

Describing Informal Learning Experiences among College-age Adults

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ABSTRACT: While the autonomous nature of free-choice learning can have numerous positive effects on student learning in science fields, there is a lack of research on how college-age adults learn in informal settings. The purpose of this study was to quantitatively describe college-age adults' experiences at informal learning settings by administering the Informal Learning Experiences Survey (ILES), which is intended to serve as a tool for practitioners to reflect on undergraduates' participation in learning experiences at informal settings. We administered the ILES to 441 introductory biology undergraduates in Fall 2018 at a single institution and found the most commonly visited informal learning setting in the last six months among our participants was city, state, and national parks. Further, participants reported that their main reason for learning about science at informal settings was for fun and enjoyment, and that their primary barrier against engaging in learning at informal settings was limited finances. We hope the ILES will (a) allow instructors of introductory college biology courses to reflect on and describe the prior experiences and interests of their students related to learning in informal settings, and (b) inform program directors at informal learning settings about how to better incorporate experiences designed for college-age adults.

INTRODUCTION

What is Free-Choice Learning in Informal Learning Settings? The National Science Teachers Association broadly describes informal learning environments in science as those that occur in out-of-school-time settings (NRC, 2009), including museums, science centers, zoos, and aquariums (MCZAs). Informal learning environments may also include experiences that occur at home or in other cultural settings, though we do not focus on such contexts in our study. Free-choice learning—or learning in which people choose what they want to learn about and for how long—in MCZAs both motivates students to persist in the sciences, and increases their understanding of science outside the formal classroom (NRC, 1996). At the K-12 level, free-choice learning is associated with increased student ownership of learning, increased understanding of science concepts, and increased persistence in the sciences compared to formal environments (Adams and Branco, 2017; Drissner et al., 2014; Fadigan and Hammrich, 2004; Gardner, 1991; Martell, 2008; Schwan et

al., 2014; Subramaniam, 2002; Zimmerman and McClain, 2015). Informal learning experiences also benefit the learning of middle-aged and older adults (Alsop and Watts, 1997; Evans et al., 2005; Sachatello-Sawyer and Fellenz, 2000; Sachatello-Sawyer et al., 2002; Schwan et al., 2014). Unfortunately, learning at informal learning settings among college-age adults is relatively understudied. The majority of research on this age group has focused on the influence of social media on self-regulated learning (e.g., Dabbagh and Kitsantas, 2012; Kassens-Noor, 2012; Madge et al., 2009) and the preparation of K-12 science teachers (Olson et al., 2001). Heberts et al. (2020) even report on the benefits of a university student-led informal learning program for middle school students to increase interest and motivation to learn science. Yet, despite the potential benefits of visiting informal settings, we do not understand how college-age adults learn in MCZAs, nor how visiting such settings influences their motivation and feelings related to learning science.

Research Goals and Objectives. The purpose of the current study was to gain a better understanding of college-age adults' experiences, specifically undergraduates in biology classes, at informal learning settings. Motivated by our desire to describe biology undergraduates' informal learning experiences after recognizing the dearth of research related to free-choice learning within this population, as well as our hope that such descriptions may encourage instructors to incorporate certain relevant informal STEM learning experiences in their curricula, we addressed this research goal by developing the descriptive Informal Learning Experiences Survey (ILES). We demonstrate here how the ILES can be used as a practical pedagogical tool for instructors to learn about the experiences of their students at informal settings. We had one primary goal in this study: To quantitatively describe biology undergraduates' experiences in informal learning settings. We explored several factors including demographic characteristics, undergraduates' reasons for visiting informal settings, barriers they experience against visiting these settings, people with whom they have participated in these experiences, and settings they visited as children or teenagers.

Theoretical Framework. While our study was exploratory and inductive by nature, our work leveraged Falk and Dierking's Contextual Model of Learning (2000), which describes a multi-factor framework for learning in informal settings based on personal (e.g., motivation, prior experience), sociocultural (e.g., social mediation), and physical contexts (e.g., visitor agendas, design of exhibits). With this study, we hoped to investigate how college-age adults experience all three of these components in informal settings.

