Toward an Understanding of the Epistemic Values of Biological Scientists as Expressed in Scholarly Publication

By

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ABSTRACT OF THE DISSERTATION

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This dissertation develops a deeper understanding of the epistemic values of scientists, specifically exploring the proposed values of community, collaboration, connectivity and credit as part of the scholarly communication system. These values are the essence of scientists actively engaged in conducting science and in communicating their work to others. In studying the epistemic values of scientists, this dissertation identifies the research problem within the literature: the lack of an understanding of what the epistemic values of scientists are; and in answering that question, does so informed by the literature that community, collaboration, connectivity and credit are probable values (Latour & Woolgar, 1987; Polanyi, 1962; Cohen, 1995).

Using a qualitative approach incorporating the concept of emerging theory (Strauss & Corbin, 1998) and the critical incident technique (Flanagan, 1954), the dissertation:

1. Explores the extent to which community, collaboration, connectivity and credit are dimensions of values.

2. Examines the inter-relationship, if any, of the values.

3. Explores the possibility of additional dimensions of values.

The methodology uses semi-structured interviews to conduct one-on-one, face-to-face interviews with life scientists who are currently engaged in research and were writing or had recently written a peer-reviewed paper. Data are analyzed using a constant comparative process (Glaser & Strauss, 1967; Berg, 2001), with each interview informing the subsequent interview. The data are first open coded without regard to the literature-identified values of community, collaboration, connectivity and credit; then a second coding occurs, identifying themes from the first set of codes and viewing the data through the framework of the literature-identified epistemic values. Through a constant comparative process, data are coded and re-examined until a story line and themes emerge from the data. The epistemic values of community, collaboration and credit were all identified and interpreted from the data. The epistemic value of connectivity was not identified from the interview data, which may be due to a limitation of the use of a single method. Other epistemic values, not previously identified in the literature, were identified in the data: contribution and competition.

Deepening an understanding of scientists' epistemic values within scholarly communication is critical to librarians and others engaged in collecting and managing scientific knowledge because the epistemic values shape and motivate the scholarly communication process.

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I gratefully acknowledge the guidance, wisdom and perpetual optimism of my dissertation advisor, Ross Todd. He offered a discerning path through theories and engaged in critical questions that aided me in developing my own approach to the research proposal while ensuring that the study was grounded in the literature and sound methodology.

My School of Communication and Information committee members, Carol Gordon and Marie Radford, each brought their own expertise to my benefit, identifying weaknesses in the research proposal, suggesting new avenues to take and making sure that all details were addressed. They worked to make sure that I would meet with success in the research study.

My outside committee member, Paul Pevsner, was invaluable in offering his connections to reach pilot study participants and was a sounding board in how to approach and work with scientists, even offering himself as a test subject, complete with on-the-spot feedback.

Dr. Pevsner's advice to me echoed that of several of the study participants: to be successful in science, one must be able, available and affable. And given the equality of all three, affable is the most important. A completed dissertation attests to able and available; I shall leave it to all the others in my life who love and care about me to

confirm whether I meet with the final criteria of success: affability. At least with a completed dissertation, I shall be more available and able to offer affability to you all.

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Chapter 1: Statement of Problem

This section of the dissertation introduces the concept of epistemic values within philosophy and philosophical literature; and the importance of value to society. The introduction provides a rationale and the significance of an empirical study of epistemic values within the context of scholarly communication, the selection of scientists as study participants and previews the review of literature and identification of epistemic values explored within the dissertation. The purpose of the dissertation and the research questions are also presented. A glossary of terms below presents terms used throughout the dissertation.

Glossary

Collaboration - united labour, co-operation; esp. in literary, artistic, or scientific work (OED, 2nd edition, 1989a)

Community - life in association with others; society, the social state (OED, 2nd edition, 1989b)

Connectivity - the characteristic, or order, or degree, of being connected (OED, 2nd edition 1989)

Credit - … to acknowledge that it is due to him; to ascribe the merit of it to him; (OED, 2nd edition, 1989b)

Epistemology - The theory or science of the method or grounds of knowledge.

