ISE Professionals Knowledge and Attitudes Regarding Science Identity for Learners in Informal Environments: Results of a National Survey

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Overview

This report presents findings from a national exploratory study on professional knowledge and attitudes surrounding science identity as an applicable theory for understanding experiences in informal science education (ISE) environments. The study was distributed by email to 2,500 names on the Center for Advancement of Informal Science Education (CAISE)'s mailing list. The survey received an 11% complete response rate with 288 complete responses, and another 181 partial responses, and an average of 15 years experience working in the ISE field for all complete respondents.

The results demonstrated that the majority of professionals found the concept intriguing with nearly half the respondents (46%) believing that identity is an important new area of study. Although a few professionals (8%) felt this subject area was not as important as other areas of study and a very small number felt this subject area was a fad (3%), most of the other respondents (40%) felt that they did not know enough about the topic to judge its relevance.

When queried on the constructs that define science identity, there was general support for the idea that identity can be explored and developed in an ISE experience. There was little support, however, for constructs related to the dimensions of science identity that predict meaning-making or behavior, or whether ethnic and sexual identity can create barriers to the development of science identity. Examination of the open-ended narrative responses revealed that there is a great deal of confusion between exploration of a science identity, and learning science concepts.

We conclude that the exclusion of identity theory from the ISE community's discourses on learning have not sufficiently prepared professionals to act on the recommendations of the National Research Council report recommending an important new strand for ISE research. We recommend that further study of science identity development continue, but more importantly, that scholars come to the aid of the ISE community by making efforts to disseminate the principles of identity theory in order to help these professionals grapple with the emerging research in their exhibitions and programs.

ISE Professionals' Knowledge and Attitudes Regarding Science Identity for Learners in Informal Environments: Results of a National Survey
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Introduction

The National Research Council in its report, *Learning Science in Informal Environments: People, Places and Pursuits,* identifies 'science identity' as a new strand for science education, worthy of its own focus with particular importance to informal settings (NRC 2009, Strand 6). Science identity is defined as the ability for people to "think about themselves as science learners and develop an identity as someone who knows about, uses, and sometimes contributes to science." Science identity is relevant to the small number of people who, over the course of a lifetime, come to view themselves as scientists as well as the great majority of people who do not become scientists. For the latter group, the informal science education (ISE) community has set itself the goal of helping these people become comfortable with, knowledgeable about, and interested in science. ISE professionals have also recognized that some groups are significantly under-represented in the science community and have worked to develop strategies for engaging these people in science learning. This new focus on identity that emerged in the NRC report is especially relevant to women and girls, ethnic minorities, and individuals from socio-economic groups historically marginalized from science.

Scholars have posed three main arguments for emphasizing identity in science education. First, science identity can play a crucial role in how learners affiliate with the exhibition content. Learners' belief in their own scientific abilities, the value they place on science, and their interest in science, all have consequences for the quality of their engagement in museums (NRC, 2007). Second, science identity is an important predictor of science participation for young people. Science identity research has started to suggest that sustained engagement is not measured by short-term change in knowledge and attitude change, but rather the underlying conception of the self as scientist that explains why some youth remain engaged while others "opt out" (Carlone & Johnson, 2007). It is necessary to focus on the entire experience related to identity development, and how a developing understanding of the self as a science thinker might have greater impact on their overall sense of self and career choices (Cobb, 2004). Third, science identity can offer a new way of understanding which aspects of an ISE environment promote or inhibit the development of science knowledge, skills, attitudes and behaviors; how ISE activities can help visitors identify and solidify their interests and social networks; and thereby provide access to scientific communities and careers (Rounds, 2006).

The NRC has urged the ISE community to create new opportunities for the public to explore their science identity. Because identity development is ongoing and continually influenced, U.S. science museums with their combined audience of nearly 40 million children each year can potentially have a substantive and far-reaching influence on fostering science identity in American youth. This new strand of research, however, does not have a robust tradition in the ISE discourse, nor has there been a great deal of discussion about how to operationalize identity theory in practice.

In order to assess the impact of this new strand for research on the ISE community, this survey was designed to examine how science identity theory is understood by professionals in the ISE community, what these professionals believe about the central constructs that define science identity, and how they feel new knowledge on this topic will impact their work. This report presents the findings of that study.

