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Factors Contributing to Amateur Astronomers' Involvement in Education and Public Outreach

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Abstract

Amateur astronomers play a critical role engaging the general public in astronomy. The role of individual and club-related factors is explored using data from two surveys (Survey 1 N = 1142; Survey 2 N = 1242) of amateur astronomers. Analysis suggests that formal or informal training in astronomy, age, club membership, length of club membership, and participation in club service are factors that contribute to the likelihood of an amateur engaging in education and public outreach. Sex (male or female) and club service were found to influence the level of outreach amateurs engage in. Interventions designed to increase amateur involvement in education and public outreach should consider these factors.

1. INTRODUCTION

Amateur astronomers, those who participate in astronomy as a hobby (Percy 1996), provide a vital link between the science of astronomy and the general public by sparking awareness and appreciation of the night sky. Education and public outreach by amateur astronomers in both formal and informal settings has been acknowledged as a critical focus for increasing the public's astronomical interest and scientific literacy (Gada, Stern, and Williams 2000; Fraknoi 1996; Percy 1996). Without amateur astronomers committing their time to education and public outreach efforts, much of the education and public outreach currently taking place would not exist. Storksdieck and Berendsen (2007) estimate that 10 000 amateur astronomers engage in some level of education and public outreach. It is therefore critical to have an understanding of how amateur astronomer involvement in education and public outreach, as well as their level of involvement in education and public outreach, can be promoted and increased.

Beginning in 1993, National Science Foundation-supported Project ASTRO by the Astronomical Society of the Pacific is an example of amateur astronomy's successful engagement in education and public outreach (Fraknoi 2004; Fraknoi and Lalor 2000). It started as a pilot project in California bringing together amateur astronomers and classroom teachers in grades four through nine with the intention of having astronomers visit classrooms to give presentations and guide hands-on, inquiry-based activities in order to instill a passion for astronomy and other sciences in participating youth. The program has evolved to where it stands today as a nationwide collaboration of over 500 active partnerships between astronomers and classroom teachers. Evaluations of Project ASTRO also helped lead to the development of the Night Sky Network, a national organization and resource base hosted by NASA's Jet Propulsion Laboratory and run by the Astronomical Society of the Pacific. A large percentage of the people surveyed for this paper came from the Night Sky Network.

As volunteers in a leisure activity, amateur astronomers must balance the hobby of public outreach not only with personal duties such as their career and family, but also with responsibilities within the club itself, such as running

for President or updating the club website. Our related ethnographic study of U.S. astronomy clubs has shown that many times the overlap between club leadership and engagement in education and public outreach is nearly 100 percent. Therefore, it is critical to examine which factors truly play a role in both determining the likelihood of amateurs engaging in education and public outreach and the level of outreach in which amateur astronomers are willing to engage. Specifically, the literatures that address outreach-type activities have identified several factors that are important, including the type of work being done, affiliation with others, the topics covered, and having a history of involvement. Knowledge about these and other factors have practical and strategic implications as well, allowing for interventions to be focused to increase both the number of amateurs engaged in education and public outreach and the level of engagement of those who do engage in education and public outreach.

The research reported herein was designed to answer the two following questions affecting amateur astronomers' involvement in educational and public outreach programs:

1. What factors contribute to the likelihood of amateur astronomers engaging in education and public outreach?
2. What factors contribute to the amount of education and public outreach amateur astronomy club members engage in?

We first identify a number of factors that have been posited to influence both entry into education and public outreach and the level of education and public outreach amateurs will engage in, and then examine data obtained from members of amateur astronomy clubs by two large scale surveys (Storksdieck *et al.* 2002; Storksdieck *et al.* 2008) and discuss factors affecting amateurs decisions to become involved in education and public outreach.

1.1. Education and Public Outreach in Other Fields

A number of key factors in education and public outreach may be transferable to amateur astronomy outreach. Vetter, Hall, and Schmidt (2009) found in a sample of Extension volunteers that across age groups, the top two motivational factors were: "the work itself" that volunteers were able to do or share, and their achievement (e.g., sense of pride associated with volunteering). These same researchers found volunteers across age groups felt that effective policy and administration (e.g., activities are well planned, sites have rules) and interpersonal relations with peers were necessary components for keeping volunteers satisfied.