1856 FERRIER Inst. Metaph. 48 This section of the science is properly termed the Epistemology..It answers the general question, 'What is Knowing and the Known?' or more shortly, 'What is Knowledge?' 1883 Athenæum 20 Oct. 492/3 He divides his work into four sections, dealing with epistemology, ontology, anthropology, and ethics. (OED, 2nd edition, 1989b)

Epistemic values - Epistemic values are embedded in human thought and understanding of what and how we know, and learn. Epistemic values are the dimensions (Nozick, 1981)of the nature of knowledge and truth. Epistemic values are a type of intrinsic values in that they are embedded in the nature of something: in this case, knowledge. However, they are not ethical or moral values (Putnam, 2002), but rather values that are associated with the learning, knowing and discovery of science (Rooney, 1992).

Value – "standard of exchange" (also known as value-in-exchange) and the "principles or standards of a person or society" (OED, 2nd edition, 1989b); also referred to as types of values: extrinsic, intrinsic; moral values, epistemic values. Examples of epistemic values are: "accuracy and consistency," (Rooney, 1992); "reproducibility in an experiment or accuracy in a measurement" (McMullin, 1982) as the types of epistemic values that a "good theory would embody" (McMullin, 1982)

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The purpose of this dissertation is to create a deeper understanding of the epistemic values of life scientists as they participate in the scholarly communication process – specifically through exploring the proposed values of community, collaboration, connectivity and credit as a theoretical framework of the scholarly communication process.

The problem addressed is the lack of understanding of the epistemic values of life scientists as expressed and situated within the scholarly communication system and derived through systematic empirical research. The research aim of this dissertation is to develop a richer understanding of the epistemic values of life scientists.

Research questions are:

1. What are the epistemic values of life scientists expressed in the context of the writing and publication of a peer-reviewed article in the scholarly communication system?
2. To what extent, if at all, are the literature-identified values of community, collaboration, connectivity and credit present in scholarly communication as perceived by life scientists?
3. What are the relationships, if any, between the values discovered? Does the relationship include the previously literature-identified values of community, collaboration, connectivity and credit?

Significance

The significance of the study is that it will substantially increase the understanding of what scientists' epistemic values are using an empirical method. Science is a privileged domain in society; scientific knowledge is seen as significant to the development of modern society and, in some quarters, rivals religion for the framework of meaning it creates for life (Wolpert, 2000). The scientific method was the embodiment of epistemology for much of the twentieth century (Popper, 1972, 1992).

This study also brings an empirical approach to philosophy's discussion of epistemic values. A philosopher's examination of scientists' values may argue the existence or not of epistemic values (McMullin, 1982; Putnam, 2002; Rooney, 1992); when reaching the end of the argument, deciding "yes" that value and epistemic values are inherent in science; the philosopher will then list epistemic values, without reference as to how those values are derived (McMullin, 1982; Rooney, 1992). Where one philosopher mentions “accuracy and consistency,” (Rooney, 1992) as examples of epistemic values; another lists “reproducibility in an experiment or accuracy in a measurement” (McMullin, 1982) as the types of epistemic values that a “good theory would embody” (McMullin, 1982).

Where a philosopher would reason his or her way toward epistemic values, the research traditions of library science require an empirical method to reach an understanding of epistemic values. Lacking an understanding of how philosophers determine epistemic values – or even what a shared, standard list of epistemic values would be – encourages methodologically sound studies, because the ‘what’: “what are scientists’ epistemic values?” is not yet known empirically. To empirically explore scientists’ epistemic values, a qualitative method was chosen as being appropriate to the research questions. The other aspect of the study, in keeping with a library science-based thesis, is in focusing solely on the epistemic values as they are found in the scholarly communication system. This focus allows the study to richly explore one aspect of scientists’ work life, and the epistemic values therein to better understand their scholarly communication system.

