Recommendations for individuals/ individual programs

GOAL

Culture shift whereby Informal Physics Education (IPE) is widely recognized as an essential physics practice

LEVER 1

Structures

Amplify structures that frame IPE as an essential activity worthy of resource allocation.

LEVER 2

Engagement of interested, influential, and impacted parties

Identify techniques for recruiting and empowering people to engage in and/or support IPE as essential physics practice.

LEVER 3

Integrating Research-Based Practices in IPE

Leverage research to understand, develop, and advocate for IPE as essential physics practice.

LEVER 1 - Structures

Amplify structures that frame IPE as an essential activity worthy of resource allocation.

- **S.1:** Structural changes are often brought about by individual 'champions' who lead organizations in adopting the change. While **we encourage individuals to advocate for the following structural changes**, especially those individuals in positions of relative organizational power, **we also recognize that no one individual ought to be responsible for ensuring the following recommendations come to fruition** within their, or any, organization.

LEVER 2 - Engagement of interested, influential, and impacted parties

Identify techniques for recruiting and empowering people to engage in and/or support IPE as essential physics practice.

- **P.1: Track program effectiveness —** University administration, funders, and others often request data on IPE program impact in order to support the effort. Sharing these impacts with interested, influential, and impacted parties can help make the case for the value of IPE. These data can be a mix of quantitative and qualitative metrics. See section III.D on research-based practices for a discussion of a variety of possible metrics.
- **P.2: Align goals with funders' missions —** Funders want to see how the project aligns with their goals. It is important to have a clear plan for the direction you want your project to go, and how support will help you get there. Additionally, proposals should incorporate rich and robust evaluation frameworks and plans for sharing evidence of impact.
- **P.3: Meet with policy makers to advocate for supportive policies and funding for IPE —** Highlight the benefits of IPE for constituencies and their connection to existing educational goals. This can be done via various mechanisms such as policy briefs, roundtables, and 1:1 meetings.
- **P.4: Invite policy makers, administrators, leaders, and faculty to interact with IPE programs —** Observing, showing up, and even participating in IPE programs will increase awareness of programs, their funding needs, and common values. These people can then be recruited as program champions, to bear witness to their importance.
- **P.5: Consistently engage community members at every stage and level of an IPE program —** Community members can be both advocates and avid participants for IPE programs. Co-creating programming with the community and your participants will lead to greater participation and impact. Co-creation can also mean leaning into the "messiness" of multiple voices and priorities.

- **P.6: Integrate IPE into your research goals —** This can take the form of a research project studying the design and impact of an IPE program, or can be incorporated into an area of traditional physics research. For example, you can engage various publics in your data collection and analysis through "community science" platforms. You can also host roundtables with community leaders to understand their needs and how they can shape your research direction.
- **P.7: When engaging in dialogue with different** interested, influential, and/or impacted parties, **articulate a relevant value proposition for supporting IPE —** This is a more general statement of a number of the other recommendations. Find the message that resonates with your audience by understanding their goals and how they connect to those of your program. For example, faculty and department leaders may be interested in the benefits to university students who facilitate IPE programs, while K-12 schools or community organizations may be interested in the benefits for younger students and their families.

LEVER 3 - Integrating Research-Based Practices in Informal Physics Education

Leverage research to understand, develop, and advocate for IPE as essential physics practice.

- **R.1: Clarify audience and goals —** Begin by clearly defining who you aim to serve or work with through your IPE program. Reflect on who your target audience is, what interests or needs they may have, and how your program can best meet those needs. Practitioners should consider conducting initial audience analysis to better understand what drives engagement within their communities. This could involve community feedback sessions, exploratory surveys, or informal discussions with representatives of the target audience. Identifying and articulating program goals aligned with the unique needs, backgrounds, and interests of your audience will make program design and evaluation more focused, meaningful, and effective [32].
- **R.2: Engage in continuous evaluation and assessment —** Evaluation should be an ongoing process rather than a one-time activity. Incorporate opportunities for iterative feedback from participants and partners throughout the program. This feedback can inform adjustments to the program and ensure it remains relevant and responsive to the needs of those it serves.
- **R.3: Align research with program goals, institutional missions, and community needs —** For those interested in conducting research, designing studies that align with program goals ensures that collected data will be directly relevant for assessment and evaluation. Research that explores how IPE can support both institutional missions and community needs (which should already be incorporated into program goals) offers a path forward for integrating IPE more fully into physics departments, labs, and national initiatives.

