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ARTICLE

Examining science capital of adult audience members at public science events

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Abstract

Visitors to public science events (PSEs) often report gains in scientific knowledge, improved attitudes toward science, and a greater awareness of science in everyday life [Jensen & Buckley, 2014; Adhikari et al., 2019; Boyette & Ramsey, 2019]. However, these visitors disproportionately come from white, well-educated backgrounds [Bultitude, 2014; Kennedy et al., 2018; Adhikari et al., 2019; Nielsen et al., 2019]. This paper utilizes a science capital framework to analyze the differential patterns of participation among PSE audiences. Quantitative analysis approaches are used to explore the kinds of science capital that visitors bring to PSEs, how the science capital of audiences differs between events, and how science capital might predict future participation in PSEs. Results reveal that PSE visitors typically have high pre-existing levels of science capital and that those with high levels of science capital are more likely to express interest in attending future PSEs. Directions for future research and practice are discussed.

Keywords

Diversity, equity, inclusion and accessibility in science communication; Informal learning; Science education

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1 ▪ Introduction

In the last two decades, public science events (PSEs) have become an important part of public science engagement. Visitors to PSEs often report that these events increase their scientific understanding, improve their attitudes toward science, increase their awareness of science in everyday life, and increase their awareness of STEM career paths [Jensen & Buckley, 2014; Pennisi & Lackey, 2018; Adhikari et al., 2019; Boyette & Ramsey, 2019]. However, these benefits have largely been conferred to white, well-educated individuals who are already interested in science to some degree [Bultitude, 2014; Kennedy et al., 2018; Adhikari et al., 2019; Nielsen et al., 2019]. In order to move toward practices which are more equitable and inclusive, researchers and practitioners must better understand why this is the case. One way to contextualize the disparities in PSE participation among different groups is through the lens of science capital [Archer et al., 2015]. Gathings and Peterman [2021], for example, utilized existing science festival data to predict shifts in science capital among attendees. This paper builds on that work by administering a validated science capital survey instrument to adult audiences at three different kinds of PSEs: a science café, a science festival, and a maker faire. Survey responses are used to identify trends in science capital and PSE participation which could inform the dismantling of inequitable practices in the informal science community.

2 ▪ Background

PSEs are an increasingly common mode of informal science engagement in the 21st century. Research has identified a number of benefits for those who attend PSEs. These benefits include increases in science content knowledge, improved attitudes toward science, increased awareness of science in everyday life, and a higher awareness of science-related career opportunities [Jensen & Buckley, 2014; Pennisi & Lackey, 2018; Adhikari et al., 2019; Boyette & Ramsey, 2019]. However, studies of PSE attendees show that the beneficiaries of these events are primarily white, well-educated, middle-class families [Bultitude, 2014; Nielsen et al., 2019]. It follows, then, that PSEs may be working to exacerbate the pre-existing social and cultural inequities present within the broader science community [see Asai, 2020; Martin & Fisher-Ari, 2021]. This paper hypothesizes that families who attend PSEs use these events as opportunities to further entrench themselves within the broader science community, reaping the benefits of informal science participation while families from marginalized backgrounds are excluded.

One way to conceptualize the differential impacts of PSEs among social classes and cultural groups is through science capital. Science capital is a conceptual tool which captures an individual's science-related cultural and social capital, as well as their science-related behaviors and practices [Archer et al., 2015]. The concept of science capital is derived from Bourdieu's [1986] notion of capital which describes the accumulation of knowledge, status, and power by privileged classes. Bourdieu notes that social and cultural norms work to entrench privileged classes atop a social hierarchy while marginalizing other groups.

Science-related cultural capital can be broadly defined as an individual's scientific knowledge and their disposition toward science. According to Bourdieu and Wacquant [1992], families play a formative role in the transfer of cultural capital. Parents who socialize their children within the norms and traditions of science — for example by providing them opportunities to engage in scientific practices — confer to them a sense of familiarity and belonging in spaces where science is valued. Researchers have used science-related cultural capital to explain differential patterns in young students' STEM career aspirations [Archer et al., 2015; Thompson et al., 2016] as well as their science identities [Thompson & Jensen-Ryan, 2018]. Some evidence suggests that PSEs may also play a role in the transmission of science-related cultural capital. A retrospective study by Gathings and Peterman [2021] showed that science festival attendance was associated with potential gains in science-related cultural capital, particularly for underrepresented groups. Boyette and Ramsey [2019] demonstrated that science festival attendees who interacted with scientists were more likely to report an increased interest in science as well as increases in science content knowledge. To better understand the role of PSEs in the transmission of science-related cultural capital, direct assessments of science capital in PSE contexts are needed.

An individual's science-related social capital encompasses the relationships they have within the science community. Parents, teachers, friends, and co-workers may all act as sources of social capital. For example, young students who have family members who work in science-related fields are more likely to aspire to science-related careers of their own [Archer et al., 2012]. In STEM classrooms, student motivation and engagement increase when teachers foster supportive learning environments [Wang & Degol, 2013]. According to Bourdieu [1986], these kinds of social relations can amplify a student's ability to pursue their own interests within a community of practice. PSEs, then, are well-suited for enhancing visitors' science-related social capital because they provide opportunities for visitors to meet science professionals, hobbyists, and other members of the broader science community [Foster et al., 2014; Wiehe, 2014; Boyette & Ramsey, 2019].