In fact, much published research on volunteer motivations suggests affiliation is a key top motive for volunteers (Culp and Schwartz 1999; Wolford, Cox, and Culp 2001). Volunteering for a topic that interests them or that they support has been found to be in line with individuals' core values (Schmiesing, Soder, and Russell 2005); research suggests personal benefits such as status, flexibility of volunteer roles, and reward for efforts played a role in motivating volunteers, as well as excellence of training, and quality of learning materials (Rohs, Stribling, and Westerfield 2002). Indicating the role of family history, Rohs, Stribling, and Westerfield (2002) found that those who had parents who were or had been Master Gardeners and those who were retired rated items significantly different than those who had/were not.

1.2. Education and Public Outreach in Amateur Astronomy

It has been noted that research focusing on astronomy education and educators is a relatively recent phenomenon (Bailey and Slater 2003). However, there have been some studies examining the role amateur astronomers play in education and public outreach. Berendsen (2005) found amateurs who took college level courses in astronomy were more likely to engage in education and public outreach than those amateur astronomers who did not, and they engaged in higher levels of education and public outreach than those who did not. Perhaps most telling, Berendsen (2005) found much higher levels of amateurs who are members of astronomy clubs engaging in occasional or frequent outreach when compared to nonclub members. Additionally, Berendsen (2005) found that amateur astronomers who are members of astronomy clubs scored higher on an astronomy concepts survey than those who were not members; that those with degrees in astronomy, physics, or astrophysics scored higher than those who had taken a few or none astronomy courses in college; and that the more frequently participants engaged in education and public outreach the higher their scores were.

Berendsen and Storksdieck (2007) discuss what is perhaps the most important variable in predicting the likelihood of an amateur astronomer to participate in education and public outreach: length of time as an astronomy club member. Referring to findings from the 2002 Storksdieck *et al.* study, Berendsen (2005) notes that those who had become club members more recently (<2 yr) were less likely to engage in outreach than those who had been club

members for longer than 2 yr. Recent members who did engage in education and public outreach were engaging less frequently than their more established counterparts. [Storksdieck and Berendsen \(2007\)](#), in discussing the findings from the 2002 survey of amateur astronomers, note that amateurs who engage in public outreach tend to do so around topics that they find interesting (e.g., astrophotography or viewing the sky through a telescope), and that these education and public outreach venues are typically star parties, school-related formal education activities, and giving workshops on topics that interest them. The authors also note the importance of partnerships to amateur astronomers, with a majority of amateur astronomers reporting that they provide education and public outreach as part of a team of multiple amateur astronomers, and that they partner with local informal science education providers such as science centers or planetariums to conduct education and public outreach.

In sum, the limited amount of literature directly pertaining to research on the education and public outreach endeavors of amateur astronomers suggests that amateur astronomy education and public outreach is predicted by club membership, length of club membership, the ability to partner with other amateurs to provide outreach, the ability to partner with local formal and informal science education venues, and possibly their level of formal astronomy education. The literature on other fields of education and public outreach also implicates the following variables: the personal attribute of pride in volunteering, the organizational variable of effective administration, and the social factor of having satisfying interpersonal relationships.

Membership in a club, engaging in volunteer activities as a member of a group, training, and length of time spent as a member of an organization are variables that have been identified both within the literature on amateur astronomy and beyond. Analysis in this article focuses on these key variables. We classify our variables as individual or club-related variables in order to identify where the key variables influencing amateur astronomers' engagement and level of engagement in education and public outreach come from. Our analysis also covers basic demographics such as age and sex to determine if any significant differences exist based on these classic factors that influence which groups are joined as well as participation in those groups.

