The Central Role of Personnel in Informal Physics Programming

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INTRODUCTION

In this paper, we take an in-depth look at the physics faculty and student volunteers, which we will refer to as the program personnel, involved in informal physics programs to better understand their roles and responsibilities, their interactions with audiences, and their connectedness with content and activities. Understanding the complexities between programs, personnel, and audiences allows us to look for areas to improve informal physics programs in being inclusive, in being equitable and accessible, in supporting physics students who participate, and in connecting more strongly to the community and home institution. It is clear from previous studies that university students volunteering in informal physics programs can be impacted by their experience; however, we do not yet know how the ways the experiences are designed and then unfold affect personnel participation. In order to design informal programs that best support undergraduate and graduate students in achieving the desired outcomes, it is necessary to determine what program structures and practices are important to this end. This leads to the following research questions: *How can structures shape the participation of physics volunteers in informal physics programs? How can the volunteers influence the content, activities, and audience interactions of these programs?*

FRAMEWORK

To gain an understanding of how the structures of different informal physics programs are related to personnel experiences, we draw on prior work contextualizing an organizational theory (OT) framework to informal education spaces. Organizational theory originates from the business literature and describes the internal and external relationships present in organizations. By contextualizing an organizational theory framework to the informal physics context, we seek to understand how organizational components of the programs interact with each other. Our goal in data collection and analysis is to reveal the pieces critical to how personnel and programs function. The dimensions of the contextualized framework consist of six categories as displayed in Figure 1.

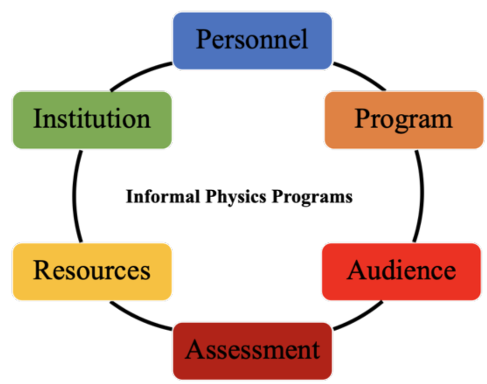

Figure 1: The dimensions of the organizational theory framework contextualized to the informal physics setting.

METHODOLOGY

With a focus on the personnel of informal physics programs, we looked to characterize numerous facets of the personnel (see Box). To answer these questions, we take a qualitative approach in order to gather the rich and complex details of the experiences and roles of informal physics program personnel. Using surveys, interviews, and site visits, we obtained information from 31 participants, spanning programs in seven states and two international programs. Each interview was with an informal physics program lead facilitator. Lead facilitators are the main organizers of the program's operations. Interviews were recorded, transcribed and coded for the elements of the six framework categories. Through emergent coding, we identified themes under each of the six categories.

Questions about personnel:

- *Who are the people involved in the program?*
- *What are their roles and tasks in the program?*
- *What are the challenges the programs face with personnel?*
- *How do the personnel and audience interact?*

Table 1: Case Studies – program descriptions

Pub Physics	monthly public lecture series hosted at a local bar on topics related to astronomy and physics research
Camp Physics	week-long summer camp for high school students held at a large physics research facility
Physics Club	undergraduate student organization that does demonstrations, open house events, planetarium shows, and visits to schools

In this paper, we take a case study approach and present analysis of three programs of different formats, physics topics, and audiences ("Pub Physics", "Camp Physics", and "Physics Club") These cases were chosen as examples of rich data with diverse and effective ways that personnel are integrated and integral to the program. In looking across these programs, our goal is not to prove a specific claim, but instead to uncover a better understanding of the organizational framework components.

FINDINGS

Importance of Personnel

In our initial analysis, we found Personnel to be a dominant code (Figure 2) as well as the main code overlapping with the other categories (Figure 3). This analysis demonstrates how important this category is to the lead program facilitators.

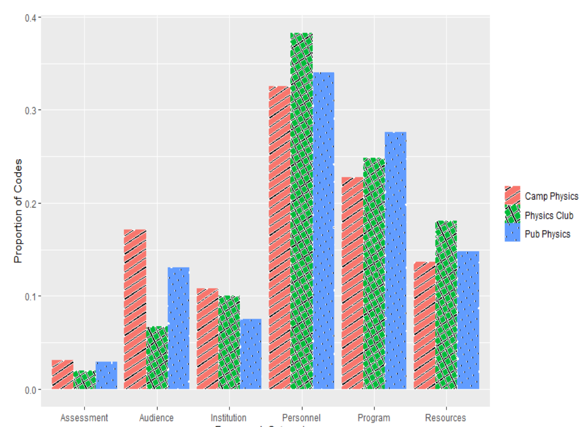

Figure 2: The percent of codes present for each framework category for each program. *Personnel* is the largest, accounting for roughly a third of all codes in each interview.