- **R.4: Seek broad expertise and partnerships —** Assemble teams with people from varied backgrounds, drawing on expertise from multiple disciplines, such as sociology, education, and communication studies. Forming research-practice partnerships (RPPs) or collaborating with other community organizations can help practitioners access a wider range of insights and resources, ensuring that programs and studies are better informed and more comprehensive.
- **R.5: Engage in dialogue rather than presenting a pitch —** Rather than presenting IPE as a "pitch" to be sold, IPE practitioners should draw on the growing body of research demonstrating its benefits to initiate dialogues that celebrate multiple perspectives and encourage collaboration – similar to the ways in which research communities typically operate. IPE provides demonstrable value to departments and organizations, and facilitators and practitioners should engage in open dialogue with the systems that could support them.
- **R.6: Define success in audience-relevant terms —** Be flexible in how success is defined, tailoring success metrics to the specific context of each program and audience. For example, if your goal is to engage younger audiences, success might focus on fostering curiosity and confidence in exploring physics. When communicating to institutions, however, metrics like participant retention and program reach might be more relevant. This approach ensures that the value of IPE is communicated effectively to different groups.

  Example: In an ongoing longitudinal research study, the Partnerships for Informal Science Education in the Community (PISEC) program at CU Boulder [85] tracks a range of impacts on youth participants, including sustained STEM interest and career aspirations. Researchers examine factors like STEM identity, college attendance, and persistence in STEM, while also capturing other emergent impacts reported by participants such as increased confidence in discussing science and fostering personal relationships, regardless of STEM career interest.
- **R.7: Collect a variety of metrics to tell the full story of an IPE program —** As discussed above, both quantitative and qualitative metrics are important in developing a complete picture of the impact of IPE programs for institutions, program leadership, community partners, and participants.
- **R.8: Document audience, facilitator, institutional, and community impacts —** Systematically document the impacts of IPE on the audience, the facilitators, the local community, and other impacted institutions, considering how all groups benefit from engagement. This includes tracking both quantitative metrics, like the number of participants, and qualitative indicators, such as identity development or shifts in attitudes toward science. It may not be possible or practical for one study to document the full suite of impacts, but a comprehensive picture should be built over time by the IPE community with multiple studies and evaluations. Sharing these impacts with interested, influential, and impacted parties can help make the case for the value of IPE.
- **R.9: Read IPE research digests to stay on top of latest research findings and how they apply to your practice —** Not all practitioners need to become IPE researchers, but it is important to stay abreast of how research findings can inform better practice.

Recommendations for departments & institutions

GOAL

Culture shift whereby Informal Physics Education (IPE) is widely recognized as an essential physics practice

LEVER 1

Structures

Amplify structures that frame IPE as an essential activity worthy of resource allocation.

LEVER 2

Engagement of interested, influential, and impacted parties

Identify techniques for recruiting and empowering people to engage in and/or support IPE as essential physics practice.

LEVER 3

Integrating Research-Based Practices in IPE

Leverage research to understand, develop, and advocate for IPE as essential physics practice.

LEVER 1 - Structures

Amplify structures that frame IPE as an essential activity worthy of resource allocation.