Value has dual definitions: one in which value is defined as extrinsic, objective; and the other where value is intrinsic, the essence of something. While the occasional study will mention intrinsic value, little research has been conducted in this area. The heuristic used in epistemic value is that of the expert opinion or expert review of the literature. Still less literature exists on epistemic value – a type of intrinsic value. There has been very little work in developing an understanding of the epistemic values of library users grounded in data and emerging through systematic analysis.

The selection of scientists as study participants was made because of the tremendous changes that are taking place within the system that scientists use to communicate with each other ("Alliance for Taxpayer Access," 2005). The standard publication vehicle, the peer-review journal, was once only available in university and research libraries. Now, however, the Web makes it possible for peer-review journals to be more accessible to scientists or anyone with internet access. In part because a peer-reviewed journal could be made freely accessible over the internet, and in part because of greater public (lay or non-scientific) interest in science, there is a push for “open access” or free access to scholarly and scientific publications ("Alliance for Taxpayer Access," 2005). Understanding the epistemic values of scientists, at a point when their methods of communication are undergoing profound change, has a compelling impact on libraries and library services. Where extrinsic values track objective measures, epistemic values are part of the underlying motivation that drive behavior.

A review of the pertinent literature suggests that scientists share the epistemic values of community, collaboration, connectivity and credit (Latour & Woolgar, 1986) within scholarly communication. The following literature review provides a framework for the design of the empirical study undertaken in this dissertation. By reviewing the literature addressing the values of both library sciences, with its tradition of curating scholarly communication; and of science, as the authors, producers and consumers of scholarly communication, gaps in understanding are expected to be uncovered, as well as providing a pathway and rationale for this dissertation.

Chapter 2: Literature Review

The intent of the study is to create a deeper understanding of the epistemic values of life scientists as expressed through scholarly communication. The literature review serves two purposes: background for understanding epistemic value, examining the epistemology of science, its significance for society and its connection to scholarly communication, which is the means by which scientists convey discovery and knowledge. The literature will also identify a values framework by examining types of values and how value is measured. The second purpose of the literature review is investigating the scholarly communication literature as the lens through which to understand life scientists' epistemic values.

The literature review examines epistemology and values; for epistemology, particularly the epistemology of science, its significance is demonstrated through its dominant role in academe and in society as to how knowledge is known. Values and how to value are an integral part of human interaction from everyday life to deeply held beliefs and motivations. The beliefs and motivations manifested in science, as explored in the literature of the philosophy of science, offers not only a window to the theoretical underpinnings of the field of science but also an understanding of science's dominant role in defining empirical knowledge for the 20th century. Knitting together the epistemology of science together with an understanding of how values are defined presents a framework for the discussion of types of values, the act of valuing and where there is a paucity of literature addressing epistemic values, particularly within the context of scholarly communication.

Both the epistemology of science and the values literatures have their roots in philosophy: they each provide a viewpoint through which to see the world and define a framework through which to examine and problem solve. The third literature reviewed, scholarly communication, is used as both source material for the epistemic values of biological scientists and a means of adding greater understanding to the epistemology of science and the framework of values. Less a circular approach, and more of a deepening of understanding, the framework of epistemic values will be enriched and detailed through a review of the scholarly communication literature. The literature on the epistemology of science acquaints the reader with long-held knowledge of the supremacy of science and the scientific method for the modern academic and the general public; and the values literature recalls to the reader the acts of valuing that occur in everyday life, the comparison of one item over another; as well as the deeply held values that motivate and animate everyday life. Scholarly communication literature is the tool used in this study to extend an understanding of both science and value(s), and provide a deeper understanding of the epistemic values that are hand in hand with knowledge creation and the commitment for scientific truth.

Epistemology of Science

In the twentieth century it was science that promised “better things for better living… through chemistry” and “the miracles of science” (E.I. du Pont de Nemours and Company, 2005) and it was science that captured the attention of philosophers, with the logical positivist school of philosophy emphasizing knowledge through empiricism and in particular through the formal empirical methods of science. Karl Popper, one of the significant philosophers of science, presented the theory of empirical knowledge and suggested the supremacy of science and the scientific method in his book, *Objective Knowledge: An Evolutionary Approach*. While a critic of logical positivism Popper acknowledged the supremacy of positivism in science and stated that the "heart of philosophy is epistemology, and in particular the nature of empirical knowledge" and the only way to know is through science and its methodology of hypothesizing, testing and rejecting (repeated) (Popper, 1972).

