

Playful Invention and Exploration

Final Evaluation Report: Executive Summary

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PIE (Playful Invention and Exploration) is a unique approach to learning that centers on the use of technology and design challenges to create powerful learning experiences in informal education settings. PIE activities involve imagination, invention and construction. People are challenged to envision a product with certain features and capabilities; they then are given a choice of materials to work with; they are encouraged to construct what they have envisioned; and they learn from the materials as they proceed. The PIE approach embeds inquiry in the context of design and creation: informal audiences are supported in imagining, constructing, learning, refining and then re-imagining – continuing to loop through this cycle of envisioning and experimentation. Integrating art, science and technology, PIE also involves some use of new digital technologies as well as more old-fashioned tinkering with hand tools, glue guns, and other simple construction materials.

The Playful Invention and Exploration (PIE) Institute project was funded in 2005 by the National Science Foundation (NSF). Building upon a previous NSF grant, the PIE Institute project sought to:

...continue the work of the PIE Network by continuing to create playful and inventive educational activities using science, art and technology, and by sharing PIE ideas with a larger audience of educators in museums and other kinds of informal learning environments.¹

Mike Petrich and Karen Wilkinson at the Exploratorium lead the PIE Institute project, working with partner museum educators from the Science Museum of Minnesota, Fort Worth Museum of Science and History, and Explora Science Center and Children's Museum in Albuquerque. Over the course of the project they have worked together as a group to refine PIE activities created in the previous round of funding, to create new PIE activities, to implement PIE activities in new settings and contexts, and to broaden the group of museums who were engaged in PIE learning and use PIE activities at their own institutions. In addition, the PIE Institute project was interested in documenting, in rich and inventive ways, the nature of their work in order to make it available to a broader audience. For the past three years, Inverness Research² has served as the external evaluator for the PIE project.

¹ From the PIE website: <http://www.exploratorium.edu/pie>.

² Inverness Research is a private education research and evaluation firm. For more information, see <http://www.inverness-research.org>.

In addition to creating new PIE activities, the Institute project sought to augment the ability of the PIE leaders to develop and share activities with other informal science educators. The project also had the goal of developing additional leaders in the informal science education community who can facilitate PIE professional development experiences for other educators; and developing a broader community of ISE educators skilled at providing meaningful PIE experiences to their visitors. Overall, 150 educators from informal science education institutions participated in the project's institutes and workshops; in turn, these educators, along with PIE leaders at partner institutions, have reached thousands of visitors through PIE-inspired program and exhibit experiences.

FACTORS CONTRIBUTING TO THE SUCCESS OF PIE

We have found the PIE project highly successful at creating empowering learning experiences for participants. In addition, the project has helped to generate a new genre of programs and exhibits at many informal science education institutions, and energized the ISE field. Several factors have contributed to the success of this project.

- A Unique Approach to Teaching and Learning

The first of these factors is the PIE approach to teaching and learning, which is highly engaging and original. The PIE approach is heavy on self-challenge, and of design under constraint. Participants come up with their own challenges within some broad framing (for example, building something that will make a noise when light is shined on a sensor; creating things that can have a conversation or tell a story; making a marble machine where the ball moves very slowly). The challenges posed are not completely open-ended and there are enough materials present so that people have options, but not so many that they are overwhelmed. Also, there is no competition involved except what participants impose on the process themselves. There is facilitation by knowledgeable educators who guide and help people when they get stuck. The combination of environment, materials, and facilitation helps people choose challenges at the appropriate level. The ultimate aim is for people to be empowered – to engage with materials, create something with them, learn from those materials, and experience the process of creation. As people succeed, they continually expand their zone of proximal development so they have greater capacity and confidence to work toward more complex and ambitious creations.

There is a great deal of learning that occurs for participants in PIE activities, but it is not school-like, conventional, science content learning. Rather, the focus of learning in PIE activities has more to do with process skills and phenomenological forms of learning – exploring materials, tools, and phenomena and building fluency in those intersecting domains. Building fluency with materials, tools, the design process, and with the way things work are all important underlying notions of the PIE work. Thus, the activities involve “constructionism – the construction of knowledge in the context of building personally meaningful artifacts.” By trying to design and make something, one learns many things. What people gain from participating in this experience is not so much content-specific as it is about learning about their own latent abilities -- they gain confidence in knowing they can make something, as well as some programming and

construction skills. PIE learning is also very much learning through play. Almost all of the PIE experiences we have observed have been “flow” experiences for participants – they are fully engaged, deeply involved, and find the experiences highly rewarding.

- The Core Elements of PIE Activities

Another factor contributing to the success of the project is the key elements that make up PIE activities. PIE involves a critical intersection of science phenomena, materials, environment or space, and facilitation. Providing opportunities for participants to “mess about with materials” in exploring rich science phenomena is a very important piece of the PIE work; the freedom and opportunity to learn through materials-rich explorations are highly limited in today’s world. The environment is designed to maximize the potential for participants to have a combined experience of rich intellectual design and hands-on construction.

PIE activities also involve skilled facilitation. Because the activities are so open-ended, and because each individual learner is engaged in creating his or her own personal creation, facilitators have to know when and how to intervene so that participants can have the most productive experiences. Another critical element to the PIE philosophy is that participants’ individual construction processes take place within a larger social context; there is a careful interplay between participants working on something as individuals and working as a community. An intentionally extended time scale is also a crucial element to the PIE work – these activities take time to allow people to have rich, deep experiences. And finally, the design process that PIE leaders go through in developing PIE activities mirrors the process that learners go through in their own PIE experiences.

CONTRIBUTIONS OF THE PIE PROJECT

Overall, we have found the PIE work to be innovative, highly engaging and very meaningful to participants. PIE activities are a natural fit in the informal science education domain. The PIE project has thus not only served individuals but also made important contributions to the broader informal science education field. First and foremost, the project has helped to create a leadership tier of museum professionals who have grown significantly in their own understanding of the PIE approach, and in their thinking more broadly about learning. These PIE leadership professionals have been deeply affected by their participation in PIE activities. Participants are empowered through their experiences and are more apt and adept at turning ideas into reality. More concretely, these museum educators have also gained new methods, activities and ideas to incorporate into programs and exhibits at their home institutions. In some cases, we saw substantial changes to the educational repertoire of many participants. And a few museum educators have also grown substantially in their ability to facilitate and lead PIE professional development experiences for other museum educators.

The PIE Institute has also made contributions at the institutional level, leading to new exhibition spaces and program changes that, in the best cases, have allowed visitors to

have important learning experiences similar to those the participants had in the PIE “ateliers.” In this way PIE has contributed to the development of the capacity of the informal science education field by enriching and expanding the possibilities of what the field has to offer. Perhaps most importantly, in many ways, we see the PIE project has helping to create a new genre of activities for museums, a general approach to doing programs and exhibits in new and exciting ways.

CHALLENGES AND OPPORTUNITIES

While the PIE project has been highly successful, there have been several challenges the project has faced, and there are also newly emergent opportunities for future work. One challenge for PIE leaders is how the integrity of PIE – the philosophy and approach to teaching and learning – is maintained, or not, as the PIE work gets translated by other museum educators and put in place at their institutions. There is clearly a challenge here for participants to take what happens in a day or two days at the Institute ateliers and then create meaningful experiences for many people in shorter time periods at their home institutions. We wondered if this challenge presents an opportunity for the project to build in more mechanisms to collectively work together -- and reflect together on the nature and the quality of the experiences they are creating for their informal audiences.

Another challenge comes for participants in the barriers they face in trying to successfully implement PIE activities at their home institutions, such as lack of time, lack of experience with PIE, and the cost of materials. Additionally, PIE leaders face the challenge of describing the nature and purpose of this type of learning. Participants report returning from PIE institutes and sometimes finding it difficult to articulate the type of learning they have experienced and its value. Participants sometimes face an uphill battle convincing their institutions to invest in this new approach and philosophy. The challenge and opportunity for PIE is to continue to find ways to document and share the value and power of the PIE learning experiences.

Another set of challenges and opportunities center on the development of the “trainers of trainers” – that is, development of informal science educators skilled at facilitating PIE professional development experiences for other educators. The question is how best the Institute can work with and provide support to its partner museums in Minnesota, Albuquerque and Fort Worth. The challenge is for PIE leaders to provide maximal support without creating a kind of over-dependency. Learning how to facilitate PIE professional development experiences is difficult and takes a great deal of time. Only a handful of people coming out of this project have truly developed those skills. There is an opportunity and need for further work facilitating the thinking about the learning at this leadership level, with the important goal of creating additional PIE leaders who can expertly facilitate PIE professional development for other museum educators.

Finally, we see a tremendous opportunity and need that has emerged from this project. A learning community of practitioners has been created around PIE – a group of educators who want to continue to learn from the Exploratorium and partner museums, as well as from one another. This community provides a solid foundation of an ongoing network of

museum educators interested in doing more, and better, PIE work at their own institutions. What is needed is a mechanism – an ongoing network – through which these practitioners can share ideas with one another, and can have continued opportunities to have personal PIE learning experiences.

SUMMARY

The PIE Institute project has been highly successful. The PIE leadership's commitment to doing thoughtful, careful work and to inviting a growing number of practitioners in to share that work with them has created a vibrant and strong community. The project has consistently provided powerful, "flow" learning experiences for museum professionals, who in turn, have returned to their institutions and attempted to provide similar types of learning experiences for their visitors.

In our evaluation work over the years, we have rarely seen the kind of energy and enthusiasm about a project that we have seen with PIE. Participants have been highly articulate in reflecting on their PIE experiences and the value of those experiences – and that articulateness reflects on the deep nature of the PIE work they have been engaged in. The innovative website, ASTC workshops, and tinkering studio booths at ASTC have brought new life and energy to the informal science education field.

It is very rare that a project in science education is truly innovative. The PIE Institute project has been exactly that, and the innovations the project brings to the ISE field are needed and important. We see tremendous value in the energy and enthusiasm the project inspires, the creativity and whimsy, and the profound, empowering learning experiences the project has provided. We see an important opportunity to continue the growth of the PIE community and we hope that NSF and other funders will provide the support needed to build upon the foundation that has been put in place.