2. METHODS

Data from two surveys of amateur astronomers were utilized to conduct the analysis for this study; both surveys were administered online by researchers from the Institute for Learning Innovation and staff from the Astronomical Society of the Pacific. One survey (N = 1142) was conducted in 2002, and the other survey was conducted in 2008 (N = 1242). [Storksdieck \(2007\)](#) critically analyzes the process of obtaining the 2002 sample, reviewing both the benefits and potential drawbacks of utilizing online samples. In short, [Storksdieck \(2007\)](#) notes that some of the potential drawbacks of using web-based surveying include low response rate, systematic bias, especially towards those familiar with technology use, a lack of prior knowledge of the representativeness of the sample to the population, and a large portion of those who start the survey not completing the survey. [Storksdieck \(2007\)](#) notes, however, that these factors were not as problematic for these studies in part because it was an attempt to gain front-end data from a population that very little was known about prior to the administration of these surveys. These are the largest known samples of amateur astronomers to date.

2.1. Sample One: 2002

In close collaboration with Astronomical Society of the Pacific staff, Institute for Learning Innovation researchers developed a list of potential questions and pilot-tested them in semi-structured telephone interviews with a random sample of 15 active amateur astronomers whose contact information was derived from publicly accessible sources. Based on the feedback received from this group, team members refined the survey questionnaire. The completed questionnaire was modified into a web-based survey. The team provided a link to the survey site, and amateur astronomers who visited the Astronomical Society of the Pacific and Astronomical League websites and associated websites mid-January to late March, 2002, were encouraged to complete the survey, as were people on relevant listservs and members of each of the two organizations. In addition, a letter to the editor in the February edition of *Sky & Telescope* plus notes in both *Mercury* and *Reflector* announced the survey.

Since the survey was solely administered on the web, we have no knowledge of the response rate or any bias that may be inherent in such a self-selected sample. However, a majority of amateur astronomers are believed to have Internet access. A total of 1142 participants took part in this study, with 349 (31%) of these participants stating they were members of a local astronomy club, association, or society. Our analysis is primarily conducted on these 349 participants who reported to be members of a local astronomy club, association, or society, with nonclub data presented occasionally as a comparison for understanding how variable a factor might be.

Storksdieck (2007) also notes there is a high drop off rate from those who started the survey to those who completed the survey—a condition that can be found in any format a survey questionnaire is administered in, especially a lengthy survey like this one.

2.2. Sample Two: 2007

A total of 1242 participants took part in this study, with 1075 (87%) of these participants stating they were members of a local astronomy club, association, or society. Our analysis is primarily conducted on these 1075 participants who reported to be members of a local astronomy club, association, or society.

The link to the online questionnaire was disseminated through numerous digital channels; email alerts to members of Astronomical Society of the Pacific and the Astronomical League, alerts on all major web sites, and listservs and blogs commonly frequented by amateur astronomers. Most specifically, the online survey was distributed through email to present and former members of the NASA-funded Night Sky Network, a community of practice of more than 300 amateur astronomy clubs that are actively engaged in education and public outreach. Based on the strategy for the 2002 survey (Storksdieck *et al.* 2002), this broad dissemination of the online survey likely reached the majority of active amateur astronomers. As is common with surveys of this kind, a true response rate cannot reliably be estimated and results cannot be generalized to all amateur astronomers. The survey featured closed-ended and open-ended questions to generate ordinal and nominal data. Open-ended responses were coded and all data were entered and analyzed using SPSS statistical software version 19. The instrument used in the 2008 study was informed by the findings from the 2002 study, and therefore the items were asked in slightly different ways to explore themes that emerged from the 2002 data. These differences are noted in the discussion on independent and dependent variables below.

2.3. Independent and Dependent Variables

The independent variables examined in this study included club membership (affiliation), length of time as a club member, club service, formal (astronomy related) education, informal (astronomy related) education, age, and sex. As shown in Table 1 below most of the variables were measured in both samples, while age and sex were only measured in the 2002 sample because they were assumed to be demographic variables with unchanging influences in the survey 5 yr later. Dependent variables included involvement in education and public outreach, and frequency or level of engagement in education and public outreach (EPO), the latter being measured solely in the 2002 sample since getting an individual through the gate to actually help do outreach became a more important focus than how much outreach people were conducting.

Analyses run included descriptive statistics (frequencies), chi-square to test the distribution of the independent variables crossed with dependent variable, and Mann Whitney U to examine the differences in frequency between groups by the independent variable.

