Personas for supporting physicists' engagement in informal education

Shams El-Adawy
Department of Physics, Kansas State University, Manhattan, KS 66506-2601 and
American Physical Society, 1 Physics Ellipse, College Park, MD 20740-3844

Eleanor C. Sayre
Department of Physics, Kansas State University, Manhattan, KS 66506-2601

Alexandra C. Lau and Claudia Fracchiolla
American Physical Society, 1 Physics Ellipse, College Park, MD 20740-3844

The pathways and engagement of physicists in informal physics education are varied, which makes their professional development needs not well understood. As part of ongoing efforts to build and support community in the informal physics space, we conducted interviews with physics practitioners and researchers with a range of different experiences. Through thematic analysis, we use personas methodology to articulate the needs and pain points of professional physicists. We present our set of four personas: the physicist who engages in informal physics for self-reflection, the physicist who wants to spark interest in physics, the physicist who wants to provide diverse role models to younger students and inspire them to pursue a STEM career, and the physicist who wants to improve the relationship between scientists and the public. This work will allow the informal physics community to create tailored resources for the variety of professional development needs of informal physics facilitators.

2022 PERC Proceedings edited by Frank, Jones, and Ryan; Peer-reviewed, doi.org/10.1119/perc.2022.pr.El-Adawy

I. INTRODUCTION

Informal physics education refers to activities and events centered on engagement with physics outside the formal classroom. Examples of informal physics activities include public talks, science festivals, museums events, and podcasts, just to name a few. Despite the wide variety of possible activities, a common characteristic they share is that participation is voluntary and activities are meant to provide participants the freedom to explore and be curious about how the world works. Over the years, the informal physics education research (IPER) community has investigated the development and impact of informal physics programs on their participants and facilitators [1–3]. For example, researchers have shown that different structures within informal physics support physics identity development [4–6]. In particular, informal physics programs are spaces for an increased sense of belonging to the physics community, and for gaining confidence and communication skills necessary for one's career [7, 8].

Efforts have also been made to survey programs to characterize the landscape of practices being undertaken. Factors such as personnel and funding were among the biggest barriers to the functionality and sustainability of programs long-term [9, 10]. Additionally, there is a common sense of isolation for facilitators and researchers in informal physics education who struggle to sustain and grow their efforts in that space [11, 12]. Nevertheless, research remains scarce on the needs of facilitators of informal physics activities. Thus, in this study, we present our methodological approach to investigating informal physics facilitators' experiences in order to design resources and professional development that address their needs.

We use personas methodology because of its usefulness showcased in education research for instructional design and professional development. For example, the research team at PhysPort [13], a professional development website for physics faculty, used personas to improve the design and development of resources and activities for faculty by understanding their needs when making changes to their teaching [14]. Personas has also been used for undergraduate researchers to support the design of research programs with student-centered approaches based on their various motivations and experiences [15]. Additionally, personas has been applied to design instructional resources around learners' needs in the workplace [16].

Personas are person-like constructs created from data of a group of potential users, which are synthesized into archetypes [17]. Each persona is created around a common goal that stems from the data and informs the design process. Data from multiple individuals are abstracted into one persona. Users can identify with multiple personas depending on their motivations, needs, and context. Personas allow us to create targeted professional development resources based on motivations, needs, and experiences of potential users.

By creating archetypes that are very human-like without representing the peculiarities of one person, several benefits emerge. First, researchers preserve anonymity of interview subjects because the synthesized patterns are a combination of features from multiple interview subjects [18]. Second, although some fictional details are added to personas to make them more human-like, personas represent real users for which resources are meant to be created instead of the assumptions of designers who may envision a variety of resources that are not useful for the actual target population [19]. Lastly, researchers focus on goals and needs of users in the entire design process of resources, which creates rich descriptions of a variety of experiences and needs of the target users. These benefits align with the goal of this project, which is to understand the needs of informal physics facilitators and develop user-centric resources to support them in order to lower barriers for implementation and participation.