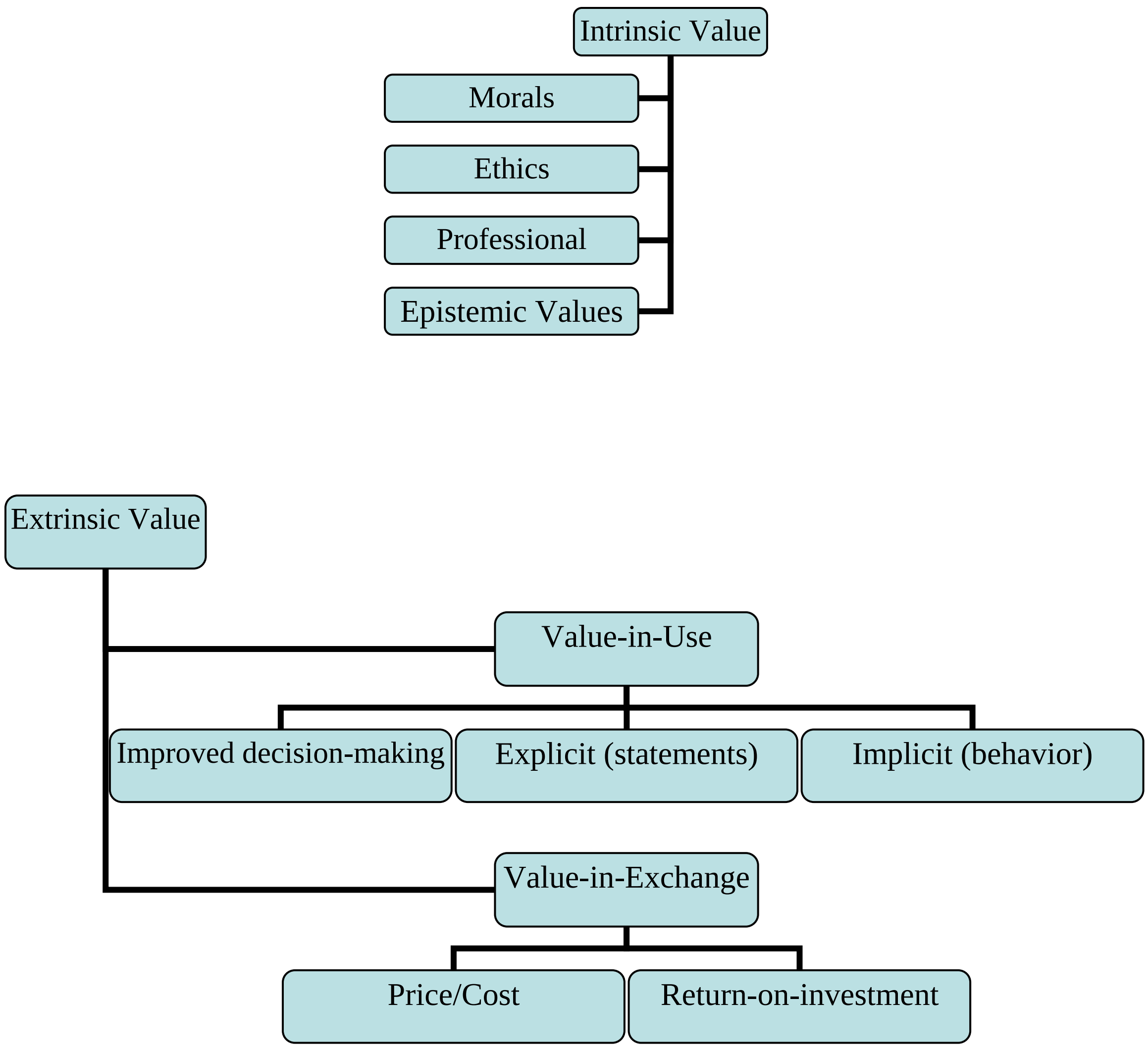
Epistemology, the field of philosophy that examines knowing and how one knows, has a particular connection to science. The dominant approach to epistemology in philosophy in the mid-twentieth century was science (Popper, 1992). The promise that science held to bring knowledge and understanding not only of science but of life itself, made the epistemology of science the only way to know (Popper, 1992). Popper determined the scientific method (hypothesize, test, accept/reject, repeat) to be the foundation of epistemology and knowledge (1992). Only what could be known through scientific research methods was of value.