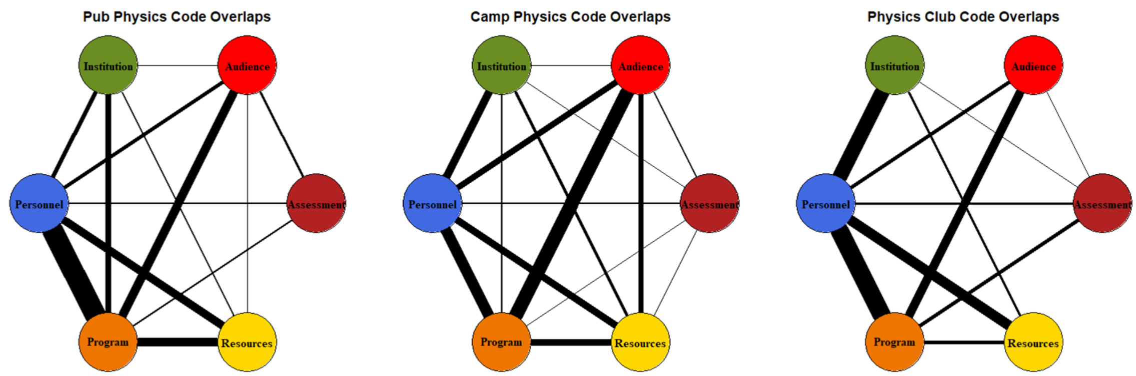

Figure 3: Overlap between framework categories for each program. The weight of the line indicates the relative amount of overlap. Personnel is to the far left, center, in blue.

Personnel Roles and Tasks

Characterizing how the personnel involved in these programs is critical to understanding who has influence over content, interactions with the audience, and what training and experiences personnel bring to their work. The table below gives examples of the work carried out by different people in the program.

Table 2: Common program tasks and who in the program carries out these tasks.

Program Tasks	**Pub Physics**	**Camp Physics**	**Physics Club**
Giving a presentation	*Guest speakers*, typically faculty at other institutions	*Lab faculty* presenting on their work	*Undergrad volunteers* answer audience questions after show
Designing and choosing activities	*Grad student* organizes trivia	*Grad students* & *postdocs* design experiments	*Lead facilitator* chooses demos
Engaging audience with demos and activities	*Lead facilitator*, *grad student*, *postdocs* answer questions	*Grad students* & *postdocs* interact alongside experiments	*Undergrad volunteers* engage with demos
Recruiting volunteers	*Lead facilitator* sends emails and connects with guest speakers	*Lead facilitator* puts out ad, recruits one-on-one, talks with guest speakers	*Lead facilitator* buys and set-up posters, sends messages in group chat
Advertising events	*Lead facilitator* designs flyers, promotes on social media	*Lead facilitator* shares info with teachers and schools	*Lead facilitator* buys promotional materials
Communicating with partners	*Lead facilitator* works with venue for space, organize tickets for speakers and raffles	*Lead facilitator* talks with resident halls *Support staff* organizes catering	*Lead facilitator* communicates with mega-organization for regional events
Maintaining connection with Institution	*Lead facilitator* communicates with department organizers	*Lead facilitator* communicates with newsletter and lab faculty	*Lead facilitator* communicates with faculty advisor

DISCUSSION

Thus far in our findings, we have explored the contexts in which five of the framework categories (Personnel, Audience, Program, Institution, Resources) connect with each other in ways which are foundational to these programs' functionalities. Figure 4 is a reimagined model of the informal physics organizational theory framework, showing connections between categories, with some descriptive examples from the data set. Personnel was the most salient framework category and connected with all other categories among our cases. Assessment is not included visually as a separate box, as it can be considered for each of the categories and their relationships. An important point is that challenges identified in one area can connect and impact other aspects. For example, programs experience challenges with the location of their events and this has an impact on the attendance of their audiences.