- **S.2: Leverage the connection between IPE and service learning** – Some undergraduate education courses are designated as "service learning" courses, in which students must engage in real-world teaching/education experience as part of the course. Physics departments and individual informal physics/STEM programs should partner with these courses to provide opportunities for students to engage in IPE and to simultaneously support the success and sustainability of the informal programs. It would be ideal if this was a structure embedded into departments and undergraduate (or even graduate) programs.

  Successful examples: Mobile Making at California State University [63,64] & Eric Hazlett's Analytical Physics 3 course at St Olaf College, which includes an active civic engagement component where students create hands-on demonstrations that are shared at local community events and with students in the St. Olaf TRiO Educational Talent program.

- **S.3: Integrate IPE efforts with other existing efforts to broaden participation –** Integrating IPE with existing initiatives aimed at expanding access and engagement can help departments and institutions make efficient use of established structures rather than creating new ones from scratch. This approach strengthens IPE while also fostering a more welcoming and supportive environment for a wider range of participants in physics. As with all recommendations, implementation will be highly context dependent and should attend to the organizational climate in which the department finds itself.

- **S.4 (*same as P.9): Hiring and promotion policies should include and reward IPE work –** IPE activities should not only be acknowledged in tenure and promotion cases [65], but they should be rewarded and encouraged, contrary to the existing norm in which IPE activities can hinder an individual's opportunities for tenure and promotion. For more context on this recommendation, please see the white paper published by the American Physical Society Committee on Informing the Public [66,67].

  Successful examples: At Lansing Community College, faculty contracts include a specified number of hours that must be dedicated on non-teaching assignments, and community outreach and events explicitly count towards this time. Dr. Bryan Stanley, LCC physics faculty, shares that in their hiring interview, they were asked about their community engagement work and plans for future community engagement they wanted to do in the position they were interviewing for.

  Similarly, the University of Texas at Austin's policy for promotion for professional track faculty (including teaching faculty) includes a statement on your primary area plus another statement on "Contributions to the Academic Enterprise" which is a broad category that can include any substantive additional work, including in IPE [68].

In Ireland, the University College Dublin 'Framework for Faculty,' used by academics in their applications for promotion, includes a specific public engagement dimension. Within this, expectations are set out for faculty with the highest levels associated with public engagement scholarship at international scale [69].

- **S.5: For faculty at academic institutions or other roles with "service" requirements, IPE activities should fulfill said service requirements —** Departments can also consider how IPE could fulfill teaching requirements if, for example, a faculty member includes an IPE component to their physics course (see recommendation S.2).
- **S.6: Provide funding for IPE work at multiple scales —** Funding need not only come from large-scale, national foundations, but should also come locally from departments, universities, etc. Funding mechanisms should prioritize IPE activities that are utilizing evidence-based practices and are designed to effectively engage the audiences of focus. Opportunities for renewable funding will help make IPE programs sustainable, and funding available to students and other junior members of institutions will help support a large population of IPE practitioners. Departments and institutions are well-suited to provide commonly needed (and relatively cheap) resources like materials, room rentals, parking waivers, and stipends for student interns.
- **S.7 (*same as R.14): Establish recognition mechanisms for exemplary IPE programs and practitioners, including students —** Such recognition could include site or practitioner awards, digital badges or professional certificates for completing IPE training, and features in institutional communications. Recognition can be implemented at the department, community of practice (e.g., JNIPER) and international organization (e.g., APS) scale.
- **S.8: Create or expand community engagement/campus extension offices —** These offices are often staffed by experts in community partnerships whose job it is to build relationships with local community members and groups. These offices can be a resource for physics faculty and students seeking to engage in IPE, as well as local audiences interested in STEM. This recommendation relates to institutions ensuring these offices have the capacity and expertise to support these kinds of connections that would be beneficial for physics/STEM public engagement.
- **S.9 (*same as P.12): Obtain the Community Engagement Elective Carnegie Classification for your institution [70]—** This classification requires a campus-wide commitment to partnership with the local community. Applications require detailed examples of academic-community partnerships, such as an IPE program. A push from institutional leaders to obtain this classification for the institution will promote buy-in from multiple interested, influential, and/or impacted parties in IPE.

