

Are the Fields of Informal Science Education and Science Communication Adjacent or Connected?

A Bibliometric Study of Research Journals From 2012 to 2016

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People encounter many opportunities to engage with science in out-of-school settings. There are two fields devoted in large part to understanding and supporting this kind of activity: Informal Science Education (ISE) and Science Communication (SciComm). The Center for the Advancement of Informal Science Education (CAISE) is currently working at the boundary between these two fields, seeking to identify common work, catalyze new collaboration, and support research-practice collaboration within and between each field.

We began our exploration with a simple question: How should we think about these two fields? We knew that both were concerned with science and the ways that people engage with, learn about, and use science at various points across the life-span. But we also knew that the history and trajectories of the fields have been quite different as well, with ISE growing from science education, museum learning, and youth development, among other places (National Research Council, 2009), and SciComm coming from communications, decision-making, and the history of science, among other places (National Academies of Sciences, Engineering, and Medicine, 2016).

If we were going to work at the boundary of these fields, we needed to understand more about the contemporary cutting edges, the shared and separate challenges, and the trajectory of both fields in the recent past.

We decided to conduct two kinds of baseline studies that mapped the relations between ISE and SciComm. One baseline study, a social network analysis of current ISE and SciComm professionals, is summarized in a forthcoming companion technical report. In this paper, we describe a second baseline study: A bibliometric analysis of ISE and SciComm research journals from 2012 to 2016. We chose this time frame because it was the five-year period preceding our new five-year project plan to work at the boundary of ISE and SciComm, which commenced in 2017.

Social Network Analysis & Synthesis

CAISE conducted two studies, including this one, to gain a clearer picture of where ISE and SciComm diverge and converge. Visit the following URL to read the social network study, as well as a synthesis of the findings from both studies: bit.ly/baseline-studies

Initially, we will look to the findings of this bibliometric study to inform our five years of work. We may also be able to conduct the study again sometime after the conclusion of our project to look for evidence that the people, ideas, and research areas that were central to the CAISE approach have taken root (or not) in the peer-reviewed research literatures of ISE and SciComm. The bibliometric study analyzed the authors, titles, and abstracts of central, archival research journals in the fields of SciComm and ISE from 2012 to 2016. In terms of SciComm, we sampled three journals that make science communication part of their identity: *Science Communication*, *Journal of Science Communication*, and *Public Understanding of Science* (n=597 articles).

As there is no comparable set of archival journals specifically for ISE, we sampled from a group of science education journals that often publish ISE-related scholarship but also publish formal science education research: *Science Education*, *Journal of Research on Science Teaching*, and *International Journal of Science Education*. To identify ISE-specific articles from among all articles published, an experienced ISE researcher coded the title and abstract of each article to categorize it as focusing mostly on formal, mostly on informal, both formal and informal, or neither. We included the articles coded as mostly informal or both formal and informal in this analysis (n=162 articles).

A Low Overlap in Researchers Publishing in Both ISE and SciComm Journals

The outlets in which researchers publish their work is a strong indication that the author thought the work was appropriate for a particular field. As all these journals were peer reviewed, the authorship of the articles is also strong evidence that the peer reviewers and journal editors found the work to be technically sound and significant in terms of contribution to the respective areas.

Over the five-year span, there were 1,894 authorships listed in the data set. Some authors published more than one article in the data set, so the actual number of individuals who appeared as authors was somewhat lower. In the five-year span, we identified 20 individuals who published in both ISE and SciComm journals (i.e., they appeared as an author on at least one article in both types of journals). The number of authors who publish in both fields did not appear to be increasing rapidly over the five-year sample: There were eight in 2012–14 (an average of 2.6 each year), and there were seven in 2015–16 (averaging 3.5 each year). These numbers do not add up to 20 people in the five-year total because some authors were only coded as publishing in both fields when the whole five-year span was considered. Because some of the 1,894 authorships could be the same person authoring more than one article, the overlap in fields is something like 1 or 2 percent of authors.

We examined authorship in order to estimate the number of researchers who might be considered dual ISE/SciComm citizens. The number we found was low—less than two percent of all individual authors in our five-year sample. Our finding is likely lower than the actual number, as many current researchers who identify as working on both fields may have been publishing elsewhere during this five-year sample, or, in the case of current junior scholars, may not have been publishing much in either field yet. However, if the fields of ISE and SciComm actually had significant overlap, one might expect considerably more than two percent overlap in the authors of research papers over five years. Our observation, in this case, is clear evidence that the relationship between researchers in the two fields cannot be described as strong or interdisciplinary.

Conducting a Frequency Analysis on Article Titles and Abstracts

Although ISE and SciComm researchers may not publish in the same journals, do they study similar kinds of problems? We began by looking at how many times particular words appeared in article titles and abstracts during our five-year sampling frame—a method called *frequency analysis*. We cleaned and reduced the data in successive steps.

First, we eliminated common words and numbers. Second, we eliminated words that were most likely to refer to the articles themselves, such as research, findings, article, implications, data, etc. Third, we combined related forms of the same word (e.g., perception/perceptions and perceived/perceive).