Personal Context. Falk and Storksdieck (2005) describe the personal context of an informal learning experience as the personal history that a visitor brings into a learning situation, encompassing a visitor's (a) motives and expectations, (b) prior knowledge, experiences, and interest, and (c) autonomy to choose what to learn and for how long (p. 747). In our survey, we ask students to describe and enumerate their reasons, or motives, for learning science in informal learning settings as well as their prior experiences at informal learning settings (i.e., as children or teenagers) within the personal context. The latter has been cited as a key factor influencing adults' decision to participate in informal learning opportunities (Falk and Needham 2013). Pintrich and DeGroot (1990) explained that people are more likely to participate in learning experiences if they associate positive feelings and values with these experiences. Not only does prior interest influence a visitor's experience at an informal learning setting (Adelman et al., 2001; Adelman et al., 2000; Csikzentmihalyi and Hermanson, 1995; Falk and Adelman, 2003), but so do less tangible aspects such as nostalgia (Borg and Mayo, 2000).

Sociocultural Context. The sociocultural context is the influence of a visitor's social and cultural relationships on a learning scenario, encompassing a visitor's (a) within-group social interactions, and (b) outside-of-group social interactions (Falk and Storksdieck, 2005, p. 747). Survey participants were also asked to describe the sociocultural context of their visits to informal settings by summarizing and enumerating the people with whom they usually engage at informal learning settings, as well as report on which informal settings they tended to visit as children and teenagers. Interactions with family members have been found to improve learning gains and scientific literacy for visitors of all ages in settings like museums, science centers, and zoos (Borun et al., 1997; Crowley and Callanan, 1998). Often, family members facilitate learning in such settings by acquiring information from exhibits and discussing this information with others in their social group (Ellenbogen et al., 2004; Hilke and Balling, 1985; Naqvi et al., 1991). Beyond family members, visitor interactions with other visitor groups, volunteers, or staff can also influence the trajectory and quality of one's informal learning experience (Koran et al., 1988; Wolins et al., 1992). How frequently people engage in free-choice learning at informal settings, as well as which settings they tend to visit more often than others, strongly depends on how acceptable and available such learning experiences and institutions are in one's culture (Falk and Storksdieck, 2005; Ogbu, 1995). While the cultural value of free-choice learning within a society influences how visitors learn at informal settings like MCZAs, primary literature demonstrating such effects is lacking (Falk and Storksdieck, 2005).

Physical Context. Lastly, the physical context incorporates any physical aspects within an informal learning setting that may contribute to how a visitor gains and applies knowledge. Collectively, these aspects may include: (a) visitor agendas, (b) orientation in the physical setting, (c) architectural design of the environment, (d) exhibit design and program development, and (e) reinforcing learning events that take place outside of the informal learning setting after the initial experience (Falk and Storksdieck, 2005, p. 747). Much of the physical context described above addresses elements of the environment when the participant is already on site, and we know anecdotally and from prior literature that college-age adults infrequently attend places of informal learning (Falk and Needham, 2013; Schwan et al., 2014). Thus, we focused on barriers college-age adults encounter in attempting to visit these settings, rather than physical characteristics experienced at the informal learning setting.

In our study, we captured some information regarding the physical context as a barrier to visiting informal learning settings among our survey respondents. For adult visitors of lower socioeconomic status (SES), opportunities to visit MCZAs are often limited (Falk and Needham, 2013; Schwan

et al., 2014). Zimmerman and McClain (2015) called attention to this SES bias in informal education research, emphasizing that MCZAs may cater more towards an educated and high SES audience, who can afford entry, rather than groups such as college-age adults who are often financially unstable or unable to procure transportation to MCZAs. Beyond financial barriers, we also evaluated if college-age adults' responsibilities interfered with their participation in informal learning environments.

Broader Impacts. We believe our study is a first step in addressing the knowledge gap of how experiences at informal learning settings influence the learning of college-age adults. Through our research, we aim to broadly describe the experiences of college-age adults at informal learning settings. Increased participation of undergraduates in learning opportunities at informal learning settings has the potential to improve students' content appreciation in formal learning environments (Wentzel and Brophy, 2014) and boost intrinsic motivation. Further, many college-age adults' future career skills will be learned informally; thus, free-choice learning experiences may better prepare them for a life as self-regulated learners (Zimmerman, 2002), and participation in such experiences may prime students' life-long involvement in such contexts.

Practically, we hope that findings from the current study will encourage college faculty to consider the informal learning backgrounds, experiences, and interests of their students via administration of the ILES. Additionally, we envision that program directors at informal learning settings could use the ILES to develop learning programs specifically designed for college-age adults.