3. RESULTS

3.1. What Factors Contribute to the Likelihood of Amateur Astronomy Club Members' Involvement in Education and Public Outreach?

3.1.1. Individual Variables

With the exception of sex (male or female) in the 2002 survey, each of the individual variables were found to have significant differences in the distribution of amateur astronomers who do or do not engage in education and public outreach. Table 2 below displays the percent of amateurs who reported involvement in education and public outreach by the categories within each individual variable and the results of the chi-square analysis. Regardless of the sample year, those who participate in astronomy-related training, formal or informal were significantly more likely to engage in education and public outreach. Examining the age of participants found that those age 31 and above have a higher level of involvement in education and public outreach than those age 30 and below.

3.1.2. Club-Related Variables

Each of the club-related variables that were explored had significant difference in the distribution between categories. Our findings suggest that membership with a club and then taking on a service role within the club influences the likelihood of an amateur astronomer becoming involved in education and public outreach. As

Table 1. Independent and dependent variables examined

Variable type	Variable	Level	Year(s) of study
Independent	Club membership	Club-related	2002, 2008
	Length of time as club member	Club-related	2002, 2008
	Club service	Club-related	2002, 2008
	Formal education	Individual	2002, 2008
	Informal education	Individual	2002, 2008
	Age	Individual	2002
	Sex	Individual	2002
Dependent	Involvement in EPO	Individual	2002, 2008
	Frequency of engagement in EPO	Individual	2002

displayed in Table 3, there is a large disparity between club members and nonclub members' involvement in education and public outreach, with club members being significantly more likely to be involved in education and public outreach. Our findings suggest the longer an amateur astronomer is affiliated with a club as an official member, the more likely he/she is to engage in education and public outreach. Results also suggest those who take on service roles within their club are significantly more likely than those who do not to become involved in education and public outreach.

3.2. What Factors Contribute to the Amount or Level of Education and Public Outreach Amateur Astronomy Club Members Engage in?

3.2.1. Individual Variables

In contrast with the findings on *likelihood to engage* in outreach, our findings suggest that sex (male or female) is the only individual variable that shows meaningful differences between groups for the *amount or level of*

Table 2. Individual variables for involvement in education and public outreach

Independent variable	n	% Engaged in EPO	Year of sample	df	χ^2	p-value
Formal training	480	—	2002	1	13.62	0.000
Yes	206	76				
No	274	60				
Formal training	1242	—	2008	1	109.69	0.000
Yes	612	79				
No	630	51				
Informal training	475	—	2002	1	16.58	0.000
Yes	327	72				
No	151	54				
Informal training	1242	—	2008	1	68.96	0.000
Yes	936	71				
No	306	45				
Age	474	—	2002	4	22.39	0.000
Under 20	21	24				
20 to 30	40	55				
31 to 50	244	71				
51 to 65	148	68				
Over 65	22	68				
Sex	477	—	2002	1		NS
Male	398	68				
Female	79	61				

Table 3. Club-related variables for involvement in education and public outreach

Independent variable	n	% Engaged in EPO	Year of sample	df	χ^2	p-value
Membership	496	—	2002	1	129.84	0.000
Yes	340	82				
No	156	30				
Membership	1242	—	2008	1	19.96	0.000
Yes	1075	67				
No	167	49				
Length of membership	310	—	2002	3	15.3	0.002
<2 yr	73	71				
2–5 yr	104	89				
6–10 yr	49	84				
>10 yr	84	92				
Length of membership	1074	—	2008	3	113.65	0.000
<2 yr	180	37				
2–5 yr	357	64				
6–10 yr	261	79				
>10 yr	276	80				
Club service	338	—	2002	1	33.34	0.000
Yes	126	98				
No	212	73				
Club service	1075	—	2008	1	136.17	0.000
Yes	395	54				
No	680	98				

Table 4. Examination of individual level variables from 2002 study potentially contributing to the amount of education and public outreach amateur astronomers participate in