We did not combine words such as science with scientist or teaching with teacher, as we wanted to be able to independently assess the frequency of activities/topics and the people/professionals who do those things. In order to track trends over time, we grouped the five years of articles into two comparison groups periods: 2012–14 vs. 2015–16.

To obtain our final measures of frequency, and to control for different numbers of articles published,

we computed the average number of times a word appeared in a title or abstract within ISE or SciComm journals in our two time frames. In looking at the abstracts, the frequency of terms ranged from an average of 5.36 times per abstract (that was *science* in ISE journals during 2015–16), to hundreds of terms that appeared just once—e.g., *steampunk*, whose single appearance resulted in .003 mentions per abstract in 2012–15 SciComm journals.

Two Distinct Conversations...

We began by analyzing terms appearing in titles. Titles are the most succinct statement of an article’s focus. Authors can spend hours crafting a title that is clear and descriptive. Titles position the article as a contribution in the field. If the title does not sound directly relevant to a potential reader’s interests, they may move on without reading the abstract, let alone the full article. Thus, analyzing terms from article titles speaks directly to an author’s understanding of the essence of an article.

Science was, by a large margin, the most frequently used term in both SciComm and ISE titles. But beyond a focus on science, what do the two fields have in common? Figure 1 displays the top 10 terms after “science” appearing in article titles.

Figure 1: The 10 most frequent terms in titles of journal articles after “science.”

Terms are displayed in rank order with font size corresponding to frequency.

Informal Science Education Journals

2012–2014

2015–2016

<p>students school learning teachers education experiences interest social/society knowledge informal</p>	<p>students learning education knowledge experiences engagement school programs social/society children</p>
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Science Communication Journals

2012–2014

2015–2016

<p>public social/society media communication climate scientist news perceptions knowledge engagement</p>	<p>public social/society communication scientist media knowledge climate technology news information</p>
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The figure shows that both ISE and SciComm have been concerned with knowledge and the social/societal context of science. However, they have pursued these concerns differently.

In ISE, the people most likely to be addressed are students and teachers, and the focus is most likely to be on learning, education, interest, and engagement. In contrast, the people most likely to be part of SciComm studies are the public and scientists, and the focus of the research is most likely to be media, climate, technology, news, or perceptions. In ISE the study of experiences is prominent, while in SciComm a major focus is communication.

These patterns have been relatively stable over the last five years, although there have been some notable changes. Within the most recent sample of ISE journals, teachers, interest, and informal have fallen from the top 10, replaced by children, engagement, and programs. Meanwhile, information and technology were no longer as prominent in recent SciComm articles as were engagement and perceptions.

It is also worth noting that, although ISE focuses on out-of-school experiences, there was a strong presence of formal education in the titles, with words like students, teachers, and school appearing often. This will not be surprising as articles often explored ISE in relation to schools, examining, for example, school trips to informal learning institutions, afterschool programs, or summer enrichment. This also may reflect the fact that there is no stand-alone ISE journal. Articles that appear in science education journals may be shaped (by authors, reviewers, and editors) toward more connections to the broader science education community, which is primarily concerned with formal science education.

... But Talking About Similar Things

The findings up to this point have suggested that ISE and SciComm are distinct fields, with only a few authors in common and titles that suggest strikingly different framing that reflects the broader fields of education or communication. To get a more detailed sense of the most recent overlap in the fields, we turned next to analysis of terms appearing in abstracts. We identified the 50 most frequent terms that appeared in ISE or SciComm abstracts in 2015–16. We then identified which terms overlapped between the two fields (i.e., appeared in both top 50 lists) and which were nonoverlapping (appeared in only the ISE or SciComm top 50). The top ranked words in abstracts were similar to those from titles—the kinds of terms that would appear in most articles in the journal, no matter what their specific focus. But, by the 50th-ranked position in our data set, there are terms that would appear in only 10 to 20 percent of articles. One might think about these occasional terms as indicating specializations within a field, as opposed to the broadest-level shared commitments suggested by more frequent terms.

As shown in Figure 2 (next page), and building on the findings from Figure 1, there are some central points of connection between recent ISE and SciComm work, with 38 percent of the top 50 abstract terms in ISE and SciComm overlapping with the other field. Thus, the two fields share interests in the topics of climate, nature/environment, and technology. Researchers from both fields are exploring individual factors such as attitudes, interest, and motivation. Learning and communication are common, as are content and knowledge. There is a shared interest in practice, publics, and also scientists as objects of research. Finally, all of this appears to be taking place amid broader questions of context, culture, and society. Thus, there is significant common ground in the range of topic covered in the fields, even if the overall framing of most articles (as revealed in Figure 1) remains more distinct.