The third and final source of science capital is an individual's science-related behaviors and practices. This includes the consumption of science-related media such as television programs and books [Ho, 2010], participation in after-school science clubs [National Research Council, 2009], visits to museums [Falk & Dierking, 2013], and conducting science experiments at home [Zimmerman, 2012; Jones et al., 2018], all of which have been shown to influence an individual's scientific knowledge and/or their disposition toward science. Similarly, PSEs also provide hands-on opportunities for visitors to participate in scientific practices and reasoning. It follows that this component of science capital may be amplified through PSE participation.

The amount of science capital an individual possesses determines their status within the scientific community and the extent to which they are able to participate in informal science education opportunities [see Bourdieu, 1986; Archer et al., 2015]. Moreover, those with high levels of capital are more readily able to accumulate further capital [Bourdieu, 1986]. By understanding the nature of science capital that attendees bring to PSEs, and subsequently how PSEs promote the accumulation of science capital among privileged groups while excluding others, we may come to a better understanding of how these events work to maintain existing inequities in science. Furthermore, this understanding might inform how PSEs can be leveraged to dismantle inequities in science.

Although adult science capital has been assessed in other settings, particularly among postsecondary students [Turnbull et al., 2020; Godec et al., 2024; Stearns et al., 2024], no studies have directly assessed adult science capital in informal learning contexts. In light of this, calls have been made for researchers to further investigate how PSEs and other informal learning contexts foster science capital [Gathings & Peterman, 2021; Kontkanen et al., 2025]. The study outlined here responds to these calls by evaluating the science capital of public audiences at three PSEs: a science expo, a science café, and a maker faire. Broadly, the purpose of this study is to identify patterns of science capital among visitors to PSEs (ages 18+) and to determine how these patterns might inform future participation in PSEs. The study was guided by three research questions:

1. What kinds of science capital do audiences bring to PSEs?
2. To what extent do audience characteristics predict science capital of PSE visitors?
3. Does science capital inform visitors' intentions to attend future PSEs?

3 ▪ Methodology

3.1 ▪ *Participants and setting*

The study sample is comprised of 141 audience members (ages 18+) from three different kinds of PSEs at the North Carolina Science Festival: the University of North Carolina (UNC) Science Expo in Chapel Hill, a science café in Chapel Hill, and a maker faire in Asheville. Demographic information about participants is contained in Figures 1–4. These events were purposefully selected because they represented three common PSE formats and were large enough to facilitate quantitative analyses. Approval to collect data on human subjects was obtained through the Institutional Review Board at the university where the researcher was employed. It should be noted that the cities of Chapel Hill, NC and Asheville, NC are considered to be wealthier and more educated than typical North Carolina municipalities [see US Census Bureau, 2020], complicating analyses related to equity. To account for this, descriptive statistics were used to compare audience demographics to local populations rather than state or national populations.

The UNC Science Expo is a signature event of the annual North Carolina Science Festival. The event features over 100 exhibitors from university research labs, student groups, community organizations, and local businesses from Chapel Hill, NC and the surrounding areas. Each year, around 10,000 visitors attend the UNC Science Expo, which features hands-on activities, live science demonstrations, and behind-the-scenes lab tours. Families with children comprise the primary demographic of the event.

The science café event was held at a local brewery in Chapel Hill, NC. At the event, a computer science researcher from UNC gave a presentation about the rising popularity of language models to an audience of 41 adults. After the 30-minute presentation, a 15-minute open Q&A session was held.

The Asheville Maker Faire is another annual North Carolina Science Festival event, hosted in Asheville, NC. At this event, engineers, artists, scientists, and local organizations facilitate hands-on activities for families with children. Over 1,000 visitors attend this event annually.

3.2 ▪ *Instrumentation*

Audience members were asked to complete a brief (5 minute) survey. The survey was comprised of four items related to demographic information, nine items corresponding to

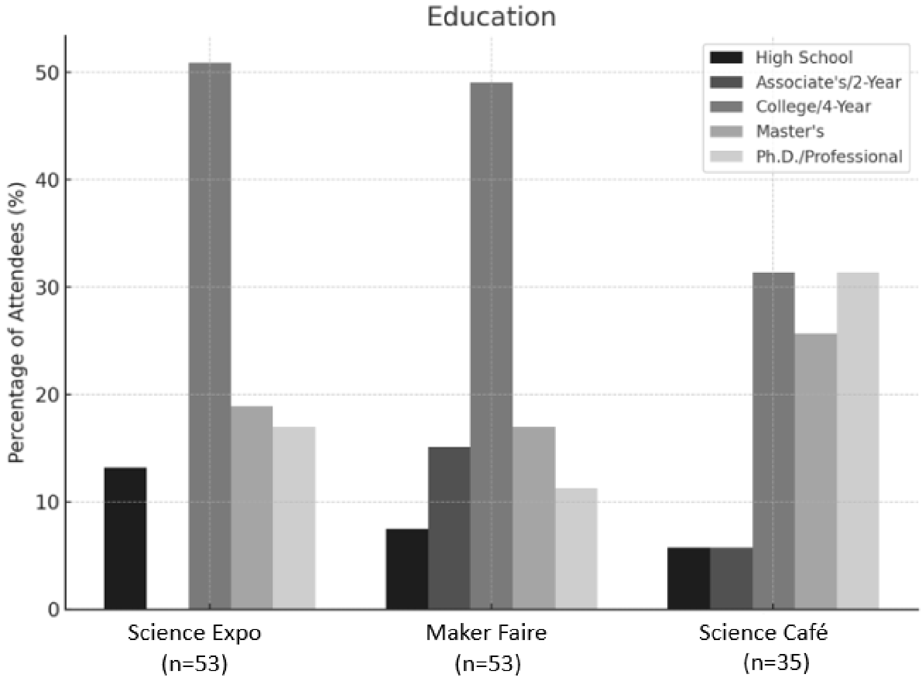

Figure 1. Education level of PSE attendees.