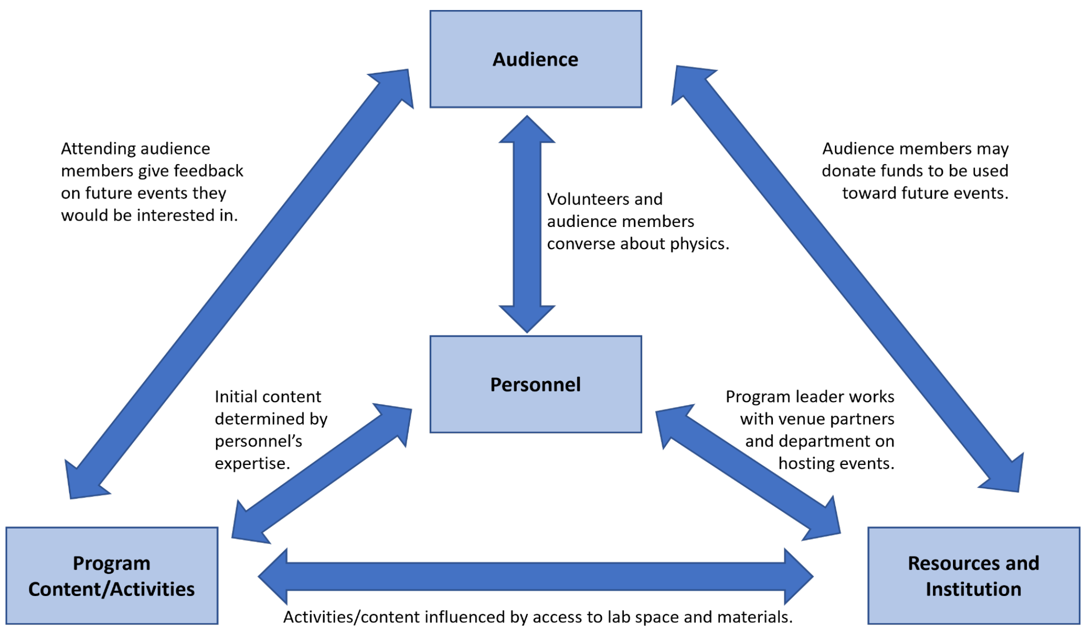

Figure 4: A visualization of how the framework categories connect with each other. Each connection is accompanied by an example extracted from the interview data.

We observed that the distribution of personnel tasks and responsibilities personnel often overlapped with the codes related to challenges, primarily due to programs having difficulties with recruiting personnel. Often a lack of personnel resulted in inefficiently distributed duties, with most of the burden on lead facilitators.

As noted by the lead facilitators of these programs, there is a need for assessment tools in informal physics programs to evaluate and monitor many aspects of their work. Given the importance of personnel members in these programs, assessing the nature of their interactions with audiences and with other program personnel, as well as their satisfaction in the program can be crucial in retaining volunteers as well as helping develop their physics identity and interest in participating in informal physics.