Thus, we present our approach to developing a set of personas for informal physics facilitators to address the research question: **What are the professional development needs of physicists who engage in informal physics education?**

Note on terminology: Typically, "facilitator" refers to a physicist who either individually or with collaborators engages directly with the audience in informal physics spaces."Practitioner" refers to a physicist who is involved in designing and managing an informal physics space; they may or may not also act as facilitators in the space. For simplicity in this paper, we will use the terms facilitator and practitioner interchangeably.

II. METHODS

A. Positionality of Authors

As authors and researchers, our affiliations and experiences in informal physics and physics education research influence the way we conducted this work. We include positionality statements to contextualize our findings because our backgrounds inevitably contain inherent biases, affordances, and limitations.

El-Adawy is a physics education researcher with expertise in STEM researchers' professional development. Sayre is a physics education researcher with expertise in persona generation in physics education spaces and STEM faculty professional development for teaching and research. She rarely engages in IPER. Lau is a physics education researcher with expertise in faculty professional development around teaching. She has been a facilitator of informal physics activities and currently manages a number of public engagement professional development programs. Fracchiolla is an IPER expert and facilitator, with more than 10 years experience designing, coordinating, and facilitating informal physics programs.

B. Context: Recruitment of research subjects

To identify individuals and networks engaged in informal physics to participate in our study, we used a snowball approach [20]. We gathered an initial list of names and networks to tap into from researchers and practitioners in informal physics who engage with the American Physical Society (APS) public engagement efforts. Once we gathered a list of about 30 individuals, we sent out a screening questionnaire to ask if they were willing to participate in the research study and/or if they had suggestions for other individuals to seek out to broaden the network of practitioners and researchers engaged in informal physics education. For those who responded positively to the screening survey, we then reached out to conduct one-on-one semi-structured interviews for our research study.

C. Data collection

The semi-structured interview protocol covered four main topics: (a) the interviewee's current role and experience with informal physics; (b) their conception of and motivation for informal physics work; (c) challenges faced with informal physics work; and (d) professional identity. Our protocol included questions such as: Could you give us a broad overview of your current professional obligations and involvement in public engagement? What is your current informal physics education/research community? What are some challenges/barriers you are encountering with engaging in public engagement activities? What would you need to overcome those challenges? What kind of support would be most helpful to you?

Interviews were conducted by the first author over video conference (Zoom), recorded, and transcribed (Zoom transcription service) for analysis. The length of the interviews varied between 30 to 60 minutes depending on the availability of the interviewee and how much detail the interviewee gave in their answers. In this paper we present preliminary results from the first round of interviews conducted with 15 informal physics practitioners.

D. Personas Development

We conducted a thematic analysis [21]. The process consisted of reading the transcripts and paying particular attention to the participants' answers about goals, needs, and resources for engaging in informal physics. For each transcript, key ideas of participants were identified and given a theme such as "interest in informal physics: recruiting underrepresented populations to physics", "resource used: discussions with practitioners", "challenge: finding time", "need: science communication: meeting your audience where they are at". All transcripts were read and an initial list of codes were generated. Then, the lead author created a table summarizing the following information for each interview: career stage (physics graduate student, postdoc, faculty, informal physics professional, physicist at national laboratory, high school physics teacher), motivation to engage in informal physics, resources used, resources needed and challenges faced. Quotes illustrative of motivation to engage in informal physics were also included in the table.

Then, we combined users by motivation to identify patterns in terms of challenges and resources needed. This led to the creation of an initial list of potential archetypes distinct in their goals. The archetypes are an abstraction from the details of the individual interview subjects. Discussions occurred among the research team on the initial proposed person-like constructs based on their motivations to engage in informal physics. Given the overlap between archetypes in terms of the challenges and resource needs, we went back to the data to identify challenges that were either unique to a persona and/or were the most prevalent challenge cited by interviewees that could identify with that persona . These prioritized challenges then corresponded directly to the resources needed that people talked about.

For example, a common theme that emerged was the need for recognition, but there were some nuances. Some users wanted recognition from those in higher positions of power at their organization and some wanted recognition from the entire physics community. Some proposed various ways by which this need could be addressed such as national awards from professional societies for their work in informal physics to elevate its status in the physics community.