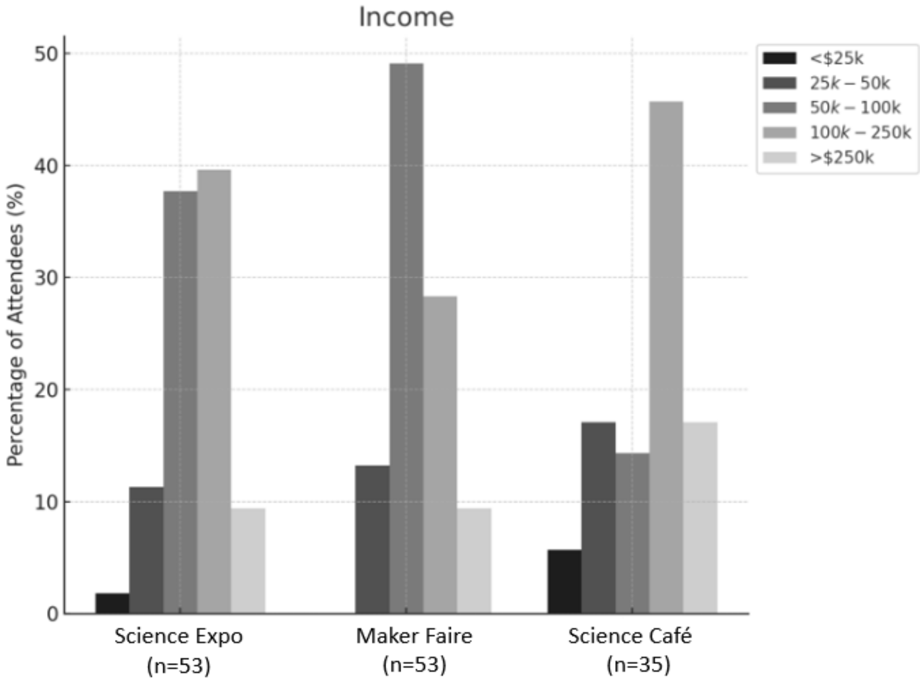

Figure 2. Income level of PSE attendees.

the various dimensions of science capital, and one question corresponding to visitors' future PSE participation (Supplementary material, Appendix A). Science capital and science participation items were administered as Likert-scale questions with 4 to 6 possible responses. For each PSE visitor, a science capital "score" was compiled by summing

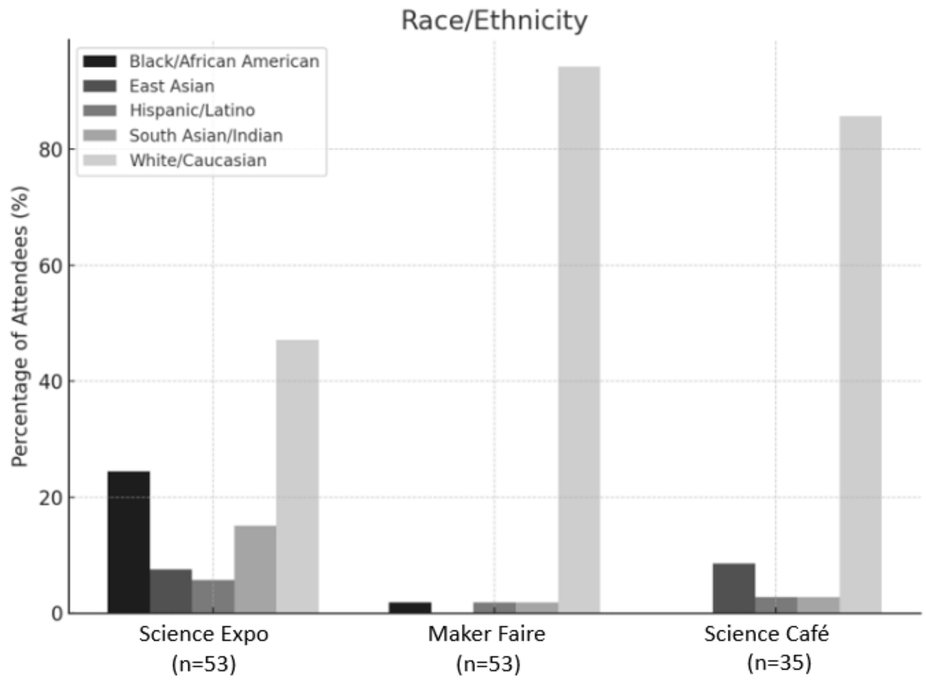

Figure 3. Race/ethnicity of PSE attendees.