Background

For more than four centuries, philosophers and psychologists have examined the self-concept or identity in order to better define how people understand who they are, and anticipate actions they will take based on that understanding within a social world (Oyserman, 2004). Selfhood as a specific construct has been defined as having three aspects: self-awareness or the reflexive consciousness of knowing oneself as a whole entity; the interpersonal awareness of the self as distinct yet related to

others in a social environment as marked by feelings of receiving love or embarrassment based on other's actions; and the executive function or sense of agency that manages a person's actions based on an anticipated set of causes and effects in that social context (Baumeister, 1998). These three aspects of identity are all salient dimensions in understanding how a person chooses to operate within a social context. For more than a century, psychologists focused on interpersonal relationships as if the self operated independently, but this tradition was refuted in the latter part of the twentieth century when an emerging group of social psychologists demonstrated that the sense of self is inextricable from social relationships (Abrams & Hogg, 2004; Ashmore, Deaux & McLaughlin-Volpe, 2004; Hogg, Abrams, Otten & Hinkle, 2004; McGrath, Arrow & Berdahl, 2000; Stryker, 2000; Tajfel & Turner, 1984). These researchers demonstrated that the interpersonal awareness of the self had a direct influence on the executive functions based on expectations of the consequences that flow from enacting or refuting social norms and conventions of groups that one holds as important to their sense of self.

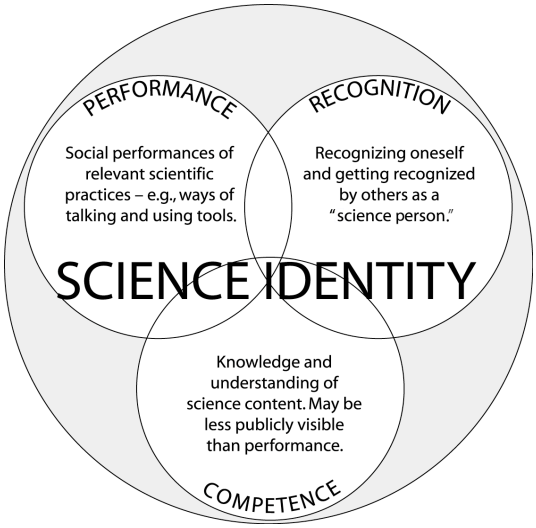

Figure 1. Model of science identity (Carlone & Johnson 2007)

In the social sciences, there is general consensus that an individual's understanding of their identity is actually a complex set of interconnected identities that are malleable and relevant in guiding attitude formation in different settings (Baumeister, 1998; Brewer, 1991; Castells, 1997; Clayton & Opotow, 2003; McAdams, 1997). Recently, the concept of a science identity as one of these multiple identities was proposed as a construct that can explain an individual's learning, meaning-making, and actions as they confront science content (Brickhouse, 2008; Brickhouse & Potter, 2001; Carlone, 2004; Carlone & Johnson, 2007; Carlone et al, 2008). In pursuing this inquiry, Carlone and Johnson proposed a model for school settings (Figure 1) based on her longitudinal study of 15 young women of color as they negotiated their experiences with science learning. The model recognizes three interrelated dimensions necessary for the construction and reinforcement of science identity:

1) Performance of relevant scientific practices, e.g., scientific ways of talking and using tools and processes (performance),
2) Recognition of oneself and by meaningful others as a 'science person' (recognition), and
3) Meaningful knowledge and understanding of scientific content (competence).

This emerging theory appeared to have been relevant enough to the explanation of how motivations, attitudes, knowledge, skills and behaviors develop in informal science education experiences for the editors of the National Research Council report (NRC, 2009) to consider identity as a new independent strand that should be prioritized in ISE research. The relatively new introduction of identity theory from the social sciences into the ISE discourse, and how that theory was framed in the NRC report suggests that there may not be a general understanding of the core constructs that define the theory, nor how this theory can be operationalized in the field.

Method

An online survey consisting of open-ended and Likert-type ranking scales was constructed in order to examine ISE professionals' understanding and beliefs about the core constructs and impacts of science identity as described in Carlone and colleagues work. Questions were developed to explore ISE professionals' believes about the social construction of science identity, how science identity can be

developed, and enacted, how a science identity can impact learning and behavior, and whether these professionals believed that other minority identities have impact on the development of science identity. Demographic questions addressed these professionals' years of experience, areas of expertise, minority identity, and their familiarity with the NRC report (Appendix A).

The survey invitation was distributed by email to 2,500 names on the Center for Advancement of Informal Science Education (CAISE)'s mailing list. The survey received 590 discrete click-throughs, of which 181 responded only to the first two questions and 288 completed the survey. These results represented slightly more than 11% response rate. It is important to note that the majority of partial responses did not move beyond the opening screen that asked if they were familiar with the NRC report, *Learning Science in Informal Environments: People, Places and Pursuits,* and were more likely to report that they *had not heard of* or *had only heard mention* of that report.