Independent variable	n	% Engaged in EPO yearly	% Engaged in EPO monthly	% Engaged in EPO weekly	df	χ^2	p-value
Formal training	309	—	—	—	2	2.33	0.311
Yes	152	16	56	31			
No	157	16	45	36			
Informal training	306	—	—	—	2	2.98	0.225
Yes	229	17	47	36			
No	77	14	58	27			
Age		—	—	—	8	12.58	0.127
Under 20	5	20	20	60			
20 to 30	22	9	41	50			
31 to 50	166	19	48	33			
51 to 65	99	12	61	27			
Over 65	14	21	29	50			
Sex	308	—	—	—	2	8.47	0.015
Male	261	18	51	31			
Female	47	6	43	51			

Table 5. Club-related variables for amount of education and public outreach (2002)

Independent variable	n	% Engaged in EPO yearly	% Engaged in EPO monthly	% Engaged in EPO weekly	df	χ^2	p-value
Membership	314	—	—	—	2	5.96	0.051
Yes	269	33	52	14			
No	45	38	36	27			
Length of membership	253	—	—	—	6	5.36	0.499
<2 yr	50	16	54	34			
2–5 yr	89	10	60	30			
6–10 yr	38	16	55	29			
>10 yr	76	18	43	38			
Club service	266	—	—	—	2	10.35	0.006
Yes	118	7	53	39			
No	148	21	51	29			

education and public outreach engaged in. Table 4 displays each individual variable examined, the percent of amateurs in each level of engagement category, and the results of the chi-square analysis run crossing each variable with level of involvement in education and public outreach. Data on the amount of education and public outreach amateurs engaged in were only collected from the 2002 sample.

Additionally, significant differences exist between the median level of engagement in public outreach between male and female participants $U(1) = 4646$, $Z = -2.90$, $P = 0.004$. The direction of the differences between men and women is unclear: women are more likely to engage in outreach weekly, men are more likely to engage in outreach monthly and yearly. None of the other individual variables had significant differences in median level of engagement in education and public outreach between groups:

- Formal training $U(1) = 11\,217$, $Z = -0.999$, $P = 0.318$
- Informal training $U(1) = 8346.5$, $Z = -0.765$, $P = 0.444$
- Age $H(4) = 4.43$, $p = 0.351$

3.2.2. Club-Related Variables

Examining differences in level of engagement by club-related variables found those holding a position of service (e.g., president, secretary, treasurer) made people more likely to engage in education and public outreach weekly or monthly than were those not holding a service position. Neither membership with a club nor length of membership influenced the *level* of engagement in education and public outreach. Table 5 below displays each club-related variable examined, the percent of amateurs in each level of engagement category, and the results of the chi-square analysis run crossing each variable with level of involvement in education and public outreach.

A comparison of the median level of engagement in education and public outreach for each of the variables in Table 5 found significant differences existed in the median distribution between groups only for the club service variable $U(1) = 7112.5$, $Z = -2.87$, $P = 0.004$. Those who hold service positions in their clubs have higher levels of engagement in education and public outreach. Club membership and length of club membership did not have significant differences in median distribution between groups:

- Membership $U(1) = 5802.5$, $Z = -0.486$, $P = 0.627$
- Length of membership $H(3) = 0.45$, $p = 0.929$

4. DISCUSSION

Much of what we found supported the literature reviewed that identified the potential variables that affect engagement in education and public outreach. While it has been noted that identifying and defining the characteristics of a volunteer is difficult (Bussell and Forbes 2002), our findings suggest both individual and

club-related variables play a critical role in influencing the likelihood of an amateur astronomer engaging in education and public outreach. Our findings provide the foundation to build a larger body of knowledge focusing on the individual and club-related factors that influence amateur astronomers specifically. Effective policy, particularly in the United States where more extensive funding is available for education and public outreach, designed to increase amateur astronomers becoming involved or increasing their level of education and public outreach must address both categories of variables. This policy design is both appropriate and advantageous for these clubs because, as seen above, in both 2002 and 2008, as overall a high percent of members reported *not* being involved in education and public outreach events.

At an individual level, amateurs who engage in training, formal, or informal, related to astronomy, as well as those ages 31 and above are much more likely to engage in some level of education and public outreach. Individuals who have sought either formal or informal training are engaging in a behavior similar to education and public outreach in that they are using their own resources, such as time, to actively engage in astronomy related educational activities. Additionally, as supported by [Berendsen \(2005\)](#), the gain in knowledge from astronomy training might increase the confidence and ability of an individual who engages in education and public outreach. Our findings highlight the need to make both formal and informal training available to amateur astronomers as a way to increase education and public outreach with the goal of improving public understanding of science; certainly, if training opportunities do not exist or are not reasonably available to an amateur astronomer, there is a decreased likelihood of their participation in training.

Examining the club-related variables we found evidence that, as put forth in the literature ([Culp and Schwartz 1999](#); [Wolford, Cox, and Culp 2001](#)), affiliation or club membership plays a critical role in increasing the likelihood of an amateur engaging in education and public outreach. There are many reasons why being a club member might increase the likelihood of engaging in education and public outreach. Being a member of a club puts volunteers in contact with those who have similar interests and might already be engaging in education and public outreach. Clubs can provide members support both logistically (resources, infrastructure, and partnerships with others) and interpersonally, providing a social channel for volunteers to network with each other. Importantly, a well-established and functional club is likely to be a resource known by the local community and other organizations, which in turn directly request education and public outreach from the club and its members. Regardless, our findings suggest club membership availability is a factor worthy of special attention for increasing the likelihood and amount of education and public outreach amateurs engage in. If an amateur astronomer does not have access to a local club or is not aware of the presence of a local club, there is a reduced chance that he or she will be able to seek out a club and take advantage of the education and public outreach opportunities that exist for club members. Clubs facilitate education and public outreach in a number of ways: they support education and public outreach, members may join clubs to increase their ability to engage in education and public outreach, and those who join clubs are exposed to additional opportunities to engage in education and public outreach. The importance of belonging to a club is reinforced by our findings that each of the club-related variables contributed to a higher level of engagement in education and public outreach, while only participant's sex had meaningful, if unclear, differences in the distribution.

Our findings for likelihood to engage in education and public outreach suggest there is interplay between the individual and club-related variables, displayed in [Figure 1](#), that is temporal: from joining a club to length of club membership, holding an officer position, and age. While the initial step of joining a club provides an increase in the likelihood to engage, the length of membership and taking on duties of a club officer might serve to enhance this likelihood. The natural progression of time that must pass for these events to occur also serves to increase the age of the person engaging. It may also hold that age is the lead-in factor; that is, the constraints and opportunities that certain age brackets, on average provide individuals more time to dedicate to activities such as club membership, club service, and volunteering in education and public outreach. The findings point to the possibility that amateurs in clubs are likely to remain members for a long period of time. We were not able to analyze the degree of outreach of former club members, however, and it is possible that staying with a club increases outreach over leaving a club. In any case, as the years of membership increase so do the number of members. However, this may also highlight a potentially negative trend in that amateur astronomy clubs are aging and younger potential members are not filling in their ranks. Additionally, our findings suggest that the club-related variable of length of club membership is increased by whether the person has received formal training.

Immediately, [Figure 1](#) shows that individual variables influence choices to participate in clubs, and both sets of variables influence participation in education and public outreach. Only gender and service in club predicted level of engagement in education and public outreach. The enclosures distinguish attributes vs choices vs