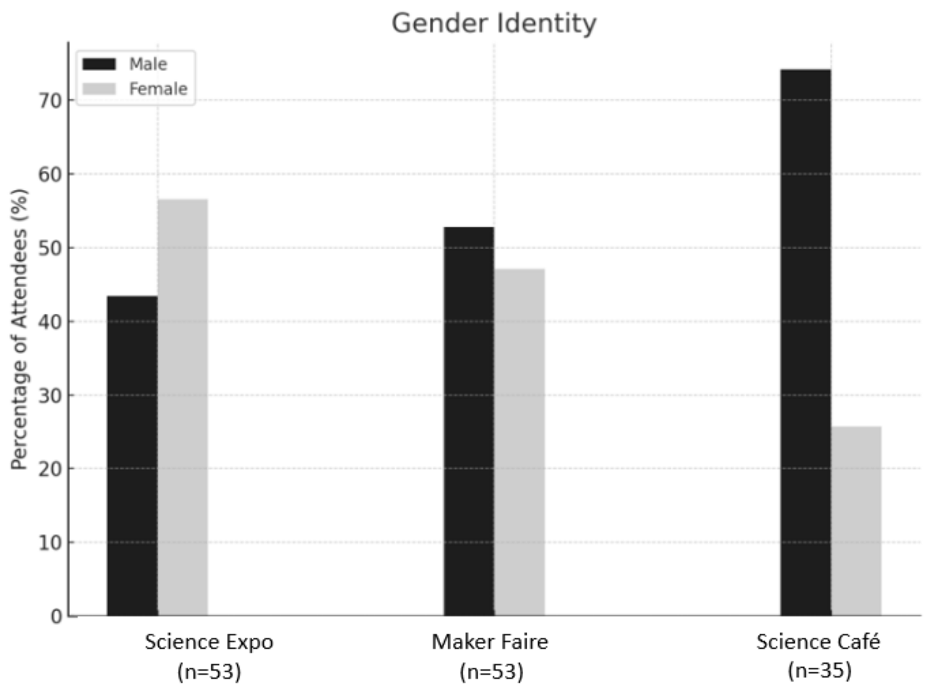

Figure 4. Gender identity of PSE attendees.

together their responses to each of the nine science capital survey items. Science capital questions were initially developed for secondary school students and later modified for adult populations [Archer et al., 2015; UK Department of Business, Energy, & Industrial Strategy, 2020]. In previous analyses, values for Cronbach's alpha for science capital items ranged from 0.729 to 0.854, indicating acceptable reliability for attitudinal instruments [Archer et al., 2015]. Construct validity for adult science capital items was determined in a separate research study through a principal components analysis, though validity coefficients were not published [UK Department of Business, Energy, & Industrial Strategy, 2020]. Content validity was determined through a systematic review of the science education literature [Archer et al., 2015].

3.3 ▪ *Sampling procedure*

In alignment with other PSE evaluation studies [see Peterman & Gathings, 2019; Gathings & Peterman, 2021], survey data for large PSEs with 50+ visitors (e.g., the science expo and maker faire) were collected via a visitor intercept method. Using this method, the researcher selected spot to stand near a highly-trafficked area of the PSE. They then drew an imaginary line across the flow of foot traffic from where they were standing and counted the individuals and groups that walked by. For the purposes of this data collection, each group of visitors counted as one unit. The researcher approached every fifth unit to ask whether or not they would be willing to complete the survey. For groups that consented to the survey, the researcher asked one person among the group, selected at random, to complete the survey. Surveys were completed on a tablet provided by the researcher.

For the science café, which was a smaller event (< 50 people), the consensus method of data collection was used. Under this method, the researcher administered the survey to every consenting member of the audience.

All visitors who agreed to complete the survey — approximately 74% of those who were approached — were provided a consent form. The consent form contained general information about informal science education research and explained the purpose and scope of the survey. This form also explained that there were no known risks or benefits to participants with regard to completion of the survey, that participation was voluntary, that participants retained the option to skip any questions they wished to, that participants had the ability to stop the survey at any time, and that all data were collected anonymously.

An a priori power analysis was conducted using G*Power [Faul et al., 2007] to determine the minimum sample size needed for the study. Effect size estimations were based on data from Moote et al. [2020] who demonstrated a medium-to-large effect of science aspirations on science capital. Using $\alpha = .05$ and power = .80, the estimated minimum sample size needed to detect a medium-sized effect ($d = .30$) of PSE participation on science capital was 111 (or 37 per group). The sample size obtained was 141.

3.4 ▪ *Data analysis*

Three sets of analysis were conducted, each corresponding to a specific research question. First, special consideration was paid to the types of science capital that audiences bring to PSEs. Descriptive statistics were used to identify particular components of science capital which scored higher or lower than expected. A series of ANOVAs were also conducted to identify which components of science capital might be differentially distributed according to audience demographics. Next, a multiple regression analysis was conducted to determine which variables significantly predicted science capital. Finally, as the third research question sought to investigate differences in future PSE participation on an ordinal scale, an ordinal logistic regression analysis was used.

4 ▪ Results

After presenting descriptive statistics of science capital among PSE audiences and comparing them to local Census data, this section discusses results from the four sets of analysis corresponding to each of the three research questions. A brief synthesis of results is included at the end of the section.

4.1 ▪ *Descriptive statistics of science capital among PSE audiences*

Science capital was measured on a continuous scale with an overall mean of 79.77 and a standard deviation of 16.47 (Table 1 & Figure 5). In accordance with previous science capital research [see Archer et al., 2015], scores between 0 and 34 were categorized as low science capital. Scores between 34.5 and 68 were categorized as a moderate level of science capital, while scores between 68.5 and 102 were considered to be high science capital. Science café participants demonstrated the highest average value of science capital (86.27) compared to science expo (77.72) and maker faire (77.5) participants.

Fifty-three participants were surveyed at a university science expo in Chapel Hill, NC. Of these, 18 were categorized as having a moderate level of science capital, and 35 were identified as having high science capital. Racial demographics of participants at the expo were comparatively more diverse than census data for the surrounding area (e.g., 45.3% white for the expo, 70.1% white for the town of Chapel Hill) [US Census Bureau, 2020]. The level of education was also higher for participants (86.8% with at least a college/4-year degree) than for the town of Chapel Hill (78.5%). The median reported household income for participants was between $50,000 and $100,000, which falls in line with $77,037 median household income reported by the Census [US Census Bureau, 2020]. It should be noted, however, that 49% of participants reported an income above $100,000. Over half (56.6%) of participants identified as female.