These nuances of needs and ways to address them allowed us to brainstorm the implications to best support our goal of designing user-centered resources. We have listed in Table I potential implications as we design resources to directly address participants' needs.

III. FINDINGS

We present our preliminary set of four personas: Logan, Spencer, Armani, and Nour. They stem from our first iteration of personas construction from our data set. Our goal for the project intentionally influenced the themes we prioritized (i.e. we focused on motivations and needs). From our data set of real experiences, we extracted details that were synthesized into a set of archetypes. This is where we lost the direct link to individuals and merged our variations into distinct personas. When we humanized our personas, we also lost individual idiosyncratic details. However, when we mapped back to the data, we made sure that personas are representative of real people. In prioritizing needs, we thought of potential resources we could develop to support our users' needs.

Logan, **the self-reflective facilitator**, engages in informal physics because they enjoy how energized they get when interacting with an audience to convey knowledge. A representative quote of Logan's goal is:

I personally get a little bit of a high from doing it. I love to be in front of a crowd and talking about things that I know. I love answering people's questions.

Although engaging with the public energizes Logan about their science and enables self-reflection, they find it challenging to figure out how to interact with different types of audiences. They are also facing organizational challenges. They are not sure how to best organize their engagement in informal physics to sustain their engagement for long periods of time while managing their many responsibilities. Logan is developing as a facilitator through practice and trial and error. They expressed the need to have access to centralized resources on how to get started when engaging with a specific type of audience or event in informal physics, especially how to organize, set up and manage events with multiple stakeholders (volunteers, audience, institutions). They also would like to get training in science communication to best engage with different types of audiences.

Spencer, **the sparking interest facilitator**, engages in informal physics because they enjoy conveying their excitement about science to others and seeing the "light bulb" moments when participants understand a new physics concept. A representative quote of Spencer's goal is:

I love when students figure something out and they get super excited and start explaining it to all their friends. [...] So the possibility that when I am doing one of these events that I could inspire someone to go to work in the sciences, positively be working in physics areas that I am really passionate about. They could go on to discover great things.

As a by-product of sharing their excitement with their audience, Spencer is hoping some participants may consider a STEM career path. Spencer is involved in established informal physics programs and gets regular training through that program. The training consists of practicing the different activities they do with their audience and learning about best practices on how to interact with their audience. Spencer feels that the broader scientific community does not support them in their informal physics endeavors and as a consequence, they feel isolated. Spencer has two types of needs around recognition and community building. In terms of recognition, they want those in higher positions of power to recognize the value of informal physics. In terms of community, they want to create partnerships between peers and institutions to support their endeavors in informal physics.

Armani, **the representation matters facilitator**, engages in informal physics because as an under-represented person in the field, it is important to them to provide diverse role models to younger students in order to inspire them to pursue a STEM career path and create a more diverse STEM workforce. A representative quote of Armani's goal is:

Trying to get more girls and people of color and women into physics.

Armani discusses their informal physics efforts with other practitioners but is frustrated by the pushback they receive from the scientific community, which does not always see it as an integral part of a physicist's job. The resources they need the most are about community building and recognition, but they have a different character than Spencer's needs. Armani would like to have a network of peers to work with to include diversity, equity and inclusion practices in informal spaces. For recognition, Armani wants professional societies and organizations to create more awards for public engagement efforts to get the attention of their departments and institutions. This need is concurrent with findings from the literature, which has shown the critical role that recognition and relational resources play in linking programmatic efforts to support representation of students from underrepresented groups and student physics identity [22].

Nour, **the societal impact facilitator**, engages in informal physics because of its potential beneficial impact on society's perception and relation with the scientific community. A representative quote of Nour's goal is:

My work in outreach and engagement is about getting the audience to appreciate that the truth is still a thing. There are facts out there, and so the scientific process has become much more of what I try to teach.