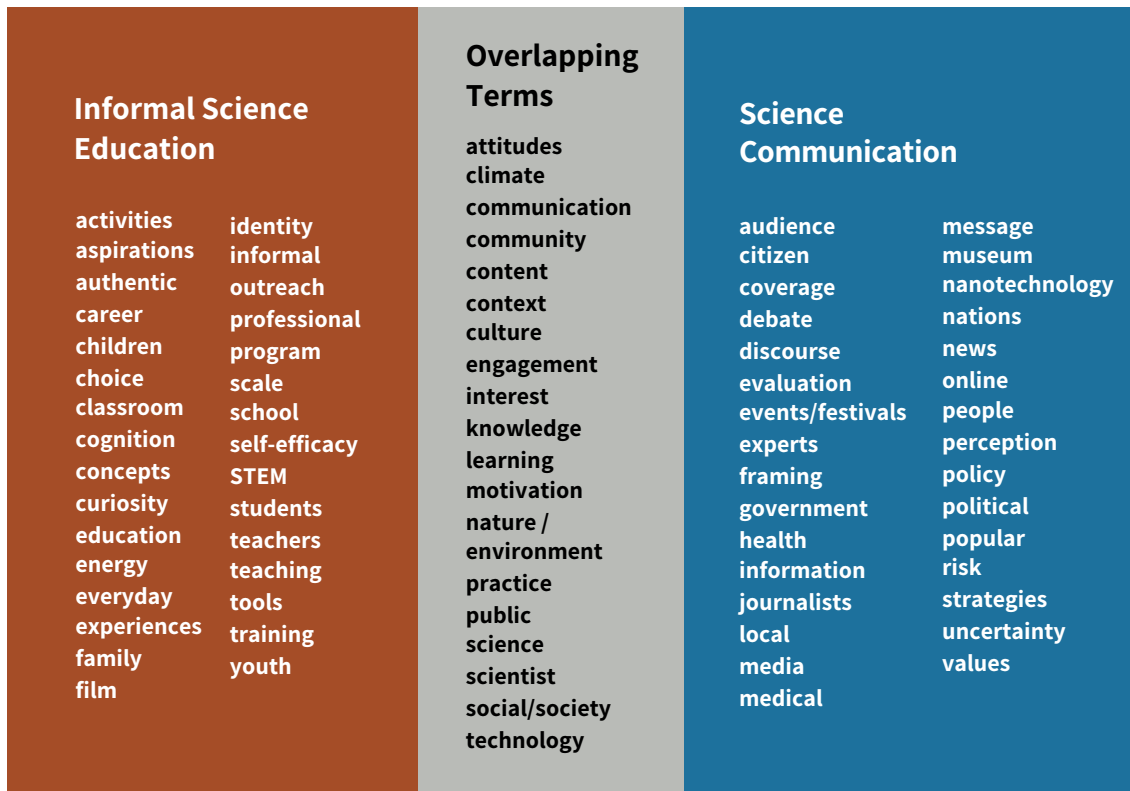


Figure 2: The top 50 terms in abstracts of journal articles in 2015–16.

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Figure 2 also reveals a number of areas where ISE and SciComm might be pursuing their own nonoverlapping interests. Many of the nonoverlapping terms follow logically from the high-level education vs. communication framing of ISE or SciComm respectively. For example, researchers in ISE, but not in SciComm, explore topics related to the STEM education pipeline for youth including, aspirations, cognition, self-efficacy, and choice. ISE researchers are interested in tools, professionals, scale, and outreach. But some also have a focus on everyday and authentic settings, perhaps where children and families develop curiosity or explore science concepts.

In SciComm, educational issues and research on children’s learning is generally absent. Instead, the focus is on citizens and general audiences interacting with messages that are framed by politics, policy, and values. Debate and discourse are highlighted, as are risk, uncertainty, and perception.

There are studies of the role of governments, experts, journalists, news organizations, coverage, and the larger media. Words like popular and local live alongside considerations of differences among nations. Topics such as health, medicine, and nanotechnology pop up in SciComm as well.

The Figure 2 data provide a detailed snapshot of recent ISE and SciComm research, but some caution is warranted. For example, while the findings suggest that film is a nonoverlapping ISE term, and museum is a nonoverlapping SciComm term, one can easily find examples of ISE studies focused on museums and SciComm studies focused on film. Given that we are now considering terms that are relatively low frequency across articles, and that we are only considering the most recent two years in the sample, we should be cautious that some of the Figure 2 findings may be artifacts of the sampling frame rather than indicative of real differences between the two fields.

The Bottom Line

This bibliometric analysis of research journals from 2012 to 2016 suggests that, at least as far as research is concerned, ISE and SciComm are largely separate fields. Only about two percent of authors published in both ISE and SciComm journals over a recent five-year span, suggesting that the overwhelming majority of authors may consider themselves as part of one field but not the other. The analysis of article titles suggested that, despite a shared focus on science, knowledge, and society, the high-level framing of research articles in the two fields is distinct, with the ISE reflecting the general educational research field and SciComm reflecting communications research.

The abstract analysis suggested that, underneath these high-level differences, however, there are promising areas of overlap between ISE and SciComm. Researchers on both sides of the ISE/SciComm boundary are currently exploring issues from attitudes to interests to motivation, from environment to climate to technology, from public to scientist to society, and from learning to communication. As CAISE continues to work at the boundary of the two fields, we should be aware of both the few current boundary spanners that exist as well as the areas of shared interest, where joint activity may be more easily catalyzed.

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