LEVER 2 - Engagement of interested, influential, and impacted parties

Identify techniques for recruiting and empowering people to engage in and/or support IPE as essential physics practice.

- **P.8: Invest in infrastructure that supports public engagement and evaluation —** Reducing administrative and resource barriers facilitates buy-in from faculty, staff, and students. Examples of infrastructure include dedicated space and materials that can be used for IPE programming, partnerships with social scientists for program evaluation, and teaching assistant lines dedicated for facilitating IPE programs.
- **P.9 (*same as S.4): Recognize IPE activities in tenure and promotion processes —** This is important for faculty and staff to buy-in to IPE as a practice they should engage in [65–67].
- **P.10: Integrate IPE activities into the curriculum and provide academic credit for participation in IPE efforts —** This provides an important marker of disciplinary value to students. It is easier for students to buy-in to IPE as an essential disciplinary practice if they get academic credit for their participation. IPE can be incorporated into curricula as part of a service-learning credit, a lab course, a pedagogical/communication requirement, or an independent study.

  Successful example: Eric Hazlett's Analytical Physics 3 course at St Olaf College, which includes an active civic engagement component where students create hands-on demonstrations that are shared at local community events and with students in the St. Olaf TRiO Educational Talent program.
- **P.3: Meet with policy makers to advocate for supportive policies and funding for IPE —** Highlight the benefits of IPE for constituencies and their connection to existing educational goals. This can be done via various mechanisms such as policy briefs, roundtables, and 1:1 meetings.
- **P.4: Invite policy makers, administrators, leaders, and faculty to interact with IPE programs —** Observing, showing up, and even participating in IPE programs will increase awareness of programs, their funding needs, and common values.These people can then be recruited as program champions, to bear witness to their importance.
- **P.11: Acknowledge the IPE career pathways that students can take and legitimize the rhetoric around those IPE careers —** Career panels and talks should include examples of physics majors who have gone on to a career in IPE, including the option to pursue the academic track with a research-focus on IPE. Job boards and career resources should also illustrate the many forms an IPE career can take.
- **P.12 (*same as S.9): Obtain the Community Engagement Elective Carnegie Classification for your institution [70] —** This classification requires a campus-wide commitment to partnership with the local community. Applications require detailed examples of academic-community partnerships, such as an IPE program. A push from institutional leaders to obtain this classification for the institution will promote buy-in from multiple interested, influential, and/or impacted parties in IPE.

LEVER 3 - Integrating Research-Based Practices in Informal Physics Education

Leverage research to understand, develop, and advocate for IPE as essential physics practice.

- **R.10: Hire faculty who research IPE —** This will indicate that the department/institution values scholarly IPE, and will facilitate the generation of new knowledge. These faculty will also train students in evaluation and research methods, expanding the research skillset of the IPE community.
- **R.11: Incorporate IPE evaluation and research into the curriculum —** Evaluation and assessment methods for both formal and informal learning environments should be included in pedagogy courses, as part of the broader body of investigation techniques.
- **R.12: Support graduate study of IPE —** Physics graduate students should be encouraged to focus on IPE research for their dissertation work, and their work with informal physics education programs should be recognized both as service and as research work.
- **R.13: Staff IRB offices with experts in the ethics and logistics of RPPs and other community-based research projects —** This will provide support for physics students and faculty who are engaging in IPE research. The IRB staff should be able to offer guidance on research involving minors and how to partner with local school districts.
- **R.14 (*same as S.7): Establish recognition mechanisms for exemplary IPE programs and practitioners, including students —** Here, exemplary refers to programs that incorporate research-based practices and evaluate the impact of their program. Such recognition could include site or practitioner awards, digital badges or professional certificates for completing IPE training, and features in institutional communications.