The importance of bridging the disconnect that can exist between scientists and the public is what drives them to engage in informal physics. They use resources found online and discussions with other physicists to support their endeavors. They are challenged by the scarcity of funding for informal physics professionals who communicate science and the difficulty in calling attention to issues facing the entire physics community that could be addressed with more public support for science. Nour identifies needs around bridging two community gaps. First is the gap that exists between full-time informal physics professionals and physicists who engage in informal physics part-time. Second is the gap between physicists who engage in informal physics and physicists who do not. Nour proposes that scientific meetings and conferences have more plenary sessions conducted by both physicists and informal physics professionals to highlight the value for physicists and bridge the two communities.

We summarized Nour, Armani, Spencer and Logan key needs and implications for the development of resources in Table I.

IV. DISCUSSION

Our study underlined the nuances in needs from a wide range of practitioners' experiences. However, in conducting our analysis, we have encountered some limitations. There was overlap in the challenges and needs across most stakeholders, which made it challenging to create distinct personas. Community building and recognition were common

Persona	Key needs	Implication for research team designing resources
 Logan: the self-reflective facilitator	• A centralized resource hub to get started • Science communication training • Logistical resources on how to organize to sustain engagement in informal physics	• Designing a searchable list of activities that are easy to implement • Designing training on skill development: storytelling with confidence and logistical programmatic factors
 Spencer: the sparking interest facilitator	• Recognition of the importance of informal physics from those in higher positions of power • Community building resources to connect practitioners and institutions	• Designing support to get community recognition (policy statements, invitations to conferences or talks) • Designing a network that allows practitioners to identify opportunities to partner with other practitioners or with researchers
 Armani: the representation matters facilitator	• Recognition awards to get institutions to support informal physics efforts • Community building by working with other practitioners to improve representation in physics	• Designing spaces for discussions to occur to get the community to recognize and elevate the value of informal physics • Designing training on programmatic efforts that focus on best practices for recruitment and retention strategies for underrepresented populations in physics
 Nour: the societal impact facilitator	• Community building by connecting informal physics professionals and physicists • Elevating value of informal physics through plenary sessions	• Designing opportunities to share ideas and findings with other practitioners, professionals, researchers at conferences

TABLE I. Personas representing variation of physicists around needs in informal physics and potential implications research team designing resources.

themes across all our dataset. We made deliberate choices to prioritize needs based on what challenges were unique and/ or appeared most frequently around each motivation, and what we could practically implement in our design process. This took away some of the descriptive details and nuances that may be important. Although losing some details is inevitable in constructing personas, in our future iterations of the cycle of development, we will need to continue to ensure that every interview subject is represented in features of at least one persona created and we did not miss any significant theme in our users' needs.

Another constraint faced was in the articulation of motivations. We based this identification on the emergent themes in the data as thematic analysis posits. Including a motivation theory to guide our development process in future work will help us articulate and distinguish our personas in a more robust way, which would greatly benefit our development of support structures and resources for practitioners of informal physics activities.

There were also affordances in using personas for our project because it highlighted features of physicists' needs we may not have captured otherwise. In constructing personas, we noticed that career stage and motivation are not in a one-to-one correspondence. There were multiple career stages represented in each persona. We had not expected that needs were not solely dependent on career level. This highlights the value of using personas for a user-centric approach rather than researchers' assumptions about users' needs. This informed us that career stage may not be the best distinguishing factor, but perhaps level of engagement in informal physics or type of activities and audience they engage with would be a feature to explore in our next iterations of personas constructions.

By developing this set of personas, we are expanding on the informal physics community's understanding of the needs of practitioners in this space. The development of these four personas informs the design of resources listed in the third column of Table I. Bringing this methodological approach to professional development in informal education enriches the development of user-centric resources to support informal physics facilitators.

ACKNOWLEDGMENTS

Thank you to our interview participants. This work is supported by the American Physical Society.

[1] M. B. Bennett, B. Fiedler, and N. D. Finkelstein, Refining a model for understanding and characterizing instructor pedagogy in informal physics learning environments, Physical Review Physics Education Research **16**, 020137 (2020).

[2] B. L. Fiedler, M. B. Bennett, N. E. Johnson, and E. B. Moore, Coordinating epistemic frames in informal physics: Agency, support, and technology, in *Proceedings of the Physics Education Research Conference (PERC* (2019) pp. 159–164.