Concept of Value

The concept of value is explored in any number of literatures, from philosophy to economics and from the right and ethical behavior of professions, people and organizations to the act of valuing that takes place everyday: comparing one item over another and establishing a hierarchy of valued items. In its most broad sense, value is usually defined as two different types: extrinsic and intrinsic (Saracevic and Kantor, 1997). Figure 1 provides a further delineation of the two aspects of value as determined from philosophy, economic, science and library and information science literatures. Figure 1 details intrinsic value as a kind of value that is inherent, the very nature of an entity and closely connected with ethics and right behavior. Extrinsic value, on the other hand, is depicted more in an economic sense and implies a hierarchy of choices: improved decision-making as a kind of extrinsic value, for example, indicates that there are levels of decisions, ranging perhaps from poor to excellent as valued by an external value-r. Similarly, price/cost and return-on-investment can each be found on a numerical scale, with highs and lows delineating value. Each of the two kinds of values – intrinsic and extrinsic – though are related through the value-r. Where extrinsic value is actively valued by a value-r; intrinsic values are innate to the value-r. Intrinsic values can motivate human behavior as an expression of the essence of someone; the motivated human behavior can be valued as an extrinsic value. Intrinsic values are the essence; extrinsic values are the observable, measurable objective measures of what is valued.

Value: Intrinsic and extrinsic

Figure 1. Intrinsic Value, Extrinsic Value, with Types



Extrinsic value is objective, and can be more easily measured than intrinsic value. Often further defined as value-in-use and value-in-exchange (Saracevic & Kantor, 1997a), extrinsic value also aligns with economics. Intrinsic value, however, is more akin to the nature or essence of something; and kinds of intrinsic value include moral or ethics; professional values and epistemic values.

Where value is extrinsic, it is comparative and ranked; for example, in math value is a “precise number,” it is a number that is higher or lower than other numbers. And in music value is the “relative length of a note” and there are longer and shorter notes. In economics, an object’s value can be expressed monetarily, though its value can be higher (over-valued) or lower (under-valued) than its actual price, it is still expressed within a financial scale. Value is constructed by the marketplace, through the willingness of one person to pay another a set price to obtain an object. The greater the desire for an object the greater the value assigned to it. Price and value can diverge when something is offered at a price lower than its generally-agreed upon value. Price and value though are still expressed in relationship to one another, with something perhaps being sold for “more than what it’s worth” (not a bargain) or “less than what it’s worth” (a bargain, a steal, a sale). Value in economic terms is referred to as value in exchange.

Relative value can also express itself in terms of its utility. A hammer may not cost a lot (be worthy of exchange in the marketplace) but it has tremendous value (worth, usefulness) to a carpenter in the course of his/her work. Value expressed as utility recognizes worth in all sorts of objects that no longer are price-worthy or never were marketplace-worthy. The value of a book may be in the information contained within and its usefulness in understanding an idea or learning a new skill.