Thirty-five science café participants completed the science capital survey. Thirty-two (91.4%) attested to having a high level of science capital. Three participants (8.6%) were categorized as having a moderate level of science capital. This event was overwhelmingly white (85.7%)

Table 1. Descriptive statistics for science capital.

	Science Expo (n = 53)	*Maker faire* (n = 53)	*Science Café* (n = 35)	*Overall*
Science Capital				
Average	77.72	77.5	86.27	79.77
Standard Deviation	18.53	13.92	15.39	16.47
Categorization	%	%	%	%
Low Science Capital	0.0	0.0	0.0	0.0
Moderate Science Capital	34.0	22.6	8.6	23.4
High Science Capital	66.0	77.4	91.4	76.6

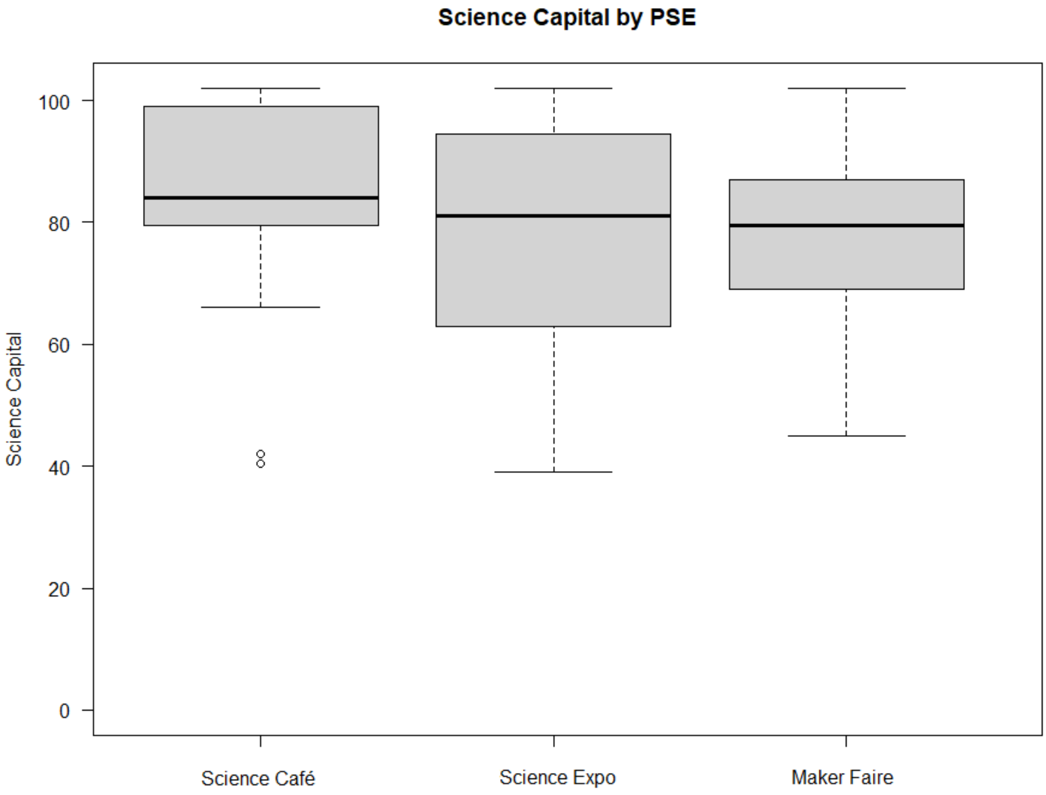

Figure 5. Boxplots of science capital by PSE.

and male (74.2%) (Figures 1–4). Additionally, 88.6% of participants had attained at least a college/4-year degree. The median reported household income of participants at the science café was between $100,000 and $250,000. Comparing these data to [2020] Census data for the town of Chapel Hill, it is clear that this particular event was disproportionately white, male, well-educated, and high-income.

Fifty-three participants were surveyed at a maker faire in Asheville, NC. Of these, 41 (77.4%) were categorized as having high science capital while 12 (22.6%) were categorized as having moderate science capital. This event was disproportionately white (94.3%) and well-educated (77.4% with at least a college/4-year degree) compared to Census data (81.4% and 50.8%, respectively) [2020]. The median reported household income for participants was between $50,000 and $100,000, which aligns with Census data for Asheville ($58,193). As with the science expo participants, however, it is worth noting that a striking number of participants (37.7%) reported a household income above $100,000.

4.2 ▪ *Analyzing the types of science capital among PSE audiences*

To better understand the types of science capital that audiences bring to PSEs, a descriptive analysis of individual science capital components was conducted (Figure 6). Across the board, PSE audiences scored highly on each of the nine survey items. In particular, participants overwhelmingly reported having an interest in science, with 139 of 141 (98.6%) responses of *agree* or *strongly agree*. This aligns with the findings of Bultitude [2014], who showed that science festival attendees tend to be already interested in science to some