Recommendations for informal STEM topical groups (e.g., JNIPER)

GOAL

Culture shift whereby Informal Physics Education (IPE) is widely recognized as an essential physics practice

LEVER 1

Structures

Amplify structures that frame IPE as an essential activity worthy of resource allocation.

LEVER 2

Engagement of interested, influential, and impacted parties

Identify techniques for recruiting and empowering people to engage in and/or support IPE as essential physics practice.

LEVER 3

Integrating Research-Based Practices in IPE

Leverage research to understand, develop, and advocate for IPE as essential physics practice.

LEVER 1 - Structures

Amplify structures that frame IPE as an essential activity worthy of resource allocation.

- **S.10: Host a member directory or other mechanism for facilitating partnerships among IPE practitioners, IPE researchers, and other physicists**
- **S.11: Publish a regular newsletter to support community building, help disseminate members' work, and provide visibility and recognition**
- **S.12 (*same as P.16): Provide toolkits and training to support implementation of partnership-focused IPE programming —** Resources will lower the barrier to starting and improving an IPE initiative because interested parties will not have to "reinvent the wheel." Examples include: a playbook of how IPE practitioners should connect to communities, defining best practices for building partnerships; "cheat sheets" that synthesize research findings and provide suggestions for how IPE practitioners can apply the findings in their work; a list of models or examples for how departments might incorporate IPE in their curriculum, major, or departmental activities and culture.
- **S.13 (*same as P.13): Provide workshops on effective grant writing, impact reporting, and evaluation strategies —** This training can help individuals prepare an IPE-focused grant proposal, and/or help individuals to directly connect their physics research meaningfully to their broader impacts components of their physics research grants.
- **S.14: Set a recognized standard for ethical and effective IPE practice and research —** These standards can be emulated and boosted by science societies, funders, and other IPE partners. Examples of standards include paying and/or recognizing students facilitating IPE programs; cultivating long-term community partnerships; engaging in research-practice partnerships; and establishing clear metrics and evaluation plans. For more on standards for research, see Section III.D.
- **S.7 (*same as R.14): Establish recognition mechanisms for exemplary IPE programs and practitioners, including students —** Such recognition could include site or practitioner awards, digital badges or professional certificates for completing IPE training, and features in institutional communications. Recognition can be implemented at the department, community of practice (e.g., JNIPER) and international organization (e.g., APS) scale.
- **S.15 (*same as R.15): Publish IPE research "digests" —** To help the IPE community and partners stay informed of recent results and findings. This digest should be shared with science societies (e.g., APS, AAPT, AIP) and others outside the immediate IPE community.
- **S.16: Create and disseminate mentorship opportunities —** To mentor people new to IPE into career pathways that incorporate IPE.

  Successful example: The JNIPER Fellows program trains a small cohort of students in science communication skills [24]. The students then apply their skills to produce content for APS Public Engagement programs. The cohort design and connection to the broader JNIPER community provide exposure to multiple pathways that incorporate IPE.

LEVER 2 - Engagement of interested, influential, and impacted parties

Identify techniques for recruiting and empowering people to engage in and/or support IPE as essential physics practice.

- **P.13 (*same as S.13): Provide workshops on effective grant writing, impact reporting, and evaluation strategies** – This training can help individuals prepare an IPE-focused grant proposal, and/or help individuals to directly connect their physics research meaningfully to their broader impacts components of their physics research grants. Training in evaluation helps practitioners know what to assess (e.g., participant value, motivations) and helps with messaging to funders and leaders because they often require metrics of IPE program impact.
- **P.14: Highlight successful IPE programs –** Concrete examples of programs that are meeting their goals and those of their community partners help promote buy-in from parties who have not experienced an IPE initiative. Similarly, sharing stories of challenges and how programs have overcome them will add to buy-in.
- **P.15: Highlight institutional practices that uplift IPE work –** Collect concrete examples of institutions that are recognizing the IPE work of their students/staff/faculty and examples how they are supporting the work. This helps facilitate change at similar type institutions.
- **P.16 (*same as S.12): Provide toolkits to support implementation of partnership-focused IPE programming** – Resources will lower the barrier to starting and improving an IPE initiative because interested parties will not have to "reinvent the wheel." This, in turn, promotes buy-in. Examples include: a playbook of how IPE practitioners should connect to communities, defining best practices for building partnerships; "cheat sheets" that synthesize research findings and provide suggestions for how IPE practitioners can apply the findings in their work; a list of models or examples for how departments might incorporate IPE in their curriculum, major, or departmental activities and culture.
- **P.17: Organize forums and roundtable discussions to discuss the role of IPE in achieving broader educational goals throughout communities –** This will engage policy makers, community members, and education/academia leaders.
- **P.18 (*same as R.18): Support strategic messaging**– Equip members to leverage research findings to promote buy-in for IPE among funders, departments, and institutions. This can include curated lists of benefits and metrics of success to demonstrate the case (with evidence) that IPE efforts align with institutional and community values; templates, examples, and resources for recruiting local champions; and training on advocacy to policy makers.
- **P.19: Connect K-12 education standards to common IPE programming –** This will promote buy-in from K-12 educators, leaders, and parents, and ease implementation of IPE in school settings.

LEVER 3 - Integrating Research-Based Practices in Informal Physics Education

Leverage research to understand, develop, and advocate for IPE as essential physics practice.

- **R.15 (*same as S.15): Publish IPE research "digests" —** To help the IPE community and partners stay informed of recent results and findings. This digest should be shared with science societies (e.g., APS, AAPT, AIP) and others outside the immediate IPE community.
- **R.16: Facilitate practitioner-researcher connections —** Support sustainable RPPs and foster collaborative research teams that bridge disciplinary boundaries by providing mechanisms for community members to connect and seek partnerships on evaluation and research. Connections are also needed to share methodologies, research/evaluation questions, and approaches. S.10 provides one example of how to implement this recommendation.
- **R.17: Provide training and resources around evaluation, assessment, and research —** Offer training in both qualitative and quantitative research methods, IRB support, and a repository of resources on methods, IPE literature, and theoretical frameworks. Training and resources can also include guidance on how different methods align with specific research questions, and how to handle data collection challenges. For example, if you cannot collect data from minors, you can collect retrospective data from undergraduates on their IPE experiences as minors. (This recommendation expands on the evaluation training mentioned in P. 13 (same as S.13)).
- **R.18 (*same as P.18): Support strategic messaging —** Equip members to leverage research findings in advocating for IPE with funders, departments, and institutions. This can include curated lists of research findings on benefits and metrics of success to demonstrate the case (with evidence) that IPE efforts align with institutional and community values.
- **R.19: Convene the community to define key research questions that need to be addressed —** The community should come to consensus on necessary research directions and how different research questions apply across a variety of IPE formats. This includes enumerating classical/existing questions: what are processes of change; who benefits and how; and why / how do programs work, as well as generating questions that the IPE community is just starting to ask: longitudinal impacts of IPE programs; international comparisons / context; and other novel, emergent questions.

Recommendations for (inter)national organizations

GOAL

Culture shift whereby Informal Physics Education (IPE) is widely recognized as an essential physics practice

LEVER 1

Structures

Amplify structures that frame IPE as an essential activity worthy of resource allocation.

LEVER 2

Engagement of interested, influential, and impacted parties

Identify techniques for recruiting and empowering people to engage in and/or support IPE as essential physics practice.

LEVER 3

Integrating Research-Based Practices in IPE

Leverage research to understand, develop, and advocate for IPE as essential physics practice.

LEVER 1 - Structures

Amplify structures that frame IPE as an essential activity worthy of resource allocation.