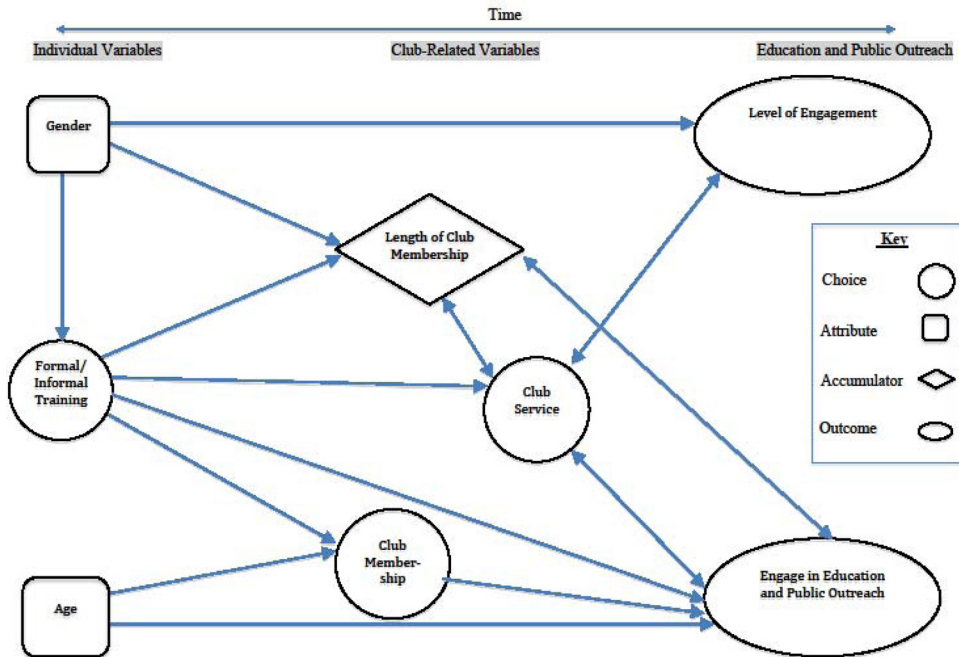


Figure 1. Model of statistically significant relationships between study variables, and proposed directionality of those relationships

accumulation (i.e., remaining in a club as an example of an accumulation is a choice but not the same kind of choice as choosing to join a club or choosing to receive training) vs outcomes. Of course, only those people who are in clubs can do club service or stay in clubs, so there is no need to draw a line between club membership and the other two club-level variables even if correlated. Arrows in two directions are included where we posit the relationship to be bidirectional and possibly mutually reinforcing.

A beneficial policy design would suggest that astronomy clubs try to increase the amount of service-related positions available to its members. In other words, the more people with a service position, the more likely individual involvement in education and public outreach. Having more people in similar service positions would also lessen individual burden and stress related to these positions and management of the group as a whole could become more effective. However, it is likely most amateurs seeking to hold a service position in a club do so and that those who seek service positions are the same who choose to engage in education and public outreach, suggesting a solution lies in attracting new club members that are both willing to hold service positions and engage in education and public outreach.

Those who create policy at a club level might consider looking into the frequency that clubs engage in or schedule education and public outreach events. Most participants stated they engage in education and public outreach on a monthly basis. This might advocate for having monthly opportunities available or ensuring that events are staggered so that members have a choice of which event to participate in each month without exhausting the supply of club members who might participate in a given month. It would seem that there is the potential for diminishing returns or member burn out if a club were to schedule too many education and public outreach events close together.

Recommendations to increase likelihood and level of engagement in education and public outreach based on our current findings are to focus on the removal of barriers to amateurs joining clubs, participating in the running of clubs, and engaging in formal or informal astronomy-related training. Each of the factors identified in this study are worthy of further explanation, alongside additional factors that might play a role in likelihood and level of amateur engagement in education and public outreach. It is probable that personality factors, past experiences, and attitudes play a role in influencing likelihood and level of engagement. It should be explored whether someone who takes on a service role in an astronomy club is predisposed to being interested in engaging in education and public outreach. This also serves to highlight the potential difficulty in increasing the number of those who engage in education and public outreach. It is unlikely that an amateur who has little desire to take on a service role will do so, though it is also possible that desire could be influenced. Further study is needed to identify common barriers to amateur astronomers' likelihood and level of engagement in education and public outreach. The authors have begun to identify these barriers through a case study reported elsewhere.

The findings presented above may also serve to inform the efforts of other groups outside of amateur astronomers that engage in education and public outreach. For example, a large group of citizen scientists act on behalf of professional ornithologists to collect data on behalf of the Cornell Lab of Ornithology. These data are of high quality and have been used to inform a number of published academic articles (Bonney *et al.* 2009). Viewing our findings through the lens of citizen science may serve to inform efforts at increasing the number of participants and level of participation in these endeavors. Additional research on how these findings might apply to citizen science efforts is needed.

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