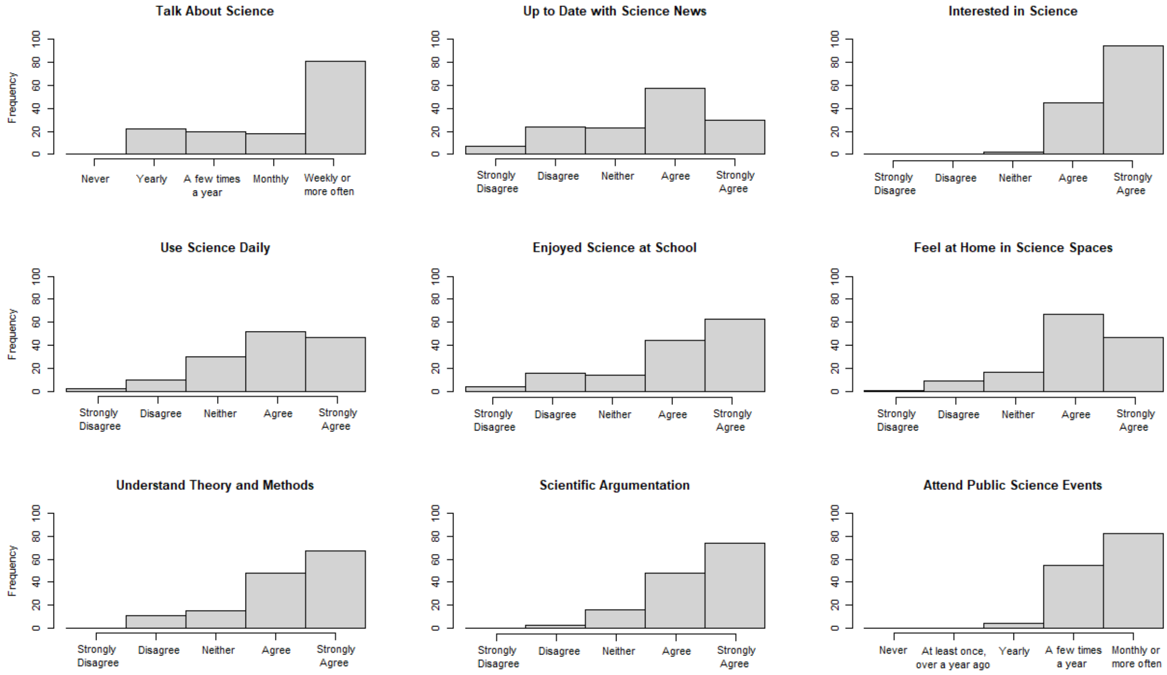

Figure 6. Science capital survey results.

degree. Perhaps unsurprisingly, 137 of 141 (97.1%) of participants also reported that they attend PSEs at least once a year.

For four of the seven survey items requiring a level of agreement, *strongly agree* was the most common response. For the remaining three items, *agree* was the most common response. It is worth noting that the highest levels of disagreement (i.e., *disagree* or *strongly disagree*) were observed in the items related to being up to date with science news (22.0%), having enjoyed science at school (14.2%), and using science daily (8.5%). The highest numbers of neutral responses were observed in the items related to using science daily (21.3%), being up to date with science news (14.8%), and feeling at home in science spaces (12.1%).

A series of ANOVAs and non-parametric tests (e.g., Kruskal Wallis H tests, pairwise Wilcoxon rank sum tests) were conducted to examine differential patterns in individual science capital items. In general, there was little evidence for statistically significant differences in individual science capital items among race/ethnicity, gender identity, and income groups. Some notable patterns, however, were observed for varying levels of education. For example, pairwise Wilcoxon rank sum tests showed that participants with Ph.D. or professional degrees expressed more agreement with statements related to feeling at home in science spaces ($p = .008$), using science daily ($p < .001$), understanding theory and methods ($p = .007$), and talking about science ($p = .002$) than did participants with college/4-year degrees.

4.3 ▪ *Determining predictive factors of science capital*

In the second round of analysis, science capital was regressed on education, gender identity, race/ethnicity, reported household income, and PSE site. The backward elimination method of variable selection was used to isolate predictors which significantly contributed to science capital [Chowdhury & Turin, 2020]. Due to heteroscedasticity within the data, weighted least squares regression was preferred to ordinary least squares regression.

The selection of reference groups for the regression analysis was based on guidance from Johfre and Freese [2021]. To avoid the pitfall of treating culturally dominant groups as the baseline for social comparisons — a practice which may contribute to the continued disenfranchisement of marginalized groups — reference groups were selected based on predicted group means (Table 2). To account for interpretability and weighting considerations, unstandardized regression coefficients (B) and standard errors (SE) are reported in Table 2.

Under the backward elimination method of variable selection, all variables are entered into the model and then sequentially removed according to specified cutoff criteria. Here, the

Table 2. Model selection for science capital.

	Full Model	*Model 2*	*Model 3*	*Model 4*	*Model 5*
Intercept	72.97	74.30	75.68	76.32	87.13
PSE Site	B (SE)				
Maker faire (reference)					
Science Expo	0.66 (3.41)				
Science Café	2.98 (3.15)				
Race/Ethnicity	B (SE)	B (SE)			
Hispanic/Latino (reference)					
Black/African American	7.21 (8.92)	6.59 (8.80)			
East Asian	4.28 (9.58)	4.61 (9.54)			
South Asian/Indian	14.54 (8.92)	13.84 (8.82)			
White/Caucasian	4.43 (8.30)	4.15 (8.19)			
American Indian/Alaska Native	18.17 (15.57)	18.38 (15.47)			
Gender Identity	B (SE)	B (SE)	B (SE)		
Female (reference)					
Male	3.78 (2.49)	4.39 (2.37)	3.35 (2.34)		
Reported Household Income	B (SE)	B (SE)	B (SE)	B (SE)	
Under $25,000 (reference)					
$25,000–$50,000	10.65 (8.53)	11.85 (8.40)	16.26 (8.42)	9.57 (8.51)	
$50,000–$100,000	19.72* (8.57)	21.86* (8.24)	20.91* (8.31)	20.68* (8.35)	
$100,000–$250,000	15.48 (8.53)	17.16 (8.32)	16.26 (8.42)	16.59 (8.45)	
Over $250,000	13.17 (8.98)	14.66 (8.81)	16.07 (8.87)	16.79 (8.89)	
Education	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)
High School (reference)					
Associate's/2-Year	20.17* (6.87)	20.39* (6.69)	19.10* (6.76)	18.72* (6.78)	14.47* (5.14)
College/4-Year	11.54* (5.57)	11.94* (5.50)	11.76* (5.56)	11.74* (5.58)	7.34 (5.52)
Master's	20.26* (6.01)	20.94* (5.91)	22.08* (5.96)	22.53* (5.98)	18.75* (5.66)
Ph.D./Professional	24.66* (6.19)	25.55* (6.05)	28.35* (6.06)	29.31* (6.05)	24.57* (5.54)
Adjusted R^2	.3014	.3073	.2852	.2795	.2345
Residual Standard Error	1.277	1.277	1.30	1.302	1.342
BIC	1209	1201	1186	1183	1176