Two concepts in understanding value are “value-in-use” and “value-in-exchange” (Saracevic & Kantor, 1997a; Kantor & Saracevic, 1997b). Both concepts are types of extrinsic value, where value is determined by external standards. Extrinsic value is relational, connected to a valuer (Bullock & Stallybrass, 1977). A human valuer will determine the value of a book, a meal, a friend, and kinds of government. All have the potential to be ranked, measured and valued against external standards: the ability of these things or other humans to inform, educate, inspire, satisfy, cherish and keep safe the humans who value (Blackburn, 1994). Value-in-exchange refers to the value of an object or activity in financial terms. How much a value-r will pay for an object or activity is its value-in-exchange. Value-in-exchange covers many human needs and activities from food to homes; vacations to transportation. The value-in-exchange concept does not explain the value though of something that is underwritten by others (a government for example) and thus is seemingly without cost. The concept of value expressed through use (value-in-use) refers to the value of an object or activity in relation to its use by a value-r (usually a human value-r) (Nozick, 1981). Value-in-use includes human activities such as internet use, for example, where the provision of information is “free,” the use of a site (how often, by whom and how long) determines its value.

Intrinsic value

The concepts of value-in-exchange or value-in-use include human activities and objects, both where there is willingness for payment (exchange) and where frequency (of use) determines value. These concepts are types of extrinsic values; values that can be measured: value-in-exchange through monetary standards; value-in-use through agreed-upon standards of scales of frequency of use. These value concepts cover a range of human behavior but they do not address the values that are inherent to human themselves.

This kind of value is referred to as intrinsic value. Usually equated with moral values, intrinsic values are the essence of something; the value of something in and of itself. Andrew (1995) characterized the philosophical movement of value from economics to value as morality (often couched in aesthetic terms of beauty and goodness) as a “flight” from economics to morals. Value-as-moral is innate to the human condition, known and shared amongst whole groups of people and found to be so compelling that there is an expectation – among fellow shared moral valuers – that value-as-moral could and should be shared amongst all humans (Frankena, 1973).

Where extrinsic values are more easily discerned through empirical means, intrinsic values have more often remained in the domain of the philosopher, who may debate the existence of value (Putnam, 2002), but after completing the debate and deciding, yes, that intrinsic value does exist, will then produce a list of values without reference to source or methodology. One example of such a list of intrinsic values is that proposed by Frankena (1973):

> life, consciousness, and activity; health and strength; pleasures and satisfactions of all or certain kinds; happiness, beatitude, contentment, truth; knowledge and true opinions of various kinds, understanding, wisdom; beauty, harmony, proportion in objects contemplated; aesthetic experience; morally good dispositions or virtues; mutual affection, love, friendship, cooperation; just distribution of goods and evils; harmony and proportion in one's own life; power and experiences of achievement; self-expression; freedom; peace, security; adventure and novelty; and good reputation, honor, esteem (p. 87-88)

The difficulty in analyzing a list of intrinsic values, is figuring out how the list came about in the first place. How do we know that these are values? The study of values has occurred more in economics, where value can be equated much more clearly with observable actions. Where extrinsic values (value-in-use and value-in-exchange) are created through human action and group decision, intrinsic value is presumed to be inherent, integral to the nature of humanity itself. Where intrinsic value is described as of itself, the discovery of what intrinsic value is takes place through reflection on the world, human behavior and the human condition.

While the types of extrinsic value are well-defined and explored in the literature, types of intrinsic value are not as well examined. One explanation for this may be that extrinsic values lend themselves more to measurement, and thus more easily studied. The extrinsic values that have an economic base are often on some type of scale – monetary, pricing, etc – and are thus easily measured. For extrinsic values that are not economic, but rather values assessed through use, these too can be counted as one would count the uses of a service, a process or a good not normally assigned a monetary price. It is possible even to cluster a set of services and assign them a value, perhaps through consensus of the providers of the services or through a consensus of the users of the services. As intrinsic values are inherent to the very nature of something or someone, a discovery of intrinsic values requires a deep knowledge of the entity in question.

