Chapter 7
Informal Science Educator Identity Construction

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The notion that professional development for informal science educators should pay special attention to identity development is still considered a somewhat innovative and foreign idea. When we originally proposed an ambitious project on precisely this subject to the National Science Foundation, it took over two years of scrutiny of the included precepts and methods and revisions before it was finally funded. However, the world of informal science education is changing. For over a decade now there has been a sustained and growing interest in professionalizing the role of "informal science educator" and with it, the entire field. Identity, it turns out, is a central concept in this effort.

In this chapter, I will share what we learned about the identity construction of informal science educators engaged in a project called STEPS (The Science Theater Education Programming System). Perhaps more importantly, I will share an identity-based conceptual framework for considering how professional learning programs and environments for informal science educators may be re-invented as vehicles for self-discovery in order to tap into the full potential these individuals bring and the quickly evolving field they comprise.

Why Professional Identity?

What do we know historically about the professional lives of informal science educators? On the positive side, we see that they work in a wide variety of alternative learning environments (museums, science centers, community and school outreach, online, etc.), they serve audiences that are in "recreation mode" and

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P.G. Patrick (ed.), *Preparing Informal Science Educators*,
DOI 10.1007/978-3-319-50398-1_7

therefore present opportunities for innovative educational programming, they represent a wide variety of pathways into the profession (there is no commonly travelled route or background), and by necessity these educators cover a wide range of science content areas. Bailey (2006) investigated science museum educators' self perceptions and found that they typically bring a strong set of values that not only attracted them to the work, but also sustains them in it. Notably, this includes the desire to be a change agent, to "make a difference," as it were, in the world. In this regard, informal science educators are not unlike their formal educator counterparts. Bailey further found that they enjoy the flexibility, social nature, and variety of their work but also cite the need to be well versed in the science. This includes being drawn to creative challenges, a love of life-long and a rich combination of teaching, presentation, science content, and project management.

On the negative side, informal science educators are often isolated from the larger community of the field. They often lack growth opportunities as education professionals (Sutterfield & Middlebrooks, 2000). They have limited pedagogical skills development opportunities and they typically have relatively low status in terms of title, salary, perceived skill sets, and job security. These status markers, positive and negative, are in fact explicit and powerful indicators of identity, akin to badges or certificates and other professional and personal identity monikers.

There is also high turnover among informal science educators, especially for front-line staff. Together, these challenges indicate a need for better and longer-term professional development including ongoing interaction among colleagues, at the very least. However, if we expect to actually professionalize the field and clear barriers to recruitment, retention, and elevate the field's professional standards and growth, it demands we re-think who informal science educators are, what they do, and what kind of professional development training they require.

Past research on similar issues facing formal classroom educators has specifically linked quality professional development to the sense of professional identity. Enhanced professional identity in formal education has long been known to translate into increased job satisfaction, higher quality educational programming, and staff retention. Museums and science centers, in particular, struggle with many of the same challenges as they try to balance effective staff recruitment, training, and retention with quality educational programming and increased visitorship. Meanwhile, multiple, varied, and indirect career pathways leading to informal education jobs (often considered a strength of the profession) can in fact complicate the sense of professional identity and may result in such employees regarding their positions as transient or as "means to other ends." I speculate that many, if not most, in the profession did not enter it thinking that it would be a "destination career," if there is such a thing in today's world.

Within this context for the STEPS project, we began with two simple questions: Given that the role "informal science educator" covers a lot of ground, can efforts to better articulate and enhance the professional identities of informal science educators lead to similar benefits as those seen among formal educators? And if so, what might those efforts look like in terms of professional development? However,

in order to even approach the subject, we had to draw upon the larger (and mostly unknown to the informal education world), sociological field of identity theory.

What Is Professional Identity?

Professional identity, concisely put, refers to a person's self-perceptions as a contributing member of a larger group of colleagues and as part of an extended profession, with goals, methods, ideals, behavioral ethics, and other values held in common to a great degree (Ibara, 1999). Professional identity is set within the larger context of identity theory, which in very general terms, considers the self as a highly complex, pluralistic, and fluid idea. "Self" is systematically unpacked into identities as dynamic psychological constructs or schemas that emerge, grow, compete, evolve and/or disappear over time. Such identities are directly related to the sense of personal agency, behavior, choices, performance, and relationships (personal and professional).

Identities exist in the mind of the individual and together give rise to the sense of self. Self is defined as a person's consciousness of his or her own being, and although usually co-located with one's physical body, it is a mental, psychosocial construct. Self allows each of us to reflect on and evaluate ourselves as both subject and object, planning and modifying on this construct in efforts to bring about desired future states. Because we can each assume different positions or roles within society, the self reflects these by way of identities. Therefore, we each have multiple identities, each one an agent capable of behavior, choice, and role taking (e.g. parent, friend, teacher).

These identities may overlap and be arranged in dynamic hierarchies, which can change moment-to-moment and certainly evolve over the years of our lives. Therefore the notion of such identities is distinct from the person owning them, but

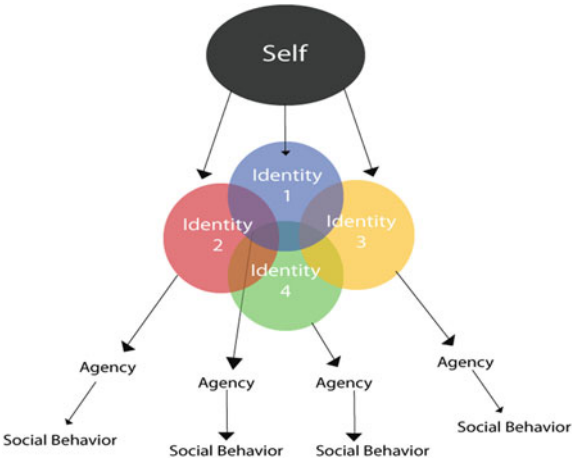


Fig. 7.1 Total sum of the identities of self

describes avenues for behavior and transactions within society and the external environment. That is, the self assumes agency through identities, and is in part comprised of the sum total of those identities (Fig. 7.1). In this capacity, "professional identity" (an "informal science educator" for instance) is a role-based designation, endowed with all the expectations and responsibilities one understands it to mean. This subjectivity, of course implies a wide range of content for the informal science educator identity across individuals—reflecting the wide range of roles within the profession. That is where identity-based models of informal science educator professional development must begin.

Identity and Professional Development

Professional development (or professional learning) efforts traditionally center around the construction of new knowledge in what can generally be referred to as the constructivist model. For informal science educators (or even formal science educators for that matter), such training typically includes two levels: content knowledge and pedagogical content knowledge. That is, respectively, knowing the science content and knowing how to teach that science content. The latter component includes the broad spectrum of learning scenarios that may occur within informal education environments (presentations, classes, workshops, activities, exhibit design, multi-media design, encounter carts, dramatic performances, etc.). Such training seeks to continually develop employees, ideally through strategically progressive steps that construct more knowledge and expertise in the form of mental constructs or schemas, and ultimately leading to increased capacity (Piaget, 1926; Zemelman et al., 1993). The reality, often due to resource limitations and staff turnover, is typically much more uncoordinated, sporadic, and opportunistic than strategic.

Alternatively, invoking identity theory shifts the focus from content and skills acquisition to include a specific consideration of the learner of that content—the informal science educator him or herself—as a holistic individual. What does this shift do? Viewing professional development through the lens of identity theory, we acknowledge that the learning of new things can go beyond their incorporation into internal frameworks or schema, to actually inform, modify, and become integrated into a person's identity or identities. Therefore, this perspective intentionally links professional development experiences (such as those we designed for the STEPS project, discussed below) to identity and the use of tools and techniques intended to promote identity building, agency development, and behavioral outcomes in concert with content and skills development.

In short, this perspective says that the construction of new knowledge can sometimes, in fact, *be* identity construction. Incorporating the self into the learning equation in the form of the relationship of the knower to the known becomes an essential element to professional learning that includes meaning making, personal relevance, motivation, agency development, actions and future choices. Viewing informal science educator professional development as a medium for identity construction purposively

promotes personal ownership of the science-related and education-related substance of the training, connections to other identities or elements of the self (often through emotions for example), and may allow for important linkages to identity growth and modification in unintended and unexpected areas.

Taking it one step further, once an identity of "informal science educator" is personally articulated, developed, and established through professional development that is designed to do so, an individual will likely then act to verify their conceptions of who they are, depending on the salience of the identity (Burke & Stets, 2009). That is, the new identity becomes a platform for continual cognitive and behavioral growth if the identity is personally and professionally important. Herein lies the secret to sustainable (and often self-driven) capacity building—both for individuals and for the institutions they collectively generate.

But how do we do this? What does informal science educator professional development that enhances professional identity look like? And does it produce the intended outcomes? That was the subject of the STEPS project.

STEPS

An Experiment in Professional Identity Construction

The Science Theater Education Programming System, or STEPS, was a four-year informal science education project funded by the National Science Foundation (award #1043060). The STEPS project created a unique network of professionals to collaboratively develop several innovative deliverables, including a new system for the development of multi-media enhanced theatrical science presentations. This network of professionals was designed as a geographically disperse hybrid (online and in-person) community of practice (CoP) as defined by Lave and Wenger (1998). The network was comprised of informal science educators from small and large museums nationwide, software designers, writers, artists, performers, scientists, and others. Partner organizations included:

- Bishop Museum (Honolulu, HI)
- Chabot Space and Science Center (Oakland, CA)
- Farmington Museum (Farmington, NM)
- Kansas Cosmosphere (Hutchinson, KS)
- Montshire Museum of Science (Norwich, VT)
- North Museum of Science and Natural History (Lancaster, PA)
- Science Museum of Virginia (Richmond, VA)
- Space Center Houston (Houston, TX)
- Association of Science-Technology Centers (Washington, DC)
- Astronomical Society of the Pacific (San Francisco, CA)
- Challenger Learning Center of Colorado (Colorado Springs, CO)
- Children's Museum of Indianapolis (Indianapolis, IN)

- Colorado School of Mines (Golden, CO)
- NASA Astrobiology Institute (nationally distributed)
- National Optical Astronomy Observatory (Tucson, AZ)
- SETI Institute (Mountain View, CA)
- Del Padre Visual Productions (East Longmeadow, MA)
- Institute for Learning Innovation (Edgewater, MD)
- The Space Science Institute (Boulder, CO)
- UXR Consulting (Baltimore, MD)
- University of Colorado at Denver (Denver, CO) professional identity study

Note: Several organizations that were not part of the development team adopted STEPS during or shortly after program completion. This group included The Pacific Science Center (Seattle, WA), The Omaha Children's Museum (Omaha, NE), The U.S. Space and Rocket Center (Huntsville, AL), and McWane Science Center (Birmingham, AL).

The STEPS project established five main deliverables:

1. Museum Partnership Network: A community of informal science educators working towards a common goal. Small and large museums were paired together for mentorship opportunities.
2. STEPS: A unique and innovative suite of software tools for science theater programming and a set of online professional development operational tutorials.
3. Astrobiology Theater Shows: A set of three performance shows with the STEM content focus of astrobiology and a set of online professional development astrobiology tutorials.
4. Professional Development products for informal science educators, including in-person workshops, online tutorials, and inter-museum interactions
5. Evaluation and research focused on understanding informal science educator identity construction, capacity building within institutions, and the relationship between professional identity and multi-institution collaborative networks.

We chose astrobiology as the STEM content for the initial theater shows because it was popular with public audiences and multi-disciplinary in its science content, giving the team ample room for theatrical creativity. Three astrobiology theater shows were developed by the educators varying in purpose, length, and theatrical components. Generally, these museum theater shows were comprised of on-stage educator/actors performing scripted stories using props, science demonstrations, interactive multimedia components and characters projects on one or more screen, and audience participation elements. These shows and their components (including special effects, virtual characters, and science-embedded plotlines) were all built from scratch, as was the software STEPS generated to create additional shows beyond the time of the project itself.

A substantial portion of the project was dedicated to an exploratory investigation of the network's collaborative model. Given this wide-ranging collection of organizations and individuals, we wanted to create a collaborative model that intentionally promoted professional identity enhancements, if we could. Two central

precepts we were concerned with were control and risk. For control, we wanted to afford as much self-direction and self-determination as possible into the model without sacrificing functionality, not knowing where such a balance point might reside. As it turned out, this balance point was a moving target and different for each individual collaborator. For risk, we wanted to encourage professional risk-taking throughout the project. We asked the participants to intentionally select work groups and sub-teams that were often outside of their comfort zones and to consider STEPS as a growth opportunity rather than just another project to crank out. Once again, the balance point between such risk-taking and work efficiency proved to be a moving target requiring frequent adjustments.

Prior to the project launch, we designed an innovative collaborative model to promote both control and risk-taking within a supportive structure. We combined Team Leadership Theory (TLT, described below) within the structure of a hybrid community-of-practice for the explicit purpose of enhancing the professional identities of the informal science educators involved. The assumption being tested was that affording participating educators a high degree of personal leadership and responsibility as well as opportunities for risk-taking, would have a positive impact on their professional identity development.

As part of this effort, the study also investigated the relationships between professional identity impacts of individual educators, their institutional capacities, and the capacity of the network formed by the project. Figure 7.2 shows this nested structure, embedding the idea that individual identity is at the heart of both institutional and network capacity.

Prior evidence had suggested promise for our collaborative model. The community-of-practice element generated structure for an extended network of professionals, an important social component to professional identity. Successful

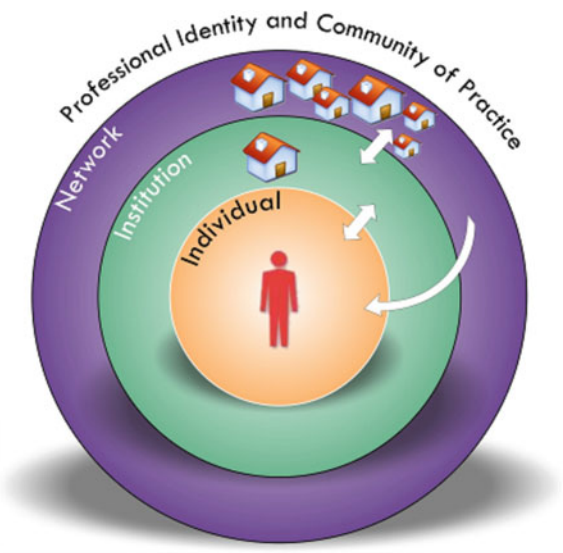


Fig. 7.2 STEPS professional development impact model

communities-of-practice combine three essential elements: Domain, Community, and Practice. The Domain—A shared domain of interest defines the community's identity and membership in the group implies a commitment to the domain. For STEPS, the domain was informal science education through interactive theatrical presentations. The Community—By forming relationships that facilitate learning, people form communities. STEPS created a partnership network of small and large science centers for informal educators to interact and learn together. The Practice—Members develop a shared practice over time including shared resources such as experiences, stories, tools, interventions, and skills (Wenger, 2006). STEPS incubated a shared practice through collaboration on an innovative project, within a partnership network, thus creating a community of practice for the professional development of participants.

As articulated by LaFasto and Larson (2001), Team Leadership Theory (TLT) is a model of distributed leadership in which participants have a high degree of freedom and responsibility regarding the decision-making, scheduling, and general leadership of a project in which they are engaged. The LTT is a model of leadership that is "from the ground up" rather than the more familiar and traditional "from the top down" models that emphasize command and control over collaboration. In developing this framework, LaFasto and Larson studied 6,000 work teams in organizations worldwide. Their research indicated that team leadership lends itself to greater productivity, more effective resource use, better decisions and problem solving, higher quality products and services, and increased innovation and creativity. Most of their studies involved groups that worked in a single organization, however, and often the same building with regular face-to-face interactions and one-year time frames for projects. STEPS was one of the first studied examples of TLT applied across a geographically distributed team, utilizing online communication technology extensively and over a four-year project period.

Importantly, LaFasto and Larson described eight characteristics for TLT excellence, which we adopted for STEPS. In Table 7.1, each characteristic is listed with a brief description of how it was actualized in the STEPS project (excerpted from the STEPS Summative evaluation, Koepfler 2011).

With this collaborative model in place at the outset, STEPS was intentionally designed as a vehicle for individual and institutional professional development via identity building. Additionally, we should note that the challenge of Museum Theater itself puts a high stake on individual informal educators. The success of interactive presentations for communicating science to the public depends heavily on the quality of the presenters, their content knowledge, facilitation and communication skills, and fluency with the format and technology. Further, Museum Theater has the advantage of synthesizing many things museums aim to do by integrating presentations, multimedia, hands-on activities, and social audience interaction. Rising to such a challenge demanded a higher level of professional development for individual educators and their institutions, thus allowing for greater impacts (positive and negative) on individual educators, institutional capacity, and collaborative interactions within the network.

Table 7.1 Team leadership theory framework adapted for the STEPS project

LaFasto and Larson TLT	STEPS TLT
(1) A clear and elevating goal	The team was tasked with the creation of deliverables that were challenging and required a multi-disciplinary team. The software and shows were novel and out of the comfort zone of the educators, but the project overall was perceived as valuable to the group with the inclusion of professional development opportunities, the STEPS software system, the astrobiology shows, astrobiology tutorial, and associated evaluation and research products
(2) Results-driven structure	Application of TLT through subteams and a "network whip" working across multiple, parallel timelines. Each subteam had a timeline and set of milestones to achieve. This framework was the nuts and bolts of the collaborative structure.
3) Competent team members	The project required and brought together informal science educators, software developers and multimedia professionals, scientists knowledgeable about astrobiology, a leadership and management team, and theatrical expertise
(4) Unified commitment	At the individual level, the team established a unified commitment to the project at the kickoff meeting by drafting and signing three governing documents: a Declaration of Collaborative Excellence, a Collaborative Framework, and a Collaborative Agreement. At the institutional level, the PI obtained buy-in from the leadership (e.g. Museum Director) as well as the informal science educator who would participate in the project.
(5) Collaborative climate	A collaborative climate was created through the use of web-based communication tools; a schedule for communication to happen face-to-face and online; shared leadership so that there was room for multiple voices to be heard; and ongoing encouragement for subteam leaders to take control of the project rather than a top-down structure
(6) Standards of excellence	The standards of excellence were set forth in the Declaration of Collaborative Excellence and carried out in practice through the process of collaboration and the creation of products for dissemination.
(7) Principled leadership	On the part of the PI, there was an explicit commitment to TLT, announced at the kickoff meeting and reinforced through monthly teleconference meetings. On the part of the participants, they agreed to the shared leadership model and the responsibilities and assigned tasks that came with it
(8) External support	External resources were in the form of financial support from the National Science Foundation, scientific review from a team of advisors, and product development support from technology and media, and evaluation and research consultants

Exploratory Study Results

STEPS Social Network Analysis

An examination of educator interactions throughout the project proved to be especially revealing in terms of how well the collaborative model worked to combine CoP with TLT. We used social network analysis (Hanneman & Riddle, 2005; McCulloh et al., 2013) to look at the interactions and social bonds of the informal educators from the eight partner museums and science centers as they developed over time. Figures 7.3, 7.4 and 7.5 present three snapshots from the project depicting three different patterns. Importantly, these connections focused on how the participants, from both large and small institutions, perceived their relationships with others (strong, weak, or mixed). Figure 7.3 shows how the group perceived each other at first—relatively few established relationships across the group. Figure 7.4 shows the network map near the end of the first year of work. It is what we might expect from a healthy community of practice, highly engaged across multiple dependent and independent lines, and in several cases strong mutual ties. Finally, Fig. 7.5 shows a situation that arose several times within the structure of Team Leadership Theory—the emergence of a leader who, for a brief period of time, is a focal point for the group. In more traditional top-down leadership models, the person at the top of the leadership hierarchy would normally occupy such a central position at all times during a project. However, in the distributed leadership model of TLT, each participant was both required, and at other times individually opted, to occupy central leadership roles on a rotating basis in the interest of professional development.

It is also interesting to note the lack of cross relations between the other reporting participants. This is a marked difference from Fig. 7.4, but here again represents a

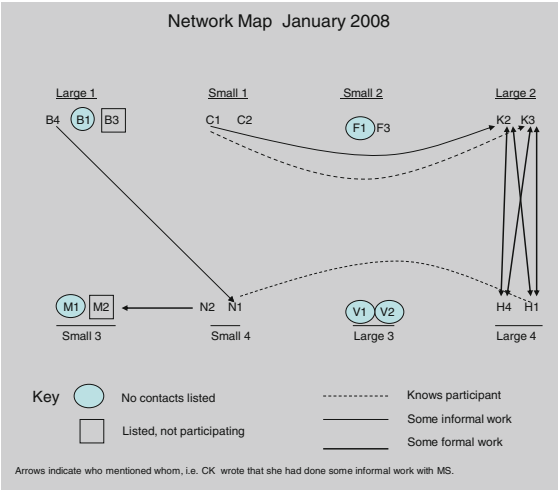


Fig. 7.3 STEPS initial social network map

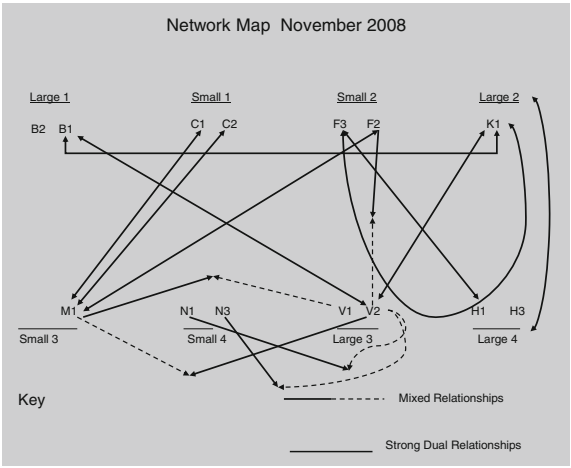


Fig. 7.4 STEPS interim social network map

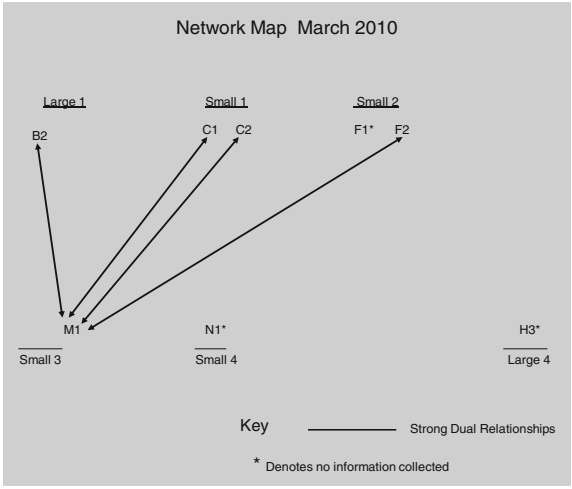


Fig. 7.5 STEPS focal point network map

feature of the project leadership design—an oscillating pattern between extensive cross communication within the community of practice at times of collective creative work (divergence) and temporary participant leaders emerging as rallying points in association with approaching project milestones.

In the case of Fig. 7.5, the project team was unveiling the STEPS software and conducting live audience testing and evaluation of the astrobiology shows in preparation for a conference debut. M1 was in a designated leadership position at that time.

Online Collaboration

In concert with the social network analysis, we also looked at communication patterns among participants online through the Basecamp Contribution Analysis. Basecamp was an online project management tool utilized during STEPS to facilitate meetings, schedules, share documents, conduct creative work, send messages and make postings. An analysis of these communications through the first three years of the project (the time of most active participation by educators) provided valuable information regarding professional development outcomes.

Using NVivo software and an open coding process, all such Basecamp contributions gave rise to an interesting set of categories: (1) scheduling; (2) technology; (3) meeting agendas; (4) network paths (referring to collaboration between individuals and institutions, whether STEPS-related or not), and; (5) edification (items promoting general professional development, including articles, reports, newsletters, etc.). Categories 4 and 5 in particular suggested the growth of relationships beyond the parameters of the STEPS project.

By reducing the data on the number and type of contributions by year and by project totals, we could track the frequency in each category by each individual and even determine how many "original" postings versus "response" postings were generated by each person. This analysis revealed several interesting patterns about how individuals moved in and out of the center of the community-of-practice and leadership roles.

First, the majority of participants demonstrated highly active involvement in the project. Secondly, as the project progressed the number of highly active communicating participants decreased, while at the same time the median number of message postings per year increased. This indicates that an increasingly smaller community-of-practice was handling increasingly more work. There seem to be at least three possible reasons for this.

1. Year 1 includes several more of the administrative staffers from each institution who were more engaged during that time in helping to create the infrastructure for the project. Once that work was accomplished, there was a diminished project presence on the part of administrative staff.
2. Staff attrition accounted for loss and replacement of project personnel throughout the project. This fact combined with the national economic downturn hitting museums at the time of the project work meant that multiple roles were often collapsed onto one person, leading to a situation in different museums of fewer people doing more work.
3. Finally, two museum partners were unable to fulfill their project obligations (in part due to the same economic situation) and ended up leaving the project by year 3, resulting in a smaller STEPS CoP.

A third observation is that there was an extremely wide range in the data in terms of who is posting and with what frequency over the three years. When one considers that a community-of-practice is a dynamic organization of people, this kind

of range for evidence of communication is not unexpected. This may be especially true when CoP is combined with TLT, which, in the case of STEPS, required different individuals to move into the center of the CoP to assume leadership roles at different times and in different capacities. Therefore, we see leaders emerging in year-one while others had yet to assume such leadership roles at that time. In years two and three we see different leaders emerging and in some cases from joining the project midstream as new participants. This kind of movement to and from the center and periphery of the CoP indicates the successful implementation of Team Leadership Theory at least in terms of function. That is, we were successful in moving different individuals into and out of positions of leadership throughout the project. Unsurprisingly, we observed a correlation between the level of communication and engagement with the CoP and the degree to which an individual was impacted by their participation in STEPS.

Based on the analysis we describe above, we believe that the life events of some participants (such as maternity leave and health issues, as well as job changes which necessitated leaving or coming into the project midstream) had a tremendous impact on participation and communication levels. A perspective on professional development that is identity-based acknowledges that the professional identity of "informal science educator" must exist in harmony with other identities (such as mother, father, patient, new-guy, etc.). Professional development that does not take identity into consideration is more likely to place these identities in conflict and create staff isolation or attrition.

Basecamp contribution comparisons to the mean communication levels for each year revealed four patterns or characteristics of individual position and movement within the CoP:

Pattern 1: High Stasis. Consistently the most active members. To remain at this level, participants had to be active in the work of several subteams, as well as a frequent leader within one or more of them.

Pattern 2: Low Stasis. Consistently the least active members. Isolated, least communicative in terms of number and frequency of interactions.

Pattern 3: Toward the Center. We noted this pattern several times and most likely was underemphasized due to the change in participants and time spans used (with no finer granularity than yearly totals, for example).

Pattern 4: Toward The Periphery. This pattern was noted for several participants at different times—often the same participants who had movement towards the center at other times. This is also as an expected feature of the successful implementation of TLT. Certainly, not everyone can remain at the center of the CoP all the time, even for projects requiring full time commitments from it members (as STEPS did not). As with movement toward the center, this pattern was likely underemphasized or underreported given this method.

Another interesting approach to this data involved comparing average yearly Basecamp contributions from small versus large museum partners. We had originally hypothesized that due to greater access to resources and staff members, larger museums would demonstrate a greater rate of contributions than the smaller

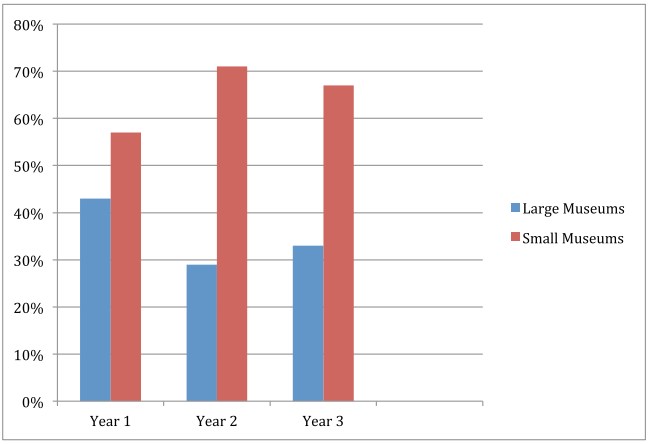


Fig. 7.6 STEPS small versus large basecamp contributions

museums. Interestingly, this was not the case. Figure 7.6 shows the average contributions separated by small and large museum staff. The results are intriguing.

The contributions from smaller museums consistently outpaced those from larger museums in each year of the project. The percentage of contributions from small museum staff doubled that of large museum staff in the second and third years. What factors could be responsible for such a dramatic difference? From interview data, it can be reliably concluded that small museum staff generally perform a wider variety of tasks within their jobs overall, are more accustomed to doing so, and have greater flexibility in scheduling those tasks themselves. By contrast, large museum staff are often more formally engaged in narrowly prescribed roles, too busy with designated tasks and do not have discretion over their schedules to spend as much time on "extra" work beyond the normal range of their daily activities. An additional indication is that participants from small museums were more ready or motivated to expand their skill sets and involved themselves in more aspects of the project in the interest of professional development, hence reflected in more Basecamp contributions. Certainly, these are significant differences in the range of professional identity for informal science educators.

STEPS Interview Analysis

While the social networking and Basecamp contribution analyses provided evidence of successful implementation of the STEPS collaborative model (Community-of-Practice and Team Leadership Theory) as well as insights into the project experiences at individual and institutional levels, interviews provided more direct assessments of personal impacts and professional identity impacts in

particular. Between the exploratory study and the evaluation efforts, we conducted interviews quarterly for three years. These interviews focused on Professional Development Opportunities, Institutional Impacts, Network Impacts, and Outside Network Impacts. Of particular importance for professional identity construction, three themes emerged from the interviews as types of outcomes that operated on an individual level, but often extended to institutional and network levels as well. We dubbed them the STEPS Professional Development Outcome Categories:

1. Awareness, knowledge, and understanding
2. Engagement, interest, and attitude
3. Skills development and transfer

Within these categories, we sought to examine and interpret participant project experiences for their possible impact on professional identity—acknowledging that not all professional development experiences would have such impacts. For example, these categories seemed to suggest a continuum of deepening impact, progressing from one to three; introductory knowledge, to active engagement and personal relevance, to expertise development and expanded engagement in or transfer to other areas of work. The deeper the impact of professional development experiences along this continuum, the more likely it had impacts on participants' self-perceptions (identity). In fact, this is what was observed among participants who experienced the deeper impacts, presented in the specifics examples below.

Example 1 Sam was the senior astronomy educator at a small museum. He was chiefly responsible for the operation and maintenance of the museum's planetarium. Although technically proficient, he had little content knowledge of astrobiology or the power of theatrical productions for learning. He maintained a very high level of participation throughout the entire project. He eventually became the leader of the story and script development subteams. As a result of his work, his museum eventually hired a local theater director to train actor volunteers for the performance of STEPS shows (and other shows later on). Sam himself performed a STEPS show at the 2012 Middle Atlantic Planetarium Society conference. In his final interview, he stated that through his STEPS experience he developed a greater appreciation and skill for theatrical productions and their use in science learning and that this has changed how he develops and produces his regular planetarium programs.

Example 2 Ginny was a children's museum educator from a small museum. She became a participant toward the end of year one due to staff attrition and reassignments at the museum. While on the project she participated at high levels in all of the threads. Toward the end of the project, she became interested in furthering her education (partly based on her interactions with other STEPS participants). At first she began looking at online graduate programs, so she could remain at her institution for the sole purpose of staying on the STEPS project. She ultimately chose to leave the museum only after completion of the STEPS project and training of other staff to ensure the project's continued usage. As she stated, "the [STEPS] project has continued to impact my professional experiences and provides inspiration for future endeavors."

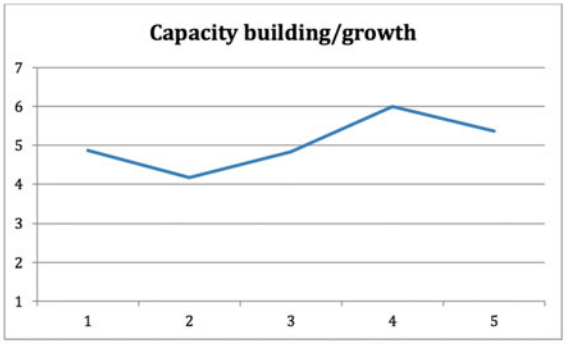
Example 3 Kath was a senior science educator with a large museum. She entered the project near the end of the first year due to a significant lay-off at the museum and reassignment of duties, including STEPS work. She became an active participant in all threads of the project, even becoming one of the performers of the first story for live audiences at conferences. After quickly familiarizing herself with the project, she maintained high levels of involvement to end culmination. She also saw immediate applications of the STEPS model and required skills and hardware to the museum's in-house and outreach programs. She was the first to recognize and promote the concept of a portable STEPS kit that could easily be transported to outreach sites. This led to an entire redesign of the STEPS hardware for all participants. Partly as a result of her leadership in STEPS, she was promoted to her current position as senior science educator, representing a formal professional identity enhancement.

Each of these participants demonstrated significant development in all three professional identity development outcomes to the point of professional identity enhancement—positive development of their self-perceptions as informal science educators. This suggests that the three professional development outcome categories, considered as a continuum of deepening impacts, may constitute operational pathways for designing and perhaps evaluating educator training that is specifically aimed at enhancing professional identity.

While the overwhelming majority of results indicated positive gains in the professional development outcome categories, contra-indications should also be noted as this may help with the design and implementation of future programs or even the recruitment of participants into such programs.

Example 4 Vance was the director of a theater program at a large museum. He was initially a very active participant on the project, due in large part to his long-standing expertise in theatrical production and performance. He enthusiastically shared his knowledge of the foundations of theatrical performance and production. After the initial scripts were developed, he became increasingly overwhelmed by and resentful of the project's research and evaluation requirements, as well as the technical knowledge required to successfully complete all facets of the project. Eventually, these elements of the project led him too far outside of his comfort zone and ultimately outweighed the benefits of the project to him. Despite showing several positive gains in the professional development outcome categories to a point, the educator ultimately perceived a detriment to and/or an invalidation of his professional identity through project participation. In this case, out-of-comfort zone tolerance was lower and indicated an important issue for future project leaders to consider when generating challenges or risk opportunities for educators with the intent of personal or professional growth.

However, for the rest of the participants, there were significant positive gains, which fall under the three professional development outcome categories. In this way, these categories may comprise a practical underpinning for enhancing informal science educator professional identity. In the STEPS project specifically, these



Note: The x-axis represents each pulse check (PC1-PC5). The y-axis represents the mean score from 1 to 7.

Fig. 7.7 Capacity building/growth

categories were operationalized within the primary project design threads, which formed the core components of the project deliverables.

Additional evidence for professional development and professional identity impacts was gathered in the external project evaluation, conducted by UXR Consulting. Specifically, the evaluation scrutinized the use of Team Leadership Theory and its impact on participants. The consultant evaluation found that the use of TLT in combination with the CoP was particularly effective in developing and maintaining a bottom-up distributed leadership structure and achieving the professional development and self-efficacy goals of the project.

> STEPS provided opportunities for every individual to learn a new skill, try something outside of his/her comfort zone, and take leadership roles based on individual self-interests. These benefits were exchanged for challenges with decision-making throughout the project. (STEPS Summative Evaluation, p. 2)

Subsequently, the evaluation compiled periodic self-assessments from the participants (Likert-like surveys on a 7-point scale) known as "Pulse Checks," including categories for Capacity Building and Growth, and Decision Making and Leadership, (among others) as shown in Fig. 7.7.

Qualitative participant comments suggested that capacity-building and growth was a success of the project. Participants cited growth at the professional development level and institutional level. Due to the unique leadership structure, each participant's growth context was individualized. For some, the key learning experiences were content based and for others they were related more towards transferable skills, as revealed in the following interview responses.

> The opportunity to just stretch in a different way, and knowing that there was no one else that was doing it [in our area] and struggling deeply to differentiate the museum from the competition in the area.

> It helped me be able to showcase what I know, like stuff people [at my institution] didn't really know everything that I could already do and that helped bring it out and people say 'Oh, wow! She's good at that' Now I've gotten more projects to do and things like that.

> I think dealing with these different teams and having to run team meetings helped me in a way, for a while I was leading [a subteam] and I felt like I developed professionally from that. I learned about running a team, and trying to be efficient about it, and being able to report back to a larger group.
>
> I've done some things on the project that I wouldn't have done otherwise… Like making that video in Camtasia. I wouldn't have done that before but I already have ideas for how I can use that in other parts of my work and just working with the STEPS system, that's a departure from my typical work.
>
> In the actual project, I was put in such a leadership position… I was given the opportunity to demonstrate my leadership – to manage stuff. That's something that I had [at my previous job] and you know I've never really been able to do [it at my current job]. This project gave me the opportunity to prove myself. I was really lucky. I was given a promotion when we were doing two layoffs. (STEPS Summative Evaluation, p. 17–18)

These benefits, made possible through the employment of Team Leadership Theory for the STEPS project came at some costs in terms of efficiency for decision-making. This area of the evaluation demonstrated mixed results of importance to consider for balancing professional development gains with project deliverable achievement. While Pulse Check data showed moderate gains in this area throughout the life of the project (Fig. 7.8), qualitative results from interviews revealed some challenges here in addition to benefits.

> The decision-making and leadership structure were two intertwined components of the collaborative process. The use of TLT required a bottom-up, distributed leadership framework, which led to the creation of subteams to accomplish specific milestones and the introduction of parallel timelines for specific deliverables. … [some] participants identified that at times the process for making final decisions was ambiguous and slowed because of this approach. … Several participants commented on the need for more structure and more top-down leadership than the TLT framework calls for, particularly at critical milestones along the process.
>
> As a whole the ownership shift from being [the PI's] baby out to it being shared among all of us really worked quite well actually, unlike a lot of projects I've done like this. It was fostered well, you could take an area and go with it and you weren't second-guessed along the way. You were really given complete ownership. That I thought worked really well.
>
> I definitely liked the idea of giving everyone the opportunity to be a leader. You know, I never expected to be the leader of the [sub]team, but it was a great experience… (STEPS Summative Evaluation, p. 34)

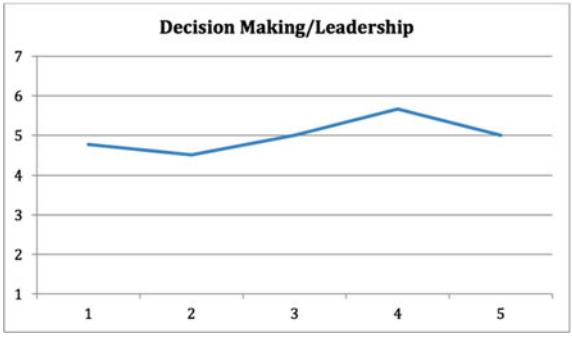


Fig. 7.8 STEP pulse check decisions/leadership

Finally, the summative evaluation used a set of four scales (three from the existing literature) to compile a participant survey on professional identity constructs, including perceived cohesion, professional development, clarity of professional identity, and overall professional identity. These included:

- The Perceived Cohesion Scale (PCS), modified from Bollen and Hoyle (1990) and defining perceived cohesion as, "an individual's sense of belonging to a particular group and his or her feelings of morale associated with members in the group" (p. 482). For STEPS the scale was used to focus on a project member's perceived cohesion toward the informal science educator community.
- A professional development scale developed specifically for STEPS where professional development was broadly conceptualized as how informal science educators grew in their careers through involvement in the STEPS project.
- The Clarity of Professional Identity Scale modified from Dobrow and Higgins (2005) and using Ibarra's (1999) definition: "the relatively stable and enduring constellation of attributes, beliefs, values, motives, and experiences in terms of which people define themselves in a professional role." (p. 3).
- A general identity perceptions measure using a modified version of Brewer, Van Raalte, & Linder's (1993) professional identity measure, which conceptualized professional identity as the degree to which people identify with their professional role.

Notably, the summative evaluation also considered the impacts on the project partners from professional organization (not informal science educators) for comparison.

Both science museum educators [Group 1] and professional organization employees [Group 2] reported high levels of perceived cohesion, indicating that in general the team felt that they were part of a larger network of informal science museum educators (see Table 7.2). However, the two groups differed regarding professional development. Informal science educators reported higher levels of professional development from participating in the STEPS project than professional organization employees. This is perhaps not surprising since STEPS was designed

Table 7.2 STEPS identity scales summary

	Group	N	Min	Max	Mean	SD
Perceived cohesion scale	1	7	4.5	6.83	6.12	0.79
	2	4	4.33	6.50	5.63	1.07
Professional development	1	7	5.25	7	6.07	0.69
	2	4	3	5.50	4.69	1.14
Clarity of professional Identity	1	7	4.25	5.25	4.82	0.35
	2	4	3	4.00	3.56	0.43
Overall professional identity	1	7	5.67	6.17	5.91	0.16
	2	4	3.00	5.33	4.42	1.00

Note Mean values range from 1 to 7. Group 1 = Science Museum Educators, Group 2 = Professional Organization Employees, *SD* Standard Deviation

to the benefit of museum and science center educators specifically. As one science museum educator reported: "It's been a huge benefit for me as far as the professional development. I've been exposed to things that I probably wouldn't have been able to do without STEPS." Scores on overall professional identity indicated that informal science educators identified with and valued their professional roles. Scores for clarity of professional identity were slightly lower. Future studies would benefit from monitoring changes in these scores over the course of such projects—which was not possible during STEPS.

Discussion

Based on these results, covering a variety of approaches to examine professional identity construction, the finding on the question, "Did the project enhance the professional identities of the participants?" is generally affirmative, it did. Further, it seems to have done so through the combination of using Team Leadership Theory in concert with the high demands of the project in terms of professional development within three broad categories (the STEPS Professional Development Outcome Categories) and including risks that took participants out of individual comfort zones.

The participant project experiences were often difficult and represented challenges, risks, and rewards which were individualized for different participants in different ways, each according to his/her own dispositions, capacities, and efforts. Consequently, as revealed in the wide range of interview responses, they led to differential identity impacts in terms of personal agency, attitudes, self-efficacy, and capacity as informal science educators.

This then also represents an avenue for future research in terms of unpacking the construct of professional identity into more specific constituent elements, which were beyond the reach of this study. Additional tools designed for related concepts, such as for personal agency or self-efficacy could be employed for such future inquires, along with more refined tools for directly assessing self-concept and identity impacts in the future.

Conclusion

With STEPS we set out to examine whether and how an innovative, difficult, highly collaborative, and distributed leadership project across a multi-institutional network could enhance the professional identities of informal science educators. The findings of this exploratory study indicate that the professional identity of "informal science educator" is highly individualized and hence so are the impacts of participation in something like STEPS. The results confirm that the STEPS Collaborative

Model succeeded in enhancing the professional self-concepts of participants, although not in all cases.

The emergent professional development outcome categories [(1) Awareness, knowledge, and understanding; (2) Engagement, interest, and attitude; (3) Skills development and transfer] suggest a structure for both designing informal science educator professional development programs and for evaluating the results. Considered as a continuum of deepening impacts (from 1 to 3), these outcome categories could be used as pathways for intentionally enhancing educator professional identity.

Additionally, although not covered in detail here, our exploratory findings support the notion that institutional capacity is inexorably linked to individual capacity and indicate reciprocal development of each, in most cases. Therefore, investment in staff professional development is essentially an investment in institutional capacity. Inversely, staff attrition is a divestment in institutional capacity (but not necessarily in individual capacity). Further, multi-institutional networks provide educators with a highly personal community that may extend in time and content well beyond project work. For STEPS, Team Leadership Theory operationalized within a distributed community-of-practice model proved to be effective for both individual professional development and institutional capacity building, but at some detriment to work efficiency and timely decision-making. Clearly, this is an area for improvement.

By placing educators at the center of concern for the project, STEPS prioritized the elements of leadership, collaboration, responsibility, and creative freedom, which in "normal" projects would typically be considered side effect benefits in service to the production of deliverables, if they occur at all. In this case, the "normal" formula was turned upside down, with lasting and transferrable gains for most of the participants. Importantly, these elements were intended to pull participants out of their comfort zones and present them opportunities to take risks and develop new skills. In the most successful examples, this brand of professional development impacted their sense of professional identity.

Therefore, our findings suggest that informal science educator professional development strategies may be well served by the following recommendations:

- Utilize project work explicitly as extended professional development opportunities for staff by providing supports and structures to facilitate gains and growth for individuals (not just production of deliverables).
- Design professional development beyond content knowledge and skills acquisition towards individual professional identity construction, including strategies for challenging intellectual, social, and emotional components.
- Create professional learning environments that encourage and support participant risk-taking in intended growth areas (out of comfort zones to a degree).
- Design and evaluate professional development efforts in terms of the three learner-centered professional development outcome categories: 1. Awareness, knowledge, and understanding; 2. Engagement, interest, and attitude; 3. Skills development and transfer.

- Consider treating these outcome categories as a continuum of deepening impacts, potentially leading to professional identity enhancement, and evaluate for such impacts.
- Explicitly link individual professional development efforts and outcomes to institutional capacity by incorporating a degree of team leadership, community building (within a single institution and/or a multi-institutional network), and actively seeking opportunities for transfer of gains to other areas of activity.
- Create protocols for online archival communication (e.g. Basecamp) and peer-to- peer mentoring (in person and online) to support collaboration, mitigate the consequences of staff attrition, and bring new educators up to speed quickly and effectively.

As an exploratory study, this work presents innovative methods for investigating professional identity impacts. However, future studies would do well to develop more direct methods for looking specifically into informal educator professional identity construction specifically. For example, the constructs of professional identity salience, commitment, and importance to an individual are all significant identity characteristics that can be more deeply explored with established methodologies from the field of identity research (Burke & Stets, 2009), but modified for informal science educators specifically.

Further, our work on this study has contributed to subsequent identity-based research by our group, XSci, at the University of Colorado Boulder. Notably, this has included important components of science educator identity construction such as the development of agency, emotional connection, personal relevance, content confidence, and behavior/choice effects within formal and informal learning environments. However, much more can done in this area. In fact, the current literature looking into the professional identity of educators predominantly deals with formal classroom teachers and has struggled with agreed upon definitions and models for understanding identity (Beauchamp & Thomas, 2009).

Defining identity in this or any context is a key step in generating research methods for examining it. Although this study was reinforced with a robust definition from the sociological area of identity theory, the methods used for examining identity impact were indirect (excepting the interviews). Other studies have utilized methods such as participant drawings, narratives, shared reflections, and even video creation as innovative approaches (Katz et al., 2011; McLain, 2012; Beauchamp & Thomas, 2009). Far less investigation into identity has been conducted for informal educators in informal learning environments, leaving the field wide open for new methods and inquiries into this difficult but important area.

As STEPS set out to enhance the professional identities of informal science educators through a novel project structure and strategy that placed a high stake on individual educators and collaboration between them, and was in large part successful in that endeavor, the findings challenge traditional thinking about the purpose of professional development. While the field of informal science education matures and becomes increasingly professionalized, STEPS and other projects are examining such front-line jobs (as opposed to administrative) in museums and

science centers as "destination careers" rather than more transitory "career moves" one might make on journeys elsewhere. Identity is central to the distinction between the two ends of the spectrum in this regard.

STEPS suggests that professional development in terms of content and skills is not enough and may actually set institutions up for a lower or even negative return on their investment in staff development (through attrition) if they fail to also attend to the continual enhancement of staff professional identity. Certainly the results of this study are beginning to articulate ways of doing this along with the importance of doing so. Identity represents a personal connection; an ownership or self-integration of the role at hand, and when reinforced and afforded growth, it becomes a powerful influence on behavior, choices and effectiveness.

NOTE: For a full discussion of the other findings regarding linkages of identity to institutional and network capacity, see the STEPS Project Final Report, NSF ##1043060, Program Officer A. DeSena or contact the Project P.I. and chapter author B. McLain at XSci.org

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