REFERENCES

1. Krishnamurthi, L. J. Rennie, A. Alliance, and L. J. Rennie, Informal Science Learning and Education: Definition and Goals, 1 (2003).
2. P. Tamir, Factors Associated with the Relationship between Formal, Informal, and Nonformal Science Learning, J. Environ. Educ. 22, 34 (1991).
3. Butler, Would Another Name Make a Difference?, APS Forum on Education Newsletter.
4. M. Doberneck, C. R. Glass, and J. Schweitzer, From Rhetoric to Reality: A Typology of Publically Engaged Scholarship, 31 (n.d.).
5. Andrews, A. Weaver, D. Hanley, J. Shamatha, and G. Melton, Scientists and Public Outreach: Participation, Motivations, and Impediments, J. Geosci. Educ. 53, 281 (2005).
6. P. Bell, B. Lewenstein, A. W. Shouse, M. A. Feder, et al, Learning Science in Informal Environments (National Academies Press, 2009).
7. J. (Ed.) Friedman, S. Allen, P. B. Campbell, L. D. Dierking, B. N. Flagg, C. Garibay, R. Korn, G. Silverstein, and D. A. Ucko, Framework for Evaluating Impacts of Informal Science Education Projects Report from a National Science Foundation Workshop The Division of Research on Learning in Formal and Informal Settings (DRL), (2008).
8. K. Sacco, J. H. Falk, and J. Bell, Informal Science Education: Lifelong, Life-Wide, Life-Deep, PLoS Biol. 12, e1001986 (2014).
9. K. E. Rowan, Book Review: Learning Science in Informal Environments: People, Places, and Pursuits, Sci. Commun. (2012).
10. S. Kanim and X. C. Cid, Demographics of Physics Education Research, Phys. Rev. Phys. Educ. Res. 16, 020106 (2020).
11. S. R. Singer, N. R. Nielsen, and H. A. Schweingruber, Discipline-Based Education Research: Understanding and Improving Learning in Undergraduate Science and Engineering (2012).
12. J. D. Adams and P. Gupta, Informal Science Institutions and Learning to Teach: An Examination of Identity, Agency, and Affordances, J. Res. Sci. Teach. 54, 121 (2017).
13. K. A. Hinko, P. Madigan, E. Miller, and N. D. Finkelstein, Characterizing Pedagogical Practices of University Physics Students in Informal Learning Environments, Phys. Rev. Phys. Educ. Res. 12, 010111 (2016).
14. B. Prefontaine, C. Fracchiolla, M. Vasquez, and K. A. Hinko, Intense Outreach: Experiences Shifting University Students' Identities, in 2018 Physics Education Research Conference Proceedings (American Association of Physics Teachers, Washington, DC, 2019).
15. B. Prefontaine, C. Mullen, J. J. Güven, C. Rispler, C. Rethman, K. Hinko, and C. Fracchiolla, Informal Physics Programs as Communities of Practice: How Can Program Structures Support University Students' Identities?, Phys. Rev. Phys. Educ. Res. (2021)
16. C. Fracchiolla, B. Prefontaine, and K. Hinko, Community of Practice Approach for Understanding Identity Development within Informal Physics Programs, Phys. Rev. Phys. Educ. Res. 16, 20115 (2020).
17. C. Fracchiolla, B. Prefontaine, M. Vasquez, and K. Hinko, Is Participation in Public Engagement an Integral Part of Shaping Physics Students' Identity?, in Research and Innovation in Physics Education: Two Sides of the Same Coin, edited by J. Guisasola and K. Zuza (Springer International Publishing, Cham, 2020), pp. 225–238.

18. C. Fracchiolla, S. Hyater-Adams, N. Finkelstein, and K. A. Hinko, University Physics Students' Motivations and Experiences in Informal Physics Programs, 4 (n.d.).
19. A. Bergerson, B. K. Hotchkins, and C. Furse, Outreach and Identity Development: New Perspectives on College Student Persistence, J. Coll. Stud. Retent. Res. Theory Pract. 16, 165 (2014).
20. APS FOEP, FOEP Survey.
21. About, https://system2020.education/about/.
22. Izadi, J. Willison, N. Finkelstein, C. Fracchiolla, and K. Hinko, Towards Mapping the Landscape of Informal Physics Educational Activities, Press (2021).
23. A. Tayşir and N. K. Tayşir, Measuring Effectiveness in Nonprofit Organizations: An Integration Effort, J. Transnatl. Manag. 17, 220 (2012).
24. C. Lusthaus, M.-H. Adrien, G. Anderson, F. Carden, and G. P. Montalvan, Organizational Assessment : A Framework for Improving Performance (International Development Research Centre, 2002).
25. B. Stanley, D. Izadi, and K. A. Hinko, Perspectives on Informal Programs: How Site Visits Can Help Us Learn More, in Physics Education Research Conference Proceedings (2020), pp. 503–508.
26. J. Willison, D. Izadi, I. Ward, K. Hinko, and C. Fracchiolla, Challenges in Methodology While Characterizing the Informal Physics Landscape, Phys. Educ. Res. Conf. Proc. (2019).
27. D. Izadi, J. Willison, K. A. Hinko, and C. Fracchiolla, Developing an Organizational Framework for Informal Physics Programs, Phys. Educ. Res. Conf. Proc. (2020).
28. C. Fracchiolla, N. Finkelstein, and K. Hinko, Characterizing Models of Informal Physics Programs, Phys. Educ. Res. Conf. Proc. 2018, 1 (2018).
29. S. B. Merriam and E. J. Tisdell, Qualitative Research (2016).
30. R. Yin, Designing Case Studies, in Case Study Research: Design and Methods (2009), pp. 24–65.
31. B. Flyvbjerg, Five Misunderstandings about Case-Study Research, Qual. Inq. 12, 219 (2006).
32. M. B. Bennett, K. A. Hinko, and D. Izadi, Challenges and Opportunities for Informal Physics Learning in the COVID Era, Phys. Rev. Phys. Educ. Res. 17, 023102 (2021).