The average respondent had nearly 14.35 years experience working in the ISE field, with a maximum of 50 years experience, and three who claimed they did not have any relationship to working in the ISE field. 13.5% of the respondents claimed to be a member of a minority community, 11% were non-white/Caucasian. Statistical analysis did not reveal any significance between these demographic criteria and any other responses. See Appendix 1: Tables 2 – 6 for additional respondent demographics.

Findings

The majority of respondents were familiar with the *Learning Science in Informal Environments: People, Places and Pursuits (NRC, 2009)* publication that introduced the concept of identity as an important strand for research, but few of these respondents claimed to have actually read the report in depth (Figure 2).

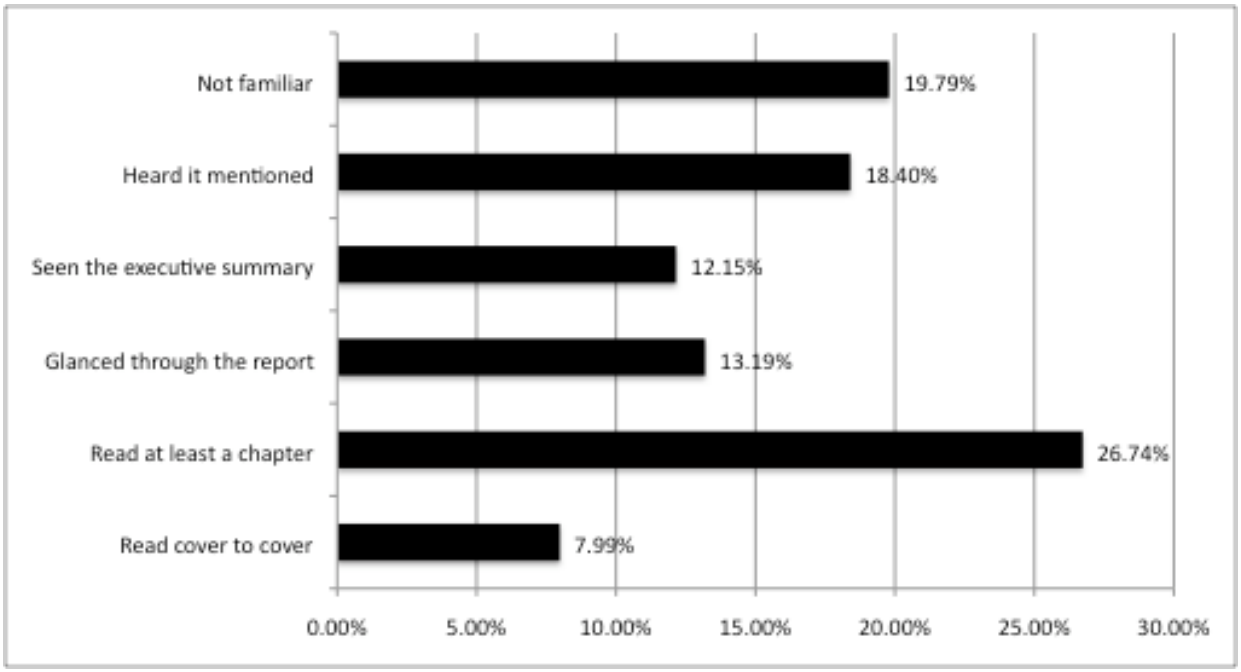

Figure 2: Respondent familiarity with *Learning Science in Informal Environments: People, Places and Pursuits (NRC, 2009)*

Familiarity with Identity Theory

Irrespective of their readership of the report, the theme of identity has captured the interest of 94% of the respondents, with 46% agreeing with the NRC report authors that this is an important new area of study, 40% feeling they needed additional information before they can judge the value of this area of study, and 8% feeling that the focus is not necessarily as important as other science learning issues. The remaining 6% either had no opinion or relegated the topic to a fad.

In order to understand these opinions further, the survey sought responses about what the terms meant to these respondents. For the 6% who claimed to have no opinion or felt this focus was a fad admitted that the concept of identity was new to them, ventured that it might be a jargon term associated with science learning or related to an institution's brand rather than an individual. For those who were unsure whether the topic was worthy of focus, there was a similar lack of understanding of the core concept of identity, but often appeared to have a rudimentary understanding of the constructs. Those withholding judgment about the value of identity research were able to describe science identity as a reason why people choose to act in specific way, but these respondents also were unsure that this research would have any impact on their work in informal science education. For those who felt this topic was worthy of study, either at an equal level to other foci or to a lesser extent, the concept of identity was often explained in terms of learning about the self in the context of an experience.