Science Communicates Its Knowledge

The challenge of acquiring a deep knowledge of science, and not just subject knowledge of science but knowledge of how science is science; the entity of science itself is choosing the method or methods in how to understand science and how to have confidence that these methods will produce an accurate understanding of science. One way to acquire that knowledge of science – without necessarily acquiring the subject expertise – is to understand how science communicates. Science's epistemological product – its knowledge base – is primarily communicated through scholarly peer-reviewed journals (Weller, 2001). The scholarly peer-reviewed literature has evolved over the centuries (Weller, 2001) into a highly structured and reward-bestowing system that all scientists, if one is to be considered a scientist, participate in (Price, 1969). Science and health sciences libraries base their budgets (Blecic, Hollander, & Lanier, 1999), their technologies (Wakimoto, Walker, & Dabhour, 2006) and services (Jankowski & Martin, 1994; Urquhart, Turner, Durbin, & Ryan, 2007) around the scholarly peer-reviewed literature. While the scholarly literature itself has been studied (Weller, 2001), and the information seeking behaviors of scientists in finding the literature important to them has been studied (Brown, 1999; Gleeson, 2001; Kwok, 1992; Lu, 2003); understanding the epistemic values of scientists as rooted in the scholarly literature has undergone limited investigation.

Scholarly communication is shaped first by the sociology of science: the how of "doing science" and by whom; and in turn the ways in which the how and who of science shapes its communication channels (S. Cole, 1970; Diane Crane, 1971; Garvey, 1979; Griffith, 1989; Lievrouw, 1988; Menzel, 1959; Paisley, 1965; Price, 1965). The nature of conducting scientific work is that it is communal, collaborative and connected (Crane, 1971). The collaborative nature of science is balanced against the individual scientist's ability to think, reason and act on his or her own. Each member of the community, while working with and for the scientific enterprise, has an opportunity to be more or less successful than his or her fellow community members. The collaborative community has elites, knit in and part of the larger group but adding a level of diversity and hierarchy within the larger group.

The communal nature of scholarly publication dates back to the 17th century, and the founding of the *Philosophical Transactions of the Royal Society* (Weller, 2001). The journal was an extension of an “invisible college” of philosophers and scientists interested in investigating nature through the use of science (Crane, 1972). The members of the invisible college chose to become visible and communicate with each other – perhaps in a more formal method – through the journal. The *Transactions*, and the many many others that followed it, served to record and coordinate the work of scientists; adjustments made to a line of inquiry in response to the work of other scientists. Science moves forward through its publications, each scientist acting as an independent agent of a closely knit organization (Polanyi, 1962).

The connectivity of the scientific community can be both transitory and more long-lasting. Science and scientists are continually reshaping and reorganizing, splintering into other smaller groups or joining and forming smaller groups into larger ones (Swanson, 1993). Swanson (1993) analyzes the scientific literature through bibliometric measures to identify growth in fields followed by fragmentation as specialties develop as a coping mechanism in the face of the burgeoning literature.

Scholarly publication adds another concept to understanding the nature of science and that is the concept of credit. Credit takes the form of authorship, degrees of authorship, being cited; all credit contributing to community awareness of oneself and one’s work (Cohen, 1995; S. Cole, 1970; Cole, 1983; Floyd, Schroeder, & Finn, 1994; Killmann, 1997; Mirowski, 2001; Polanyi, 1962; Smith, 1981; Trueba & Guerrero, 2004). Cohen (1995) write about the "culture of credit" in science; Killman, Mirowski and Trueba & Guerrero (1997, 2001, 2004) assert an author's right to be credited for his or her work, admonishing other scientists to award credit to one's colleagues.

Scientific communication is communal, collaborative and connected: in science, information is shared; since what the work of one scientist does is dependent on the work of another scientist, knowing and sharing the methods, results, successes and failures is essential to the continued growth and knowledge of the field (S. Cole, 1970; Paisley, 1965). Scientific or scholarly communication is collaborative: scientists created and founded the means of communication (particularly journals) (Weller, 2001). They also created a commonly agreed-upon peer review system, which serves as a gatekeeper, filter and promoter of scientific ideas and work (Weller, 2001). Scholarly communication depends on dialogue among participants, establishing and maintaining a high-degree of connectivity and ensuring that ideas or arguments put forth can be visible to all. The connections to and amongst scientists and scientific work is reflected in their references to each other's work through citations.