METHODS

Site Description. All data were collected at a single, public four-year university in the western U.S. with an enrollment of nearly 9,000 undergraduates and 2,500 graduate students. Within the entire student population at this institution—at the time that we conducted our study—approximately 58% of the undergraduates were white, 20% were Latinx/Hispanic, 4% were African American, 4% were multi-racial, 2% were Asian, <1% were Native American or Hawaiian/Pacific Islander, with the remainder of race data unknown or unreported. Almost 85% of undergraduates were classified as in-state, while 34% of undergraduates identified as first-generation students. Nearly 64% of all undergraduates enrolled at this institution were females, while 36% were males. Further, the institution where this study was conducted was located in close proximity to numerous city and state parks, one popular national park, and numerous MCZAs in the surrounding region.

Participants. We used a non-experimental research design and observed a single sample of a college-age adult population. Since college-age adults outside of academia are difficult to recruit, we narrowed our selection of participants to matriculating first- and second-year undergraduates within a biology major, as this was the STEM population that the researchers had access to within their department. We were interested in exploring informal learning experiences in the first half of students' college degree programs, because the first two years of degree programs in STEM disciplines are vital to undergraduate retention (Consortium for Student Retention Data Exchange, 2013; Dagley et al., 2016).

Through convenience sampling, we sampled 453 students from five introductory 100-level biology courses, and complete survey responses from 441 students were analyzed. To improve response rates, students in all five of the participating courses were offered extra credit for completing the online survey. While volunteer participation sometimes results in non-response bias, the completion rate of 95% was proximal to the accepted average noted in psychological studies (Baruch, 1999).

The courses from which students were recruited were designed for biology majors, and represented the first two courses in an introductory biology series (cellular-molecular course, $n = 4$ lecture sections; ecology-evolution course, $n = 1$ lecture section). These biology course sections were taught by three instructors over the Fall 2018 semester (i.e., two instructors taught two sections each). In the five participating courses, student enrollment ranged from 39 to 245 students (mean = 156 students per course). We assumed that informal learning experiences of undergraduate students enrolled in these five courses would be representative of the average first- or second-year undergraduate biology student, and furthermore, that our results would be applicable to individuals of this population, given our subset (i.e. college-aged people enrolled in an introductory biology course for biology majors). Exclusion criteria were defined as students aged 17 and under to maintain the exempt status of this research and avoid accommodation of a vulnerable non-adult population. We should note that since this survey was administered to students in the fall semester, and we asked about their informal learning experiences over the past six months, students' responses likely incorporated time they spent at university during the fall as well as the preceding summer.

Most student participants (80.3%) were women, while 17.2% were men, and 2.5% were transgender men or women, gender-queer or gender-nonconforming, or another gender identity. Nearly 73% of students were white, while 24% identified as Latinx or Hispanic, 7% as Black or African American, 7% as Asian, 4% as American Indian or Native Alaskan, and less than 1% as Native Hawaiian or Pacific Islander, unknown, or prefer not to state. Most students (90% of total sample) were enrolled in the cellular-molecu-

lar course. The majority of students identified as one of two majors (44.8% in Nursing, and 24.2% in Biology with a Pre-Health emphasis), while remaining students were primarily enrolled in various STEM programs at the university where this study was conducted. This sample consisted of mostly first-year students (75.8%), though second-year students comprised 14% of the sample and those above second-year making up the remaining sample. Further, 80.5% of students were either 18 or 19 years of age. A large portion of students (14.7%) identified as transfer students from different institutions. Students grew up in households with a variety of annual incomes, though this question is often difficult for students to respond to accurately if they are not aware of their households' salaries; nearly 80.6% of students' mothers and 71.7% of students' fathers earned at least a high school degree. Almost 97% of sampled students were single or in a relationship but never married, and 97.5% did not have children. Nearly 72% of students reported that they spent the majority of their childhood in the state where the institution was located.

Due to the high proportion of students identifying as white and as women in our sample, and the fact that this study was conducted at a single institution, we would like to emphasize that our findings may not be representative of or generalizable to all first- and second-year biology undergraduates.

Instrument Characteristics. The Informal Learning Experiences Survey (ILES) is composed of five items each with "choose all that apply" (CATA) responses, and the opportunity to write-in an "other" response. Numerical responses to Item 1 (i.e., *Frequency/type of informal learning*, our dependent variables of interest) were comprised of 12 CATA responses. Scores were created based on frequency of visitation in the last six months (sum of all informal learning visits from zero up to 10+ visits, across 12 environments, ranging from 0-120) and types of unique informal learning institutions visited at least once in the last six months (sum of all settings a student visited, ranging from 0-12) for each student (Appendix A). We were also interested in exploring students' reasons for participating and not participating in learning at informal learning settings, the remaining four items of the ILES asked students to reflect on their reasons for learning about science (Item 2; *Reasons for learning about science*); barriers against participating in learning at informal learning settings (Item 3; *Barriers*); with which people they tended to engage in learning at informal learning settings (Item 4; *People*); and which informal learning settings they visited as children or teenagers (Item 5; *Informal learning as children/teens*; Appendix B). We assumed that student responses on the ILES would reflect opportunity and upbringing.

It should be noted that because all items were in a CATA format, students also had the option to not select any of the

listed options, which may have contributed to non-response bias on certain items. Non-response bias is one challenge of using CATA formats within instruments (Meulenet et al., 2009), though CATA items offer the primary benefit of allowing for multiple options to be selected, thus allowing for a richer description and interpretation of each participant's responses. However, in our study, non-response bias did not appear to be an issue, as only eleven students did not respond to Item 1; three students did not respond to Item 2; and two students did not respond to Item 3. Students selected at least one CATA option on all other ILES items. To create scores for the latter four items, selected CATA responses were summed to calculate a score for each ILES item (i.e., 12 reasons for learning about science in Item 2; 11 listed barriers in Item 3; 9 people in Item 4; and 12 learning settings visited as children in Item 5). Thus, if a student selected 4 of the 12 reasons for learning about science in Item 2, they would receive a score of 4 for that particular item (Appendix B). For all demographic items (Appendix C), with the exception of Item 13 (i.e., zip codes were converted to binary codes: within-state and out-of-state locations), response options were categorical and therefore had to be dummy coded for inclusion in statistical analyses.

Data Analyses. We ran descriptive statistics to summarize the student sample and examine distributions and frequencies of the data, as well as answer our primary research question. Crosstabulation analyses were conducted to examine differences in ILES item responses across demographic characteristics; p-values from Pearson chi-square tests represented two-sided asymptotic significance, and a Bonferroni-adjusted alpha of 0.0036 per test was used to maintain an error rate of 0.05 across all demographic variables when running the crosstabulation analyses. All data analyses described were conducted using SPSS Statistics 24.0 (IBM Corp. 2016).

Human Subjects. The Institutional Review Board of the University of Northern Colorado approved the procedures for this study (IRB #1227292-2). Written informed consent was obtained by all participating students at the beginning of the study.

RESULTS

The most commonly visited informal learning setting among our participants was *City, State, and National Parks* ($n = 1871$ total visits; 86% of all students noted that they had visited a park in the past six months). A breakdown of visit frequencies to each informal setting are included in Table 1. The mean number of different types of informal learning settings visited by our sample in the previous six months was 4.87 ($SD = 2.78$).

Students reported that in the last six months their main

reasons for learning about science at informal learning settings (i.e. ILES Item 2) were *For fun and enjoyment* ($n = 353$; 80%), *To gather with friends and family* ($n = 252$; 57%), and *To learn about something new* ($n = 195$; 44%). The top reported barriers against engaging in learning at informal learning settings (i.e. ILES Item 3) were *Limited finances* ($n = 312$; 71%), *School responsibilities* ($n = 284$; 63%), and *Lack of transportation* ($n = 214$; 48%) as well as *Job responsibilities* ($n = 214$; 48%). Students overwhelmingly noted that the people with whom they most commonly visited informal learning settings (i.e. ILES Item 4) were *Friends* ($n = 368$; 83%), *Parents* ($n = 282$; 64%), and *Siblings* ($n = 273$; 62%). Lastly, a majority of students had visited *Zoos* ($n = 426$; 96%), *Museums* ($n = 407$; 92%), *Aquariums* ($n = 390$; 88%), *City, State, and National Parks* ($n = 376$; 85%), *Science centers or Butterfly pavilions* ($n = 317$; 72%), *Theme parks* ($n = 314$; 71%), *Space centers or Planetariums* ($n = 257$; 58%), *Botanical gardens* ($n = 256$; 58%), and *Nature centers/preserves* ($n = 232$; 53%), as children or young teenagers (Figure 1; ILES Item 5).

No demographic differences were detected via crosstabulation analyses, aside from a difference in diversity of informal settings visited as children between students identifying as white and non-white ($p < 0.0036$).

DISCUSSION

College-Age Adults Most Commonly Visit City, State, and National Parks. As the institution where this study was conducted was located in close proximity to numerous city and state parks, and one popular national park, it seems reasonable that these are the informal settings most frequented by participating undergraduates in the last six months based on ILES responses. Further, there has been a recent push to expand free-choice learning opportunities in U.S. national parks—which welcome over 300 million visitors each year (Storksdieck and Falk, 2020)—as such settings are ideal for experiential learning experiences which may include guided activities, sign reading, and exploring visitor centers (Storksdieck and Falk, 2020).

Participants Learn about Science for Fun and Enjoyment at Informal Settings. In our study, we found that participants' principal reasons for learning about science were as reported in the ILES were: (1) for fun and enjoyment, and (2) to gather with friends and family. Interestingly, individuals also reported that they most often participate in free-choice learning at these settings with friends, perhaps reflecting the social nature of learning experiences at informal learning settings for college-age adults. Likewise, Falk and Gillespie (2009) suggested that the unique experiences offered through informal learning exhibits, and the emotions elicited by such experiences, may in part be due to the so-

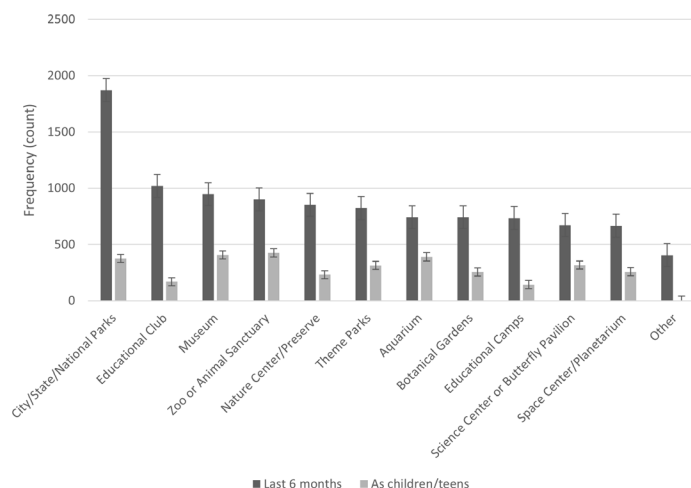


Figure 1. Most frequently visited informal learning settings among students in the last six months and as children/teenagers. City, states, and national parks were the most frequently visited places in the last six months. Further, students visited significantly more informal settings as young adults in the last six months compared to when they were children or teenagers. Scores for the “frequency” item were created by summing all of an individual’s informal learning visits; thus, this figure also incorporates multiple visits to the same location by individuals, which is why our findings are represented as frequency counts rather than percentage of students.

ciality often associated with visiting informal learning institutions. Further, Falk, Scott, Dierking, Rennie, and Jones (2004) found that interactive exhibits improved how students socially engaged in science learning.

The fun and enjoyment that individuals in our study associated with learning science at informal learning settings may be rooted in Pugh’s (2004) idea of transformative experiences, in which students use science concepts for meaning making in their everyday lives and often become more motivated to learn science autonomously (Pugh et al., 2010). Studies have also reported the appeal of autonomous learning among participants of informal learning opportunities, focusing on the notion that people are more willing to learn voluntarily about a topic when it directly relates to their daily lives (Alsop and Watts, 1997). Falk and Dierking (2002) also emphasized that even in informal learning settings characterized more by entertainment than education, learning can still be a significant by-product of free-choice, environmentally-oriented experiences. Additionally, learning in outdoor or natural environments and direct encounters with nature can motivate people to learn about and become more aware of the natural world while simultaneously providing opportunities for leisure (Kellert, 1997; Kola-Olosanya, 2006; Negra and Manning, 1997). Free-choice learning experiences that incorporate direct encounters with nature (e.g., at parks, in the wilderness) may also encourage people to reflect on environmental sustainability and stewardship and connect with various aspects of their ecosystem—re-

Table 1. Frequencies of undergraduates' visits to informal settings in the last six months, ranging from one to ten or more visits.

	Frequency of Visits in Last 6 Months									
	1	2	3	4	5	6	7	8	9	10+
Zoo	88	32	13	5	3	0	0	0	0	2
Aquarium	91	20	5	2	0	1	2	1	0	2
Museum	61	29	19	11	9	3	0	0	0	1
Nature/ Environmental center	46	25	14	6	5	1	0	0	0	1
Science center	36	18	7	2	2	0	0	0	0	0
Space center/ Planetarium	36	10	3	1	0	1	1	0	0	0
Nature preserve/ Conservancy	35	14	11	4	1	1	2	0	0	0
Botanical gardens	41	11	7	7	1	0	2	1	0	0
State/National park	61	58	37	25	20	6	7	2	3	17
Local nature areas/ Trails/City parks	37	29	29	34	30	15	15	9	5	47
Educational club	25	16	13	6	14	4	2	0	0	10
Educational camp	19	0	4	0	0	0	1	0	0	1
Other	4	2	0	1	0	0	0	1	0	2

Note. Student responses of zeros were not included, as the researchers had no way of distinguishing between responses of zeros and missing data.

ardless of whether such experiences are more (e.g., attending a ranger-led hike) or less (e.g., enjoying a picnic in the park) structured (Kola-Olusanya, 2005). In future iterations of the ILES, we would like to further explore distinctions of park-related learning experiences, including qualitative data collection to more richly describe the learning experiences and activities of students at parks.

Limited Resources are Cited as Barriers for Visiting Informal Learning Settings. The most frequently reported barriers against engaging in learning at informal learning settings within our sample were limited resources and other obligations. Further, our data suggest that fewer barriers among college-age students may also contribute to more frequent visits to informal learning settings and a greater diversity of informal settings visited. Our findings support previous reports that limited opportunities for visiting informal learning settings often exist due to one's socioeconomic status and lack of resources (e.g., financial, transportation, time; Falk and Needham, 2013; Schwan et al., 2014). However, this confirmation of SES bias associated with engagement in learning at informal learning settings reinforces the urgency to provide better learning opportunities for college-age adults who may not have the resources to participate in such activities outside a classroom environment. Additionally, if unique and engaging experiences are not available for certain age groups at informal learning settings, or visitors are not made aware of potential learning experiences and spe-

cial events at informal learning settings, they are unlikely to allocate time to visit such places (Kola-Olusanya, 2006).

College-Age Adults Most Commonly Visit Informal Settings with Friends and Family. We know from prior research that visits to informal settings are often highly social experiences, and the social groups with whom people choose to visit informal settings are highly linked to learning outcomes (Falk and Dierking, 2018). Thus, our finding that undergraduates in our study reported visiting informal settings most often with friends, parents, and siblings aligns with what has been previously established in the literature. While ILES participants more commonly cited friends versus family as members of their informal learning social groups, this is not surprising considering college is often the first time many young adults are living independently and away from their immediate family. Regardless, social interactions with other people at informal settings positively influence the trajectory and quality of one's learning experience (Koran et al., 1988; Wolins et al., 1992), underscoring the significance of sociocultural considerations in visits to MCZAs and other informal institutions.

College-Age Adults Reported Varied Prior Experiences at Informal Settings during Childhood. It would not be surprising if participants' informal learning experiences as children or young teenagers influenced the frequency of their participation in informal learning opportunities in college, particularly since the majority of students in our sample had visited zoos, museums, aquaria, and other common settings of informal learning as children or young teenagers. If long-term effects of K-12 informal learning programs truly are maintained across time (Drissner et al., 2014), perhaps the students in our current sample, of which nearly 78% reportedly grew up in-state, have had meaningful learning experiences at the many informal institutions located in the region (e.g., museums, aquariums, science centers).

Further, we found that significantly more white students engaged in informal learning opportunities when they were children compared to non-white students via cross-tabulation analyses based on ILES data. On average, white students visited 7.7 types of informal settings as children or teenagers, while non-white students visited approximately 6.8 types of informal settings; we did not ask students the frequency of times they visited these settings as children, as we expected the counts might not be accurately remembered and reported, though we would like to investigate this further in future ILES iterations. While these differences could simply be artifacts of the mainly white population of students in our sample, the limited participation of non-white or under-represented minority students could be alluding to the idea that prior experiences, privilege, and SES are highly influential in adults' decisions to participate in informal

learning (Falk and Needham, 2013), though we did not find significant differences in frequency or diversity of informal settings visited as college-age adults, nor barriers, across racial identities reported by students. Future research on the ILES should further explore this demographic gap and why it did not exist during students' adulthood, as well as the lack of variation in students' informal learning experiences across other demographic variables (e.g., gender).

Limitations. As is true of most survey-based studies, ILES data are self-reported, which may result in bias (van de Mortel, 2008). Additionally, the sample used in this study was disproportionately comprised of females (80% of the total) and whites (73%); only sampled introductory biology students; and only sampled from one location in the intermountain west of the U.S. Thus, other more heterogeneous populations may respond differently on the ILES, and our findings may not be generalizable to all first- and second-year biology undergraduates—though the high proportion of female and white students who participated in our study is representative of courses within this institution's biology department. Further research on the ILES should explore why we did not find more differences in informal learning experiences and barriers across demographic groups, as prior studies have documented barriers among distinct demographics (Falk and Needham, 2013; Schwan et al., 2014; Zimmerman and McClain, 2015).

Though students anecdotally commented that they appreciated the CATA format of most items on the ILES, this format made data preparation and analyses challenging (e.g., non-response did not necessarily translate to missing items), hence the creation of total summed scores for each item. One way we could alleviate this issue in future versions of the ILES is to include a "none of these apply" option and revise items to be forced response (Meullenet et al., 2009); therefore, if none of the provided options applied to the student, they could simply choose "none of these apply" rather than skipping the question or choosing an option that did not accurately describe their experience. While we recommend maintaining the CATA format of items in future iterations of the ILES to allow for richer descriptions of student experiences, we suggest that future administrators of the ILES consider how they will code responses (e.g., binary coding) on the ILES prior to distribution and analyses to improve data organization. For future iterations of the ILES, we would propose sampling a more diverse population of students across a broader range of U.S. institutions as well as incorporating more open-response follow-up questions for richer descriptions on certain topics. Additionally, items focused on the availability of informal settings in one's community and how free-choice learning and informal settings are influenced by students' cultures would provide more insight into why students may or may not engage in informal learning opportunities.

Practical Applications of the ILES. Through our research, we sought to broadly describe the experiences of college-age adults at informal learning settings by sampling first- and second-year biology undergraduates at our institution. Thus, a primary intention in developing the ILES was to provide a means for instructors, informal learning administrators, and other practitioners to better understand and reflect on this population's experiences at informal learning settings. We posit that reflecting on students' ILES responses may encourage instructors to incorporate certain relevant informal STEM learning experiences in their curricula, depending on how frequently and recently their students visited these places. For college instructors or informal learning settings that intend to administer the ILES, we believe the most useful findings from completed surveys would be the percentage of individuals choosing each CATA response within each item. While the sums (i.e., scores) for each item can be used to broadly summarize the *Frequencies/types of informal learning settings* visited and the overall counts for each item (i.e., *Reasons for learning, Barriers, People, and Informal learning as children/teenagers*), these scores may not be as meaningful as identification of specific sites, reasons and barriers.

Conclusions. Our study is a first step in addressing the knowledge gap of how experiences at informal learning settings influence the learning of college-age adults, specifically first- and second-year undergraduates. Our findings could inspire faculty to consider the informal learning backgrounds, experiences, and interests of students via administration of the ILES. Additionally, we hope that program directors at informal learning settings might use the ILES to develop learning programs specifically for college-age adults, and that college instructors may implement more relevant informal STEM learning experiences in their curricula after reflecting on their students' survey responses. The ILES is best suited to be used as an instrument for reflective purposes among practitioners (e.g., to better understand the learning experiences of undergraduates at informal STEM learning settings).

ASSOCIATED CONTENT

Supplemental material mentioned in this manuscript can be found uploaded to the same webpage as this the manuscript.

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Author Contributions

The manuscript was written through contributions of both authors. Authors have given approval to the final version of the manuscript.

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ABBREVIATIONS

CATA: "Choose All that Apply" ILES: Informal Learning Experiences Survey; MCZAs: Museums, Science Centers, Zoos, and Aquariums; SES: Socioeconomic Status.

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