- **S.17 (*same as R.20): Academic and commercial publishers should establish common publication venues for IPE work —** Existing venues such as *Physical Review PER* [71], the *Journal of STEM Outreach* [72], *Citizen Science: Theory & Practice* [73], T*he Physics Teacher* [74], and *Connected Science Learning* [75] should better connect with the IPE community to make them aware of their publication options. Journals should also establish multiple submission types to allow for both research and programmatic articles rooted in experience, practice, and evaluation. Whenever possible, these publication venues should also be made open access.
- **S.7 (*same as R.14): Establish recognition mechanisms for exemplary IPE programs and practitioners, including students** — Such recognition could include site or practitioner awards, digital badges or professional certificates for completing IPE training, and features in institutional communications. Recognition can be implemented at the department, community of practice (e.g., JNIPER) or international organization (e.g., APS) scale.
- **S.18 (*same as R.22): Create dedicated IPE sessions at physics conferences and schedule them in prime slots** — Science societies that run physics conferences can include IPE in their abstract sorting categories, consider IPE practitioners for plenaries, and more.
- **S.19: Funding agencies should support IPE through the following mechanisms —** Require all grants to include a public engagement plan, and providing detailed guidance on evidence-based best practices; Attend to public engagement action and implementation in annual grant reports and reviews, ensuring that quality IPE is valued and is not relegated to a "box-checking" exercise; Fund IPE programs directly; Fund studies of public engagement and science communication trainings to expand knowledge of effective training practices; Direct graduate fellowship awards to include funding for public engagement training and implementation. (This last example is aligned with the call from the Research!America Public Engagement Working Group [76] .) This recommendation overlaps with R.23.
- **S.20: Create federal structures that support national agencies in growing their participatory public engagement and science communication efforts—** See, for example, the August 2023 Letter from the Presidential Council of Advisors on Science and Technology [77].

LEVER 2 - Engagement of interested, influential, and impacted parties

Identify techniques for recruiting and empowering people to engage in and/or support IPE as essential physics practice.

- **P.11: Acknowledge the IPE career pathways that students can take and legitimize the rhetoric around those IPE careers –** Career panels and talks should include examples of physics majors who have gone on to a career in IPE, including the option to pursue the academic track with a research-focus on IPE. Job boards and career resources should also illustrate the many forms an IPE career can take.
- **P.20: Physics societies should release policy statements on the importance of IPE to physics –** This will promote buy-in from members, and also provides a pathway for the organization to engage in formal advocacy on the topic.

  Successful Example: APS Statement on Public Engagement [67].

LEVER 3 - Integrating Research-Based Practices in Informal Physics Education

Leverage research to understand, develop, and advocate for IPE as essential physics practice.

- **R.20 (*same as S.17): Academic and commercial publishers should establish common publication venues for IPE work** – Existing venues such as *Physical Review PER [71], the Journal of STEM Outreach [72], Citizen Science: Theory & Practice [73], The Physics Teacher [74],* and *Connected Science Learning [75]* should better connect with the IPE community to make them aware of their publication options. Journals should also establish multiple submission types to allow for both research and programmatic articles rooted in experience, practice, and evaluation. Whenever possible, these publication venues should also be made open access.
- **R.21: Academic and commercial publishers should build infrastructure for collective data sharing –** In many cases, this is already, or soon will be, required by international and US-federal funding agencies. Publishers should require open data whenever possible, to facilitate the research community's ability to replicate and build upon prior studies.
- **R.22 (*same as S.18): Create dedicated IPE sessions at physics conferences and schedule them in prime slots -** Science societies that run physics conferences can include IPE in their abstract sorting categories, consider IPE practitioners for plenaries, and more.
- **R.23: Funding agencies should support IPE evaluation, assessment, and research –** There are at least two mechanisms for this support: (a) Provide grant lines for IPE research, as well as training for physicists in IPE research methods; (b) Require all grants to include a public engagement plan which incorporates evaluation. This evaluation should be a required component of the annual and summative grant reports, and funding withheld if evaluation is omitted. This recommendation overlaps with S.19.