Most efforts in understanding the value of scientific literature have focused on the worth of the knowledge contained in the literature and the utility of the literature to other readers or scientists. Valuing scientific communication has frequently fallen into the realm of librarians and library researchers. As the curators of the products of scholarly communication – books and journals – and managers of databases and systems that make the products available, librarians have long been interested in the value of the literature.

Valuing Scientific Communication

Value-in-exchange and value-in-use

In valuing the scientific literature, librarians have used the values framework of value-in-use and value-in-exchange. Value-in-exchange is associated with cost or price and seeks to determine the willingness of an individual or institution to pay for something, be it product or service. Value-in-use is ascribed to the utility of something, as determined by library user statements (in response to questions, surveys, and such) as to the value of something to them. Studies that value libraries have used both value-in-exchange and value-in-use to seek an economic understanding of value, either through assigning a numerical figure to the value of a library or its services or through an assessment of a library or library holdings (an article or journal, for example) use (Saracevic & Kantor, 1997a, 1997b).

Determining what to value

Using the value-in-exchange concept seems logical in light of society's re-conceiving of itself as a knowledge economy. In the knowledge economy there would then be knowledge products. In the knowledge economy concept, there is a heavy reliance on marketplace terminology and investigations, emphasizing the economics of information. Information is described as a "product," studied along with its methods of production (Repo, 1989). The value of information in this context comes through an examination of production costs or willingness of users to pay for the information product. Libraries hold many pieces that can be valued: the library itself, the books, journals, audio-visuals in the library, technology; or the library could be valued as services, from the delivery of reference, to interlibrary loan, to circulation and provision of information through the web site.

Value-in-exchange studies (Griffiths, 1982; Byrd, 1989) commonly identify a part of a library service to value. The value might be that of an article, of a library service like interlibrary loan or reference services or of technology. The emphasis on valuing libraries economically makes sense when juxtaposed against the larger societal changes in the United States, especially the shift to the "information economy", and away from the industrial economy. Where an industrial society has a product (a car or widget or other assembly-line produced item), the information society also has a product: information. The analogy posits information directly in the path of economics and economic theory. Where published information is treated as product, its value can be measured by exchange or through cost (Byrd, 1989).

Limits of value-in-exchange studies

Valuing libraries economically has its limitations, particularly when there was an effort to isolate information product from information user or information conduit (e.g. technology) from information user (Glazer, 1993). The nature of information is rooted in its integration with the service or conduit that delivers the information (Griffiths, 1982). The weaknesses of value-in-exchange studies in valuing information/services is that the price of information/services is artificially set; value is usually examined in a specific library setting and value is more interdependent than independent, raising the ongoing difficulty of identifying what is actually being measured. Another limit of value-in-exchange studies as applied to libraries are that libraries are not businesses that produce products for sale thus adding to the artificiality of the study (Saracevic & Kantor, 1997a). Researchers in value-in-exchange studies often conclude their articles with a statement of the importance of context, the user and suggest that should be a “dual approach to the value of information”: information products (service, channel, system) studied using a value-in-exchange approach and the cognitive aspects of information studies using a value-in-use approach (Repo, 1989). Though treating information as a highly measurable entity, Glazer ultimately opts for information that is valued best when it is valued subjectively, stating that all the information presented is for the benefit of the company’s managers, who “themselves are the best judges of the value of variables with which they work” (1993, p. 103). The subjective, as expressed by the user, plays a critical role in information value.

As society changed from an industrial economy to the knowledge economy, some of the metaphors, terminologies and viewpoints from the older economy transferred to the newer one. Where the old economy provided highly visible units of value – products that were bought and sold; the metaphor of information product was not robust or sustainable when used in the knowledge economy. The nature of information – its perceived increased “value” when known and held by many, directly contradicted the value attributed to scarce commodities. Information proved to be more slippery when trying to define it and the institutions that carried, held and housed information are not usually profit-producing organizations. In valuing information and libraries, it is more important to ask not “what will you pay” but “what do you use.” