collection techniques. In fact, it is one of the most labor intensive (which could also be read as "most costly") of data gathering methods (Haeseler, 1990; Yalowitz & Bronnenkant, 2009). For example, tracking a sample of 15 visitor groups at the Melbourne Zoo required 40 hours of tracking time (Churchman, 1987). Two of the tracking studies discussed earlier in this articles (i.e., Fuller et al., 2004; Serrell & Associates, 2009) had sample sizes of only 52 and 40 visitors because of the time intensive nature of such research. Ross and Lukas (2005) managed to collect a much larger sample of 350 visitor observations but spent a year collecting the data.

In short, evaluations involving visitor tracking face an interesting predicament. Does the evaluator collect a small sample (with all of the built-in limitations to statistical and informational power that come with it) in a reasonable amount of time, or does he or she collect a larger sample over an extended timeline that delays decision making while elevating costs?

The purpose of this article is to describe an innovative method that was created in response to a project that required the evaluation of visitor circulation to answer key research questions but was limited by time and money. The project goals were to understand both visitor timing and behavioral flow patterns throughout the museum to address questions related to visitor behavior for management purposes. Although the evaluation goals were basic in nature, the project epitomized the dilemma of balancing sample size with cost and researcher time.

When approached with the task of evaluating visitor circulation in a 30,000 square ft collections museum with a budget equal to only 30 hours of data collection time, it became necessary to deviate from the standard tracking methodology. Not only was the space quite large, but visitation length posed another problem. The museum features the world's largest collection of American firearms and is visited regularly by the most avid of collectors and aficionados, some of who spend entire days within the space studying the nuances of rare items. Tracking one of those individuals would use a lot of resources for very little benefit. Although the majority of visitors are not engaged for as much time, the researchers would have no way of distinguishing between the two groups until the tracking had already begun. Excluding the collector subgroup from observation would create issues of sampling bias, so that was not an option.

A compromise between money, time, and sample size was struck by asking visitors to self-map their route through the museum. Although Study 1 was originally developed to be evaluative in nature, the results are analyzed here to demonstrate that visitors are capable of tracking their own behavior, and the self-mapping technique is at least as efficient as traditional tracking methods. By having visitors track themselves, and by time-stamping the maps at the beginning and end of their visit, the evaluation team was able to provide circulation data similar to that obtained through actual tracking but without the large investment of researcher time. Over the course of one hour, a single researcher could easily distribute 10–15 maps using random sampling procedures and have most of the maps returned during the subsequent hour. In a museum with average visitation time close to one hour, this equates to roughly 7–10 self-maps collected per hour compared to one traditional tracking.

In Study 1 we sought to show that visitor self-mapping is both possible and more efficient than traditional timing and tracking methods. The most important measure of the success of this new method, though, is whether it could provide useful, accurate data regarding circulation and visitation length. Therefore, in Study 2, we directly assessed the self-mapping method by comparing the results obtained from traditional tracking with those collected using self-mapping. This direct test of validity was carried out in the same museum as Study 1, but separate from the initial evaluation.

STUDY 1

Method

Participants

A sample of 147 visitors completed the self-mapping exercise with about 75% of visitors approached agreeing to participate. (Of the 53 visitors who declined to participate, almost all reported being “not interested” or “in a hurry.”) In general, visitors were traveling in small groups of one or two people (87% of sample) without children (82% of sample). This sample composition is representative of the museum’s population, which has been shown to be largely composed of retired couples with only one fifth of visitors being family groups with children.

Materials and Procedure

A simplified floor plan of the museum (see Figure 1) was used as a framework for participants to track their route as they explored the museum. The map provided information regarding placement of display cases and exhibition rooms throughout the museum. In an effort to orient the visitor, the word *START* and an *X* were placed at the entrance of the museum (which was also where they were handed the map). Labels were added to the map to show the location of prominent displays or exhibits to support visitor orientation.