When comparing the responses in open-ended questions, those who focused on the importance of identity research were also more capable of situating identity development as part of a life-process that could intersect with informal science experiences at museums. For those who did not have familiarity with core identity concepts appeared to focus on single museum visits in their responses. The vast majority of responses, irrespective of the focus on importance as a science topic did demonstrate at least partial understanding that identity can influence learning behavior, and that identity development is, in part, influenced by the experience of being involved in informal science learning.

Science Identity Constructs

A series of 7 point Likert-type agree/disagree ranking questions sought to understand whether respondents agreed with the validity of the constructs used to define science identity by Carlone and Johnson (2007). These questions used statements to explore ideas about the social construction of identity, how identity develops through experiences, impacts learning, predicts action, is related to the understanding of the self, and whether minority identities create barriers to the development of science identity. In general, respondents generally agreed with concepts associated with the socio-cultural development of identity and identity's impact on learning outcomes, but did not support the concept that science identity can predict action or that other identities limit the development of science identity.

In order to analyze the responses, we defined a supported concept as anything that had a mean ranking above 5 and a standard deviation demonstrating general concordance with the mean. In order to assess whether agreement with these concepts could be explained by demographic variables, we explored whether those who supported this area of research were significantly more likely to support a construct, whether reading the NRC report had a significant impact on agreeing with the statements defining science identity, and whether years in ISE practice significantly influenced the respondent's likelihood to agree with the concept. These factors were only significant in a few instances (Table 1).

Two statements were used to assess the socio-cultural development of identity, one addressing the idea that identity is socially constrained and the other noting that identity is evident in an individual's actions. In general, respondents to this survey did not support the basic theory that identity

is socially constrained, a concept that has been robustly proven in the field of identity research. They were, however, supportive of the idea that an individual's actions reveal their identity. Those respondent's who claimed to have worked for a longer time in informal science education were less likely to believe that science identity is socially constrained (p=0.03) and is evident in an individual's actions (p = 0.01).

Table 1. Results of Agreement/Disagreement Statements

	On a scale from 1-7, please rate how much you agree or disagree with the following statements:	Mean	Standard Deviation
Socio/cultural impacts	Identities are socially constrained (individuals cannot assume identities that are not recognized by others in their social world)	4.17	1.79
	An identity can be observed in a person's actions or words	5.15	1.30
Identity Development	An identity is developed through interaction with other people	5.28	1.44
	Science identity can explain how visitors make meaning from their experiences with science phenomena in different ways	5.10	1.42
Predicts Action	Someone who has developed a science identity demonstrates competent performance in scientific practices	3.98	1.49
	Someone who has a science identity uses scientific tools and practices	4.48	1.50
Perceptions	Someone who has a science identity is recognized by others as a "science person"	4.13	1.54
	Someone who has developed a science identity finds scientific information important for their life decisions	5.35	1.32
Role in Development	Museums and other informal learning settings can play an important role in developing science identities for visitors	5.77	1.35
	Schools play an important role in helping youth to develop science identities	5.43	1.54
Barriers	Science identity is particularly challenging for minority youth	4.62	1.70
	There are more challenges for women to enact a science identity than men	4.34	1.77
	There are more challenges facing people from minority communities to enact a science identity	5.06	1.52
	Low economic status prevents students from developing their science identity	3.98	1.80

* Concepts not supported by respondents shown shaded.

α Were this procedure to be repeated on multiple samples, the calculated confidence intervals would encompass the true population parameter 99% of the time.

Respondents moderately supported the idea that identity is developed through interaction with other people, and that science identity informs how people make meaning from scientific phenomena. Those who believed identity research to be a short-lived fad did not agree with these statements, but with only 3% of respondents holding this view, these results were not significant.

Three statements were used to gauge whether respondents supported the idea that science identity can predict behavior. These questions explored whether the development of a science identity reveals itself in more competent performance of scientific practices, that person's ability to use science tools, and whether their actions would lead others to consider them a science person. Respondents did not agree with any of these ideas. Years working in the field again were more likely to believe that a science identity would lead others to consider someone a science person (p = 0.03) but this belief did not impact the overall lack of support for these identity concepts.

Respondents agreed with two statements suggesting that schools and museums play a role in the development of science identity. Not surprisingly, the more someone believed science identity is a valuable study area for ISE research the more likely they were to believe that museums influence the development of science identity (p = 0.00). These respondents also agreed that, "*Someone who has developed a science identity finds scientific information important for their life decisions*."

Lastly, four statements characterized other identities that may pose barriers to science identity including minority identities, gender identity, and economic status. In general, the vast majority of respondents did not feel that any of these concepts were barriers to identity development.