[3] D. B. Harlow, The excitement and wonder of teaching science: What pre-service teachers learn from facilitating family science night centers, Journal of Science Teacher Education **23**, 199 (2012).

[4] R. Dou, Z. Hazari, K. Dabney, G. Sonnert, and P. Sadler, Early informal STEM experiences and STEM identity: The importance of talking science, Science Education **103**, 623 (2019).

[5] C. Fracchiolla, B. Prefontaine, and K. Hinko, Community of practice approach for understanding identity development within informal physics programs, Physical Review Physics Education Research **16**, 020115 (2020).

[6] B. Prefontaine, C. Mullen, J. J. Güven, C. Rispler, C. Rethman, S. D. Bergin, K. Hinko, and C. Fracchiolla, Informal physics programs as communities of practice: How can programs support university students identities?, Physical Review Physics Education Research **17**, 020134 (2021).

[7] R. Wulf, K. Hinko, and N. Finkelstein, Promoting children agency and communication skills in an informal science program, in *AIP Conference Proceedings*, Vol. 1513 (American Institute of Physics, 2013) pp. 430–433.

[8] C. Rethman, J. Perry, J. P. Donaldson, D. Choi, and T. Erukhimova, Impact of informal physics programs on university student development: Creating a physicist, Physical Review Physics Education Research **17**, 020110 (2021).

[9] C. Fracchiolla, N. D. Finkelstein, and K. A. Hinko, Characterizing Models of Informal Physics Programs, in *2018 Physics Education Research Conference Proceedings* (American Association of Physics Teachers, Washington, DC, 2019).

[10] D. Izadi, J. Willison, K. A. Hinko, and C. Fracchiolla, Developing an organizational framework for informal physics programs, in *2019 Physics Education Research Conference Proceedings* (American Association of Physics Teachers, Provo, UT, 2020).

[11] C. Thorley, *Physicists and Outreach: Implications of schools physics outreach programmes from the perspective of the participating physicists*, Ph.D. thesis, UCL (University College London) (2016).

[12] M. B. Bennett, K. A. Hinko, and D. Izadi, Challenges and opportunities for informal physics learning in the covid era, Physical Review Physics Education Research **17**, 023102 (2021).

[13] S. B. McKagan, L. E. Strubbe, L. J. Barbato, B. A. Mason, A. M. Madsen, and E. C. Sayre, Physport use and growth: Supporting physics teaching with research-based resources since 2011, The Physics Teacher **58**, 465 (2020).

[14] A. M. Madsen, S. B. McKagan, L. E. Strubbe, E. C. Sayre, D. Zohrabi Alaee, and T. Huynh, User-centered personas for physport, in *Proceedings of the Physics Education Research Conference 2019* (2020).

[15] T. Huynh, A. M. Madsen, and E. C. Sayre, Undergraduate researcher personas, arXiv preprint arXiv:2003.00364 (2020).

[16] R. Maier and S. Thalmann, Using personas for designing knowledge and learning services: results of an ethnographically informed study, International Journal of Technology Enhanced Learning **2**, 58 (2010).

[17] T. Huynh, A. Madsen, S. McKagan, and E. Sayre, Building personas from phenomenography: a method for user-centered design in education, Information and Learning Sciences (2021).

[18] A. Madsen, S. B. McKagan, E. C. Sayre, M. Martinuk, A. Bell, *et al.*, Personas as a powerful methodology to design targeted professional development resources, arXiv preprint arXiv:1408.1125 (2014).

[19] J. Pruitt and J. Grudin, Personas: practice and theory, in *Proceedings of the 2003 conference on Designing for user experiences* (ACM Press, San Francisco, California, 2003) p. 1.

[20] C. Parker, S. Scott, and A. Geddes, Snowball sampling, SAGE research methods foundations (2019).

[21] V. Braun and V. Clarke, Using thematic analysis in psychology, Qualitative Research in Psychology **3**, 77 (2006).

[22] S. Hyater-Adams, C. Fracchiolla, N. Finkelstein, and K. Hinko, Critical look at physics identity: An operationalized framework for examining race and physics identity, Physical Review Physics Education Research **14**, 010132 (2018).