Using a random sampling procedure, every third visitor group was approached as they entered the museum and asked if they would be willing to track or map their route through the museum. If a member of the visitor group agreed to participate, the researcher recorded the time on a map, which was then given to the visitor with a clipboard and writing utensil. Only one map per group was handed out. The instructions were kept very simple in an effort to test the new method and, therefore, visitors were not asked to record anything other than their route through the museum. When visitors were given the map, the researcher oriented them relative to the starting point and told them to record wherever they went in the museum by drawing a line along their route of travel, and then to return the map to the researcher. It was assumed

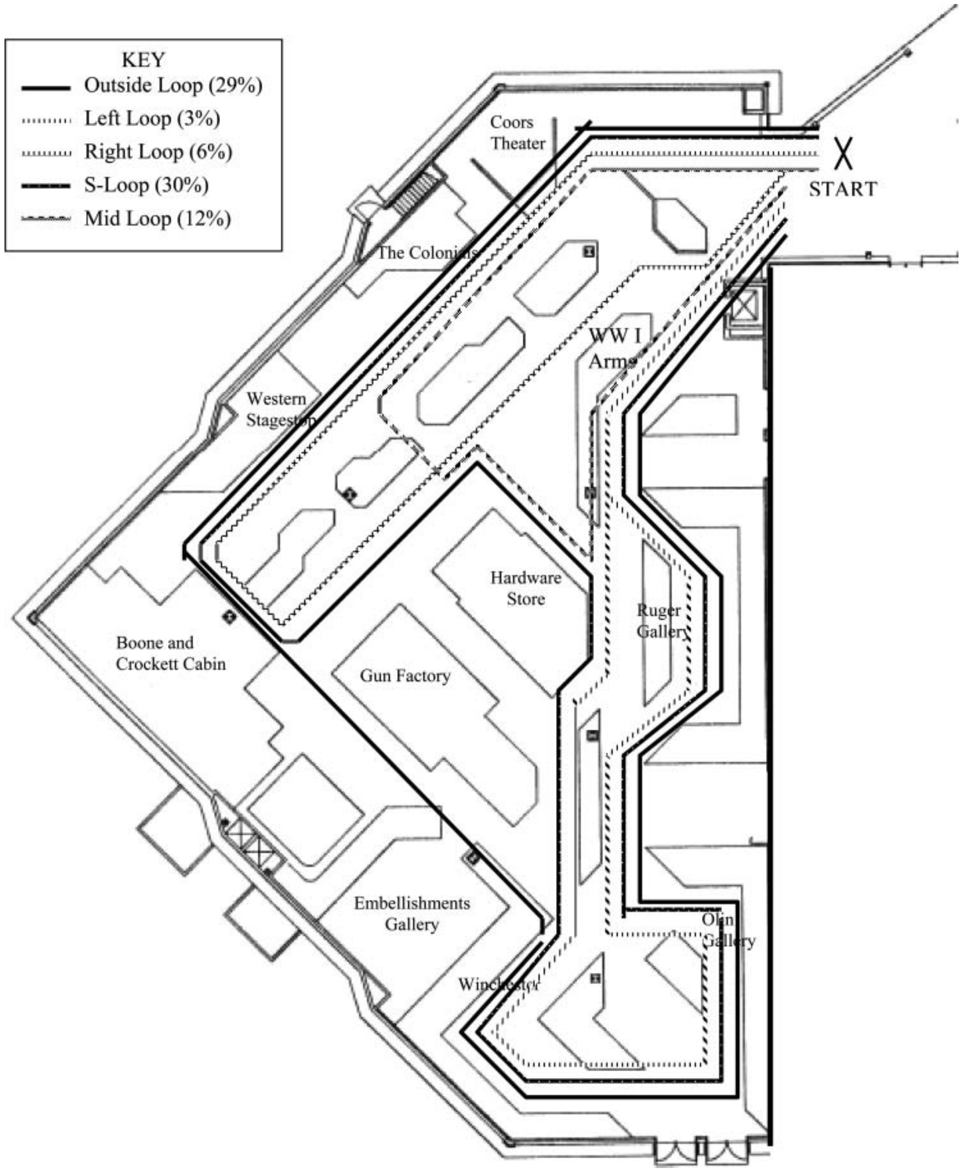

Figure 1. *Major routes through the Cody Firearms Museum (CFM) indicated on visitor maps in Study 1.*

that most groups moved together or that the visitor doing the mapping tracked his or her own route.

Maps were distributed during the first hour of data collection allowing for sufficient time to collect them when visitors exited the museum. Depending on daily visitor attendance, 10 to 15 maps were handed out in an hour. After all maps were handed out, the researcher remained at the exit of the museum (which is also the museum's entrance) to collect the maps when the visitors returned. As each map was turned in, the exit time was noted on the map. Time of day for data collection was varied to minimize bias within the sample. Data collection took place during the summer of 2009 at the Buffalo Bill Historical Center in Cody, Wyoming.

Results

This study aimed to provide support for two arguments about self-mapping: It is possible and it provides interesting data that are accurate. To address these arguments, the maps were analyzed first to identify what kinds of data were collected, or how "rich" the data were. Therefore, maps were coded by researchers for how much visitors saw of the museum (*level of extensiveness*) and how specific were the visitor behavioral recordings (*amount of detail*). After deciphering what the visitors reported and the clarity of the information, maps were assessed for the reliability of their information. To this end, reported visitor behaviors were analyzed for consistency within the sample and with other research findings in the field.

Richness of the Data

The self-mapping task elicited various levels of completeness from participating visitors with 135 deemed complete by researchers, 11 partially complete, and 1 illegible. The 11 partially complete maps were used for some analyses but tended to be missing a portion toward the end of the route. Visitor fatigue (with the exhibition, the task, or both) may have played a role, although no data were collected to support this. In cases of incomplete data, the reported data were used for partial evidence of movement patterns (e.g., right turn bias, choice point decisions, time in museum). Although all of the incomplete maps appeared to adhere to the dominant circulation patterns, they were not included in the calculations of route frequency and movement patterns. In all, there was less than 10% participant attrition using the self-mapping approach. Although circulation data were not complete for some of the maps, 100% of the maps were returned with usable time data (which was recorded by the researchers). The average time a visitor spent was 51.9 min ($SD = 39.4$; mode = 30), or a little under an hour. About 70% of the visitors we asked to carry a map throughout the museum exited within an hour of their start time, although the amount of time the visitors spent in the museum varied, ranging from 5 to 220 minutes.

Content analyses were completed on the maps that were at least partially completed ($N = 146$) to evaluate the quality and comprehensiveness of the self-mapping. The level of extensiveness and amount of detail present in each map were derived by assessing the amount of area they covered in the museum (extensiveness) and how completely the map was filled in (detail). Each map was evaluated by two independent evaluators and given two scores ranging from 1 (*not very extensive/detailed*) to 3 (*very extensive/detailed*). For example, an extensiveness score of 1 indicates a visitor whose map shows that he or she only made it through one side of the museum and stopped at only one or two exhibits. An extensiveness score of 3 indicates a map with a route that covered the museum footprint comprehensively. Table 1 provides the operationalization behind both of these measures. Agreement between the two sets of raters was high, with interrater reliability at .89 for extensiveness and .94 for detail.

Extensiveness indicates the level of exposure or the number of exhibits visitors passed by and is a measure of visitor movement throughout the museum. The largest portion of the visitors (42%, $n = 61$) was assigned a score of 2, or moderate extensiveness, and 21% ($n = 31$) of the maps were rated 3, or high in extensiveness (see Table 2). It is important to note that a high or low extensiveness rating does not necessarily define an engaged visitor, but merely acts as an indicator that might be of interest to museum officials that can be interpreted in many different ways depending

Table 1. Guidelines for content analysis of visitor self-maps

	Level		
Richness of data	1	2	3
Extensiveness	Visited only part of the museum	Visited both sides of the museum and made it to the back of museum	Traveled every exhibit pathway available on the map
Detail	Provided a basic line denoting their path through the museum	Provided a basic line denoting their path through the museum, but also incorporated directional symbols or stopping points	Provided a basic line denoting their path through the museum, but also included immense information related to stopping points, direction, exhibit names, etc.

on exhibition. For example, a visitor might only travel the mid-loop of the museum (see Figure 1), but spend 2 hours doing so while reading every piece of information provided by the curators. On the other hand, another visitor might track through the entire museum, but not necessarily spend much time or see all aspects of the exhibit.

The results pertaining to extensiveness levels support the argument that self-mapping can provide enough variation within the sample to look at visitor circulation differences and similarities. Additionally, level of extensiveness was significantly correlated with time spent in the museum (Pearson $r = .28$, $p < .01$). This suggests a relationship between time spent in the museum and the amount of space covered, but the moderate level of correlation leaves room for visitor variation in speed traveled throughout the museum and differing levels of engagement with the objects viewed.

The analysis for amount of detail assessed unsolicited reporting of behavior that provided more specific information about visitors' route in the museum, measured by extras that visitors provided on the map that were not asked for as part of the task. For example, a visitor might include arrows along the entire route or specify favorite

Table 2. Distribution of extensiveness level and detail level scores and mean visitation times for Study 1 and Study 2

	Study 1	Study 2	
Measure	Cued ($n = 145$)	Uncued ($n = 20$)	Cued ($n = 20$)
Extensiveness level Count (%)			
1	53 (37)	6 (30)	6 (30)
2	61 (42)	9 (45)	8 (40)
3	31 (21)	5 (25)	6 (30)
Detail level Count (%)			
1	58 (40)	n/a	6 (30)
2	61 (42)	n/a	13 (65)
3	26 (18)	n/a	1 (5)
Time (min) *M* (*SD*)	51.9 (39.4)	34.6 (17.9)	41.6 (20.6)
Total time (min) *M* (*SD*)	51.9 (39.4)	38.1 (19.4)	

places. In addition, some participants were more likely to clarify which exhibits they stopped at or passed by. This construct, therefore, does not pertain to the amount of material the visitor was exposed to, but the level of documentation of the material that they saw. The level of detail that visitors provided varied somewhat within the sample. It is important to note that despite the rating system, even the maps that were rated 1 for level of detail (40%, $n = 58$) were still considered adequate enough to obtain basic circulation patterns and timing data. The majority of visitors provided moderate detail (42%, $n = 61$), and a smaller percentage of visitors were placed into the high level (18%, $n = 26$). Although no level of detail was specified when the maps were given to visitors, the results indicate that nearly 60% of the participants (those with maps rated moderate or high) went above and beyond what was requested of them.

Reliability of the Data

The second research question assessing the reliability of the data is addressed in two analyses: Do the documented circulation patterns through the museum have internal consistency? Are the findings consistent with other research?

The maps were classified by the type of circulation patterns visitors took through the museum and analyzed for internal consistency. A majority of the visitors followed one of five routes shown in Figure 1: an outside loop, a mid loop, a left loop, a right loop, or an S-shaped loop. For example, the maps with an outside loop depicted visitors who traveled only the outside perimeter of the museum. In the S-shaped loop, participants did not follow the expected routes but, instead, seemed to find another path through the middle of the museum. Only 2 of the 147 maps did not show a pattern that could be categorized into one of these routes.

Research on traffic patterns in museums has suggested a right hand turn bias (e.g., Bitgood, 1995, 2006; Bitgood & Dukes, 2005). A majority of the visitors sampled in this evaluation also indicated that they went toward the right when first entering the museum. In fact, 92% indicated that they went right when entering in the museum and only 8% indicated that they went left. The alignment of this finding with previous observational findings suggests that self-mapping can act as an accurate assessment of at least some visitor behaviors, such as the right turn bias.

The results were compared to two other observational studies collected at the same institution, but in two different museums. The comparison studies included unobtrusive observational visitor tracking throughout the museum including circulation and timing. Those museums are smaller than the collections museum (14,100 square ft and 18,600 square ft compared to 30,200 square ft), but a comparison of sweep rate indices suggests that all three samples (obtained from the same general visitor population) were moving at roughly the same pace (SRI = 587 and 581, compared to 580). This comparison indicates that the timing data in this study are similar to other findings from the same institution, suggesting that the self-mapping data are a reliable measure of some visitor behaviors.

STUDY 2

Because Study 1 focused on research questions associated with the feasibility of self-mapping, Study 2 was undertaken to address concerns of validity attached to this method. We sought to answer two questions: Does cueing visitors (i.e., asking people to track their behavior)[1] affect their behavior, and do visitors accurately report their route? Study 2 was completed in the same museum as Study 1 and compared self-mapping with researcher observations.

To address these questions, two forms of data collection were included in Study 2: (a) an investigation of behavioral influences related to cueing, including researcher-recorded maps based on observations of visitors unaware that they were being observed (uncued maps), and (b) a test of the accuracy of self-report in behavioral mapping, with a sample of paired maps that included self-mapping by visitors who were simultaneously mapped by the researcher (cued maps). The latter sample was aware that they were participating in a research study, because they had been asked to map their pathway, but were unaware that they also were being observed by a researcher. The researcher's maps were used as a control for both the maps from Study 1 and the paired maps in Study 2. Overall, the data collected in this study targeted the reliability and validity of the self-mapping methodology by focusing on two sets of comparisons:

1. Across sample comparisons: First, to test reliability concerns, we examined whether there was variation in content among the three samples (i.e., Study 1, uncued sample of researcher behavioral observation, and the visitor cued sample included in the paired sample). The content will be tested across samples to evaluate if cueing (or the potential of cueing) influenced results. In this case, both Study 1 and the paired sample in Study 2 are cued and will be compared to the uncued sample in Study 2. In these analyses, constructs measured and evaluated in Study 1 will be used for the comparison (i.e., richness of data and circulation patterns).
2. Paired maps comparisons: Secondly, the issue of validity will be addressed with the paired maps in the cued sample in Study 2. The researcher maps and the visitor maps in this sample will be compared to investigate potential errors in self-report.

Method

Participants

A total of 40 visitors were included in this study. The uncued sample consisted of 20 visitors who were tracked unobtrusively during their visit, and the cued sample consisted of 20 visitors who participated in the self-mapping exercise. The response rate was 83% with four visitors not willing to participate in the self-mapping portion of the study. Reasons for non-participation were similar to those reported in Study 1 (e.g., in a hurry). Participants were traveling primarily in groups of one or two (82%).

Materials and Procedure

Participants were selected as they were walking into the museum around the time the researcher was available to track a new visitor. The uncued sample participated in a basic non-cued observational study. After participants were selected, they were unobtrusively tracked throughout the museum during their visit by a researcher. Procedures for the cued sample were similar to Study 1 in which visitors were approached and

[1]Usually cued/uncued terminology in visitor studies research refers to whether or not visitors know that the researcher is observing them. In this study, it is being used to indicate whether or not they are doing their own mapping—with the concern that merely prompting them about the research by having them fill out their own map might "cue" them and alter behavior somehow. Therefore, the terms *cued* and *uncued* are used in this study to help identify the two types of samples—with and without visitor self-mapping.

asked to participate in the self-mapping task during their visit. Similar instructions as Study 1 were given to the visitors as they were handed the map. After the participant had the map in hand and began the route in the museum, the researcher simultaneously monitored the behavior of the visitor. The researcher used the same map as visitors to track the movements of the visitor (see Figure 1).

Because two methods were being used for a single participant in the cued sample, it was important not to allow visitors to know they were being observed to minimize behavioral influence. Because of participation in the self-mapping exercise, the visitors were already cued to the fact that research was going on and therefore were more likely to notice that they were being observed. In this instance, the researcher took special care to remain as invisible as possible while tracking visitors. The researcher was able to do this successfully because of the design of the museum (i.e., multiple sections) and the use of observational techniques such as tracking from a distance or passing by quickly as if on the way to do something in a different area of the museum.

Results

Across Sample Comparison

Analyses compared the three sets of map data. Richness of data (extensiveness and detail), movement, and timing were compared across samples to assess reliability.

Richness of data. Overall, results detailing level of extensiveness in the Study 2 mapping data were similar to that of Study 1. A chi-square analysis indicated there is no significant association between sample and extensiveness level, $\chi^2(4, N = 185) = 1.07$, $p = .296$. To ensure this was not because of a small sample size, Fisher's exact test was included in the statistical analysis revealing a non-significant association ($p = .202$). The results indicate there is no difference in the distribution of extensiveness levels between any two of the three samples.

The level of detail assigned to each map in Study 2 shows similar trends as Study 1 (see Table 2). For example, at least 60% of the sample was assigned detail ratings greater than 1, again indicating that over half of the sample went above and beyond the instructions in both studies regardless of whether they were cued or not. Additionally, a nonsignificant Fisher's exact test indicates that there is no association between detail level and sample ($p = .136$).