Discussion

All of the statements used to assess beliefs about science identity were derived from the central constructs used to pursue identity research and were derived from the concepts that emerged from Carlone and colleagues studies of youth development of science identity. These data suggest that that the majority of ISE professionals are intrigued by the concept of science identity, but identity theory itself remains elusive. Although a few professionals (8%) felt this subject area was not as important as other areas of study and a very small number felt this subject area was a fad (3%), it is apparent that most respondents were trying to grapple with the application of identity theory because it seemed valuable to them.

The open-ended responses demonstrated that identity theory is not well understood in practice, and that there is substantial need for professional education in order to ensure the field is able to operationalize new findings in practice. Confusion between knowledge learning and the development of the self-concept as a science learner represent significant challenges for the interpretation of evaluation results and the development of new theories of how to promote science learning.

Simply stated, identity development is socially constrained because we develop our self-understanding through interpreting how people respond to us as we present our thoughts and feelings. In a science museum, a social cohort could encourage someone to believe that they are valued as a science learner by commending them for the use of their skills reasoning through a science concept, or that person could just as easily cause that person to suppress this aspect of their sense of self because it would lead to social exclusion. This social constraint has a significant impact on both the opportunity to expand knowledge through shared inquiry, and also may lead someone with latent capacity to develop good science reasoning skills to not pursue this work because it would isolate them from the people they depend on for security and validation. The respondents to this survey demonstrated that they would like to believe that museums support identity development, but did not understand that the social context surrounding that visit could be the most substantial exogenous factor that limits the success of the institution.

These data also demonstrated that there is little support in the ISE community for recognizing the discordance between minority identities and the exploration of self as a science person. It has been well documented, and noted as a priority by the National Science Foundation that these under-represented populations need to be addressed in order to expand science learning equitably across American society. Yet, ISE professionals did not support the idea that these identity conflicts may represent a core reason why these minority communities may continue to be under-represented in the coming years. Further exploration of these constructs is warranted, but more importantly, a focus on helping ISE professionals to understand the key concepts in identity theory in order to help these professionals develop new strategies for engaging these communities.

Conclusions

It was heartening for the research team to see the very high degree of interest in learning about identity theory. At the time of publication, there is a deficit of literature surrounding the application of identity theory to the practice of museum design and program development. These results demonstrate that there is a willingness in the industry to learn about identity theory, and science identity in particular. However, the theory itself will remain without action if those exploring the theory do not engage directly with ISE practitioners to develop experimental strategies for overcoming the barriers to science identity development and enactment in the museum setting.

We conclude that the exclusion of identity theory from the ISE community's discourses on learning have not sufficiently prepared professionals to act on the recommendations of the National Research Council report recommending an important new strand for ISE research. We recommend that further study of science identity development continue, but more importantly, that scholars come to the aid of the ISE community by making efforts to disseminate the principles of identity theory in order to help these professionals grapple with the emerging research in their exhibitions and programs.

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Appendix 1: Demographic Results

Table 2. Respondent's Areas of Expertise

What is your area of expertise? (select all that apply)	n	%
Education	236	85%
Curatorial	43	15%
Science/Scientific Research	77	28%
Administrative	78	28%
Support Services	25	9%

Table 3. Respondent's Reported Racial Heritage

Which of the following best describes your family heritage? (select all that apply)	n	%
White/Caucasian	248	89%
Black/African American	3	1%
American Indian/First Nations	1	0%
Asian/Pacific Islander	7	2%
Other	10	4%
Prefer not to answer	13	5%

Table 4. Percent of Respondent's Claiming Spanish/Hispanic/Latino Heritage

Are you Spanish/Hispanic/Latino?	n	%
No, not Spanish/Hispanic/Latino	261	93%
Yes, Mexican, Mexican American, Chicano	4	1%
Yes, Puerto Rican	0	0%
Yes, Cuban	0	0%
Yes, Other Spanish/Hispanic/Latino	5	2%
Prefer not to answer	11	4%
Total	281	100%

Table 5. Respondent's Self Perceptions as Members of a Minority Community

Do you consider yourself to be a member of a minority community?	n	%
Yes	39	14%
No	226	80%
Prefer not to answer	16	6%
Total	281	100%

Table 6. Respondent's Claimed Level of Academic Achievement

What is your highest level of academic achievement?	n	%
Some high school	0	0%
High school diploma/GED	0	0%
Some college	1	0%
Undergraduate degree	33	12%
Some post-graduate studies	32	11%
Post-graduate degree	215	77%
Total	281	100%