* $p < 0.05$.

variable with the highest regression p-value greater than 0.05 was removed at each step. This process continued until all variables demonstrated significance at the 0.05 threshold. The full model containing all the predictor variables was:

$$Y_{\text{science\_capital}} = \beta_0 + \Sigma\beta_i X_{\text{education\_i}} + \Sigma\beta_j X_{\text{gender\_j}} + \Sigma\beta_k X_{\text{income\_k}} + \Sigma\beta_l X_{\text{PSE\_l}} + \Sigma\beta_m X_{\text{race\_m}} + \varepsilon$$

The PSE site, race/ethnicity, and gender identity variables were removed from the model in stepwise fashion because they did not fall within the specified p-value threshold (Table 2). This left a model which contained the education and income variables. The education variable continued to demonstrate statistical significance at all categorical levels, while the income variable showed significance at only one categorical level (*Between $50,000 and $100,000*). From here, four more models were considered: a model containing only income, a model containing only education, a model containing both variables, and a model containing both variables with an interaction term. The interaction term did not demonstrate significance. After comparing the adjusted R^2 values, residual standard errors, and BIC values for each model, it was determined that the trimmed model containing only the income and education variables was the most parsimonious.

4.4 ▪ *Using science capital to predict future PSE participation*

An ordinal logistic regression analysis was conducted to investigate the relationship between participants' science capital and their intentions to pursue PSE opportunities in the next 6 months. The outcome variable, future PSE participation, was assessed via a Likert-scale question with possible responses of *strongly disagree*, *somewhat disagree*, *somewhat agree*, and *strongly agree*. The ordinal logistic regression model can be defined as:

$$\operatorname{logit}\left(P(Y \leq j)\right) = \beta_{j0} + \beta_1 X_1 + \ldots + \beta_p X_p$$

where $P(Y \leq j)$ is the cumulative probability that Y is less than or equal to a specific category, $j = 1, \ldots, J-1$, taking into account *p* predictors.

Beginning with the statistical model including all of the independent variables, the backwards elimination method was used to remove nonsignificant predictors [Bursac et al., 2008]. What remained was the ordinal logistic regression model containing only the science capital and education variables:

$$\operatorname{logit}\left(P(Y \leq j)\right) = \beta_{j0} + \beta_1 X_{\text{science\_capital}} + \beta_2 X_{\text{education}}$$

To facilitate interpretation, the education variable was treated as an ordinal variable with 5 levels (1 = High school, 2 = Associate's/2-year, 3 = College/4-year, 4 = Master's, 5 = Ph.D./Professional). Each one-level increase in education is associated with more years of education (e.g., an Associate's degree requires 2 years of education which can be utilized for vocational training or as a stepping stone for pursuit of a college/4-year degree). Brant test results indicated that the proportional odds assumption held for this model.

The model containing science capital and education was found to explain a significant amount of variation over the intercept-only model ($\chi^2(2) = 42.04$, $p < .001$). Science capital ($\beta = .056$, SE = .012, OR = 1.058, $p < .001$) and education ($\beta = .390$, SE = .172, OR = 1.476,

$p = .024$) both significantly predicted future PSE participation. Each one-point increase in science capital was associated with a 5.8% chance of participants stating that they were more likely to attend a future PSE. A one-level increase in educational attainment was associated with a 47.6% chance of being more likely to state that they would attend a future PSE. Overall, science capital and education accounted for 13.3% of the variation in future PSE participation (McFadden's pseudo-$R^2 = .1332$).

It is worth noting that one of the components of science capital involves the leisure time that participants spend engaging with informal science education opportunities (e.g., PSEs). To account for this, a second ordinal logistic regression analysis was conducted excluding this component. Using participants' adjusted science capital scores, the new model explained significantly more variation in future PSE participation than the intercept-only model ($\chi^2(2) = 39.34$, $p < .001$). Both adjusted science capital ($\beta = .055$, $SE = .013$, $OR = 1.057$, $p < .001$) and education ($\beta = .410$, $SE = .172$, $OR = 1.501$, $p = .018$) significantly predicted future PSE participation. Each one-point increase in adjusted science capital was associated with a 5.5% chance of participants being more likely to state that they would attend a future PSE. A one-level increase in educational attainment was associated with a 50.1% chance of being more likely to attend a future PSE. Overall, adjusted science capital and education accounted for 12.5% of the variation in future PSE participation (McFadden's pseudo-$R^2 = .1247$).

5 ▪ Discussion

Prior to this study, little was known about science capital in PSE spaces. One study by Gathings and Peterman [2021] analyzed secondary data to illustrate the potential of PSEs to promote science capital among audience members, but no research had directly assessed adult science capital in these settings. This study sought to address several gaps in the PSE literature by examining the kinds of science capital that audiences bring to PSEs, determining predictive factors of science capital, and exploring how science capital informs continued participation in PSEs. The results presented here may inform future research and practice in ways that promote equity in PSE settings.

These results show that PSE audiences demonstrate high levels of science capital across all nine observed dimensions. In particular, audience members overwhelmingly reported a strong interest in science, an understanding of its theories and methods, and a familiarity with scientific argumentation. This aligns with previous studies of PSEs which show that audiences are already interested in or engaged with science to some extent [Bultitude, 2014; Kennedy et al., 2018; Nielsen et al., 2019]. If organizers of PSEs intend to shift toward more equitable practices, they must find ways to reach audiences on the peripheries of scientific interest and understanding. One approach would be to consider organizing these events in places that are more likely to draw in more casual visitors and passersby [Crettaz von Roten, 2011].

Another important finding of this study was the extent to which high levels of science capital were correlated with high levels of education. Notably, this finding aligns with results of Suortti et al. [2024] which demonstrated a correlation between Finnish parents' science capital and level of education. It follows, then, that a shift toward more equitable practices would include organizing PSEs specifically to benefit historically marginalized communities with restricted access to educational opportunities. DeWitt and Archer [2017] note that although students from historically marginalized groups are less likely to participate in structured informal science activities, they still regularly engage in everyday science learning. This suggests that these groups maintain interest in science but that opportunities for more structured participation (e.g., PSEs) are limited. Indeed, informal science education spaces have long engaged in cultural and institutional practices of exclusion [Dawson, 2014].

Organizers of PSEs, then, may need to reconsider 'what counts' as science by finding ways to leverage the cultural capital and practices of non-dominant groups [Dawson, 2018]. It is important to note here that successful community-based science outreach programs foreground the lived experiences of those in the community they serve, establish trust among those involved, and implement accountability protocols [Dubowitz et al., 2015; Kaiser et al., 2020; Jenkins et al., 2022]. Organizers of PSEs and other leaders in the informal science community may also need to rethink their organizational practices and the white, hegemonic ideologies that sometimes underlie those practices [Le & Matias, 2019; Dawson, 2018].

One strategy for foregrounding community experiences in research is community-based participatory research (CBPR). In contrast to traditional research approaches, CBPR approaches allow for community input on all phases of the research process, including the formulation of research questions, collection and analysis of data, and reporting of results. These approaches also emphasize principles of social justice, cultural humility, and sustainability [Collins et al., 2018]. Furthermore, the flexibility provided by the CBPR framework ensures that it is adaptable to a variety of research-community partnerships. Moving forward, PSE researchers might consider CBPR and similar approaches for eliciting ways in which PSEs might better serve communities who have been historically marginalized in science spaces.

A third finding of this study supports the hypothesis that those with high levels of science capital are more likely to attend future PSEs. Combining these results with the findings of Gathings and Peterman [2021], who showed through secondary data that PSEs allow audiences to cultivate science capital, a clearer picture of the relationship between PSE participation and science capital is beginning to coalesce. High levels of science capital allow PSE visitors to leverage informal science education opportunities to learn about science and develop their scientific interests. That participation, in turn, begets even higher levels of science capital. In this way, PSEs function as gatekeepers of science capital where the rich get richer and historically marginalized communities continue to be left on the fringes.

6 ▪ Limitations

The present study is intended to provide a broad overview of the role that PSEs play in the accumulation of science capital by public audiences. Many questions about the underlying mechanisms through which science capital is accumulated, however, remain unanswered. One potential mechanism is the direct interactions with scientists that public audiences are afforded at these events. Research has shown that such interactions benefit public audiences in a number of ways, including higher levels of scientific interest and understanding and a greater awareness of science in everyday life [Boyette & Ramsey, 2019]. These interactions and other features of PSEs (e.g., hands-on activities) should be more rigorously interrogated in future research. Moreover, future studies may consider the use of pre-post instruments to better understand how much of an effect individual PSEs have on visitors' science capital. Finally, as PSEs constitute only a part of a broader STEM learning ecosystem [Corin et al., 2017], future research should investigate how long-term participation in PSEs contributes to science capital accumulation.

It is also necessary to acknowledge the potential limitations of the science capital instrument used in this study. Although several steps were taken to establish reliability and validity for the instrument in prior research [Archer et al., 2015; UK Department of Business, Energy, & Industrial Strategy, 2020], it is difficult to capture any construct as complex as science capital on a nine-item survey. Future research should investigate potential components of science capital which are not captured by existing instruments. To do so, researchers may need to rethink 'what counts' as science by challenging the white, hegemonic ideologies that pervade science spaces [Le & Matias, 2019; Dawson, 2018]. Furthermore, because science capital is often assessed via self-report measures, future studies might consider measuring science capital in more direct ways or supplementing survey results with in-depth interviews [see Moote et al., 2021].

7 ▪ Conclusions

PSEs are becoming an increasingly vital part of the science education landscape. These events provide public audiences with opportunities to engage with scientific practices in meaningful ways, but those in attendance disproportionately tend to possess high levels of science capital. Those with low or moderate levels of science capital are being excluded, whether by accident or by design. Future research and practice must confront systemic practices of exclusion which, if left unchecked, will continue to exacerbate the gap between those who are allowed to participate in science and those who are not.

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Supplementary material

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Appendix A — Science capital survey for adult audiences