Movement and timing. Similar to Study 1, 95% of the sample ($n = 38$) was documented as going to the right when entering into the museum. As shown in Table 3, circulation patterns in Study 2 were similar to Study 1, with a majority of maps containing either an outside loop (30%) or an S-shaped loop (25%). A chi-square analysis indicates a lack of significant variation in circulation patterns between studies, $\chi^2(5, N = 185) = 1.12$, $p = .950$. In contrast, recorded time spent in the museum was significantly lower for this sample compared to Study 1, $t(121) = 3.208$, $p = .002$ (see Table 2). A more nuanced comparison breaking the Study 2 sample into cued and uncued groups reveals less clear cut differences between the three samples, $F(2,182) = 2.871$, $p = .059$. The cued sample in Study 2 is not significantly different from the cued sample in Study 1, $t(38) = -1.15$, $p = .258$, suggesting that there is

Table 3. Count distribution of maps indicating each visitor circulation pattern in Study 1 and Study 2

Route	Study 1 count (%) ($n = 145$)	Study 2 count (%) ($n = 40$)
Outside	46 (32)	12 (30)
Midway	19 (13)	6 (15)
Center	9 (6)	1 (3)
Right	16 (11)	4 (10)
S-shaped	33 (23)	10 (25)
All	22 (15)	7 (18)

not a clear understanding of how cueing in self-mapping influences time spent in the museum.

Paired maps. To assess reliability and validity, pairs of maps for each visitor were compared. The comparison included the richness of data constructs and evaluated both maps in the cued sample of Study 2. An independent samples *t* test indicated that there was no significant difference in the mean extensiveness level between the researcher map and visitor map, $t(38) = .237$, $p = .814$. Similarly, the loop contour assignments were compared between the researcher and visitor maps reflecting a nonsignificant Fisher's exact text, $p = .982$ (see Table 4). These results demonstrate that the paired maps were rather consistent between researcher and visitor, therefore suggesting that the visitor is accurate in their reporting.

GENERAL DISCUSSION

Overall, self-report mapping was an effective adaptation that provided rich and accurate data about general timing and circulation patterns of a collections museum without overtaxing the personnel and evaluation budget. It is important to note that the self-report mapping method introduced in this study did not attempt to gather more detailed information typically provided by visitor tracking (e.g., holding power, or the amount of time visitors spend at particular exhibit components). The most important implications of these results are that when cost and time constraints are present, self-mapping can be a viable evaluation option.

Table 4. Mean extensiveness levels and distribution of circulation patterns for maps completed by the researcher and the visitors

Measure	Researcher	Visitor
Extensiveness level *M* (*SD*)	1.95 (.60)	2.00 (.72)
Route Count (%)		
Outside	6 (30)	7 (35)
Midway	2 (10)	2 (10)
Left	1 (5)	1 (5)
Right	2 (10)	2 (10)
S-shaped	6 (30)	7 (35)
All	3 (1)	1 (5)

Results demonstrate the ability to gather interesting information related to mapping content provided by visitors. Results from Study 1 suggest that self-mapping can produce data that are complete, detailed, and informative. In addition to providing valuable information, the collected data were similar to other research findings. Furthermore, circulation patterns identified in Study 1 support the claim that visitors have some internal consistency in route behavior across the sample. That is, the same visitor patterns that were present in Study 1 were also identified in Study 2. This supports that notion that behaviors in the two samples were similar.

The validity and reliability of self-mapping were further explored in Study 2 by testing the effects of cueing visitors on map content, showing that self-mapping can increase efficiency of data collection without any deficit to the accuracy of certain portions of the task. It was shown that there was little variation across samples in Study 1 and Study 2 (in both the cued and uncued conditions) in the richness of data and in the distribution of circulation patterns. In addition, the paired maps in the cued sample (Study 2) allowed for direct comparison of the information provided by the visitors. Results demonstrated that regardless of who is recording the behavior (i.e., visitor or researcher), the map data, specifically the measure of extensiveness, were similar.

It is important to highlight one other finding: The act of self-mapping had an influence over the time visitors spent in the museum, encouraging them to spend more time (Table 2). Though this was not an original focus of these studies, it was noticed during data analysis. The average duration of cued samples ranged from 6 to 16 minutes longer than the uncued sample. There are at least two possible explanations of why self-mapping increases visitation time. First, self-mapping cues visitors to the fact that they are participating in a research study, possibly encouraging longer visitation via demand characteristics of appearing interested or engaged. Second, the act of self-mapping itself might take additional time, which could be added to the regular, uncued visitation time. Research by Serrell (2000) dealing with the issue of cued versus uncued visitation times offers some insights into which explanation is more likely. Serrell found that for museums averaging visits less than 20 minutes in length, cuing visitors was related to increases of 25% to 100% in time spent in the museum. However, for museums averaging visitation over 20 minutes, an effect of cuing was not present. In the current research, the average visitation time exceeds 20 minutes (i.e., 34.6 minutes in the uncued condition in Study 2) suggesting that being cued via recruitment for the self-mapping exercise should not impact times considerably. Thus, it is more likely that the actions involved with self-mapping (e.g., recording the path being followed, orienting using the map) were likely driving the increase in visitation time. This potential confound could be the topic of further research that compares uncued and cued samples and should be collected simultaneously and with more participants than in Study 2.

There are limitations of utilizing the self-mapping technique. Evaluations using the self-mapping technique in museums or exhibitions with short visitation times will need to consider the consequences of cuing on time estimation. Also, the efficiency of the self-mapping method diminishes as the average visitation time shortens because researchers could conduct more unobtrusive observations in the same amount of time in locations with short visits. Other situations, such as interactive components in science museums, may change the effectiveness of this method. Asking visitors to self-map limits the use of their hands and some visitors may not enjoy the hassle. Similar concerns could arise with individuals pushing strollers or wheelchairs. Self-mapping also is limited in the types of data that can be collected. Although this article highlights the information that can be garnered from self-mapping, other kinds of data, such as time spent at exhibit components, might be more challenging to document.

Self-mapping can increase the efficiency of data collection in certain situations without compromising accuracy or richness of the data. Thus, the real-time tracing of routes by visitors represents a valid alternative to observational tracking. Other methods have been explored that allow visitors to map their route through a recreation area after their visit. For example, Deans, Martin, Neon, Nusea, and O'Reilly (1987) asked visitors to retrace their circulation route through a zoo. Similarly, the Association of Zoos and Aquariums' (2012) research on visitation motives employed a "reflective mapping" approach in which visitors reported at the conclusion of their visit where they went within the institution. In these instances, retracing or reflecting worked to maximize efficiency, similar to self-mapping, but also added an element of retrospective recall that might compromise the accuracy of the findings. Retrospective reporting also inhibits recording accurate timing data since time perception is often flawed. Self-mapping minimizes the effect of potential memory lapses by asking visitors to trace their route as they pass through the museum and timing is handled by the researchers rather than the visitor. In addition, the results show that self-mapping did not limit the richness of the data and there is potential to enhance the data. For example, the pilot nature of the methodology resulted in researchers keeping instructions simple. Despite this, time and circulation data could be extracted from nearly all maps. In the future, additional instructions can be added to enrich the data further or to pinpoint questions for a particular museum or element in the museum.

In conclusion, these results indicate that self-mapping should be considered an appropriate and valid method for the evaluation of leisure environments in certain situations without compromising reliability or validity of the results. This method is an effective and efficient tool that can be added to a researcher's toolbox for certain evaluation efforts in museums.

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ABOUT THE AUTHORS

Gretchen Nurse Rainbolt is currently an Adjunct Professor in the Family and Consumer Science department at University of Arizona. Her research is based in Environmental Psychology and covers such topics as sustainable consumer behavior, visitor studies, decision making, and attitudes and values related to natural resources. Address correspondence to: University of Arizona, Norton School of Family and Consumer Science, 650 N. Park Ave., Tucson, AZ 85721 USA. E-mail:gnurse@email.arizona.edu.

Jacob Benfield is an Assistant Professor at Penn State University's Abington College where he specializes in environmental psychology and interpersonal conflict. His primary focus within museum visitor studies includes methodology and the role of physical environment on visitor experiences.

Ross J. Loomis is Psychology Professor Emeritus at Colorado State University. He completed his doctoral work at the University of Denver and sabbatical work at the Smithsonian Institution and the University of Karlsruhe in Germany. He has also done sabbatical research at the Stiftung Haus der Geschichte der Bundesrepublik Deutschland in Bonn, Germany. Research interests have included environmental quality issues, such as clean air, and museums as unique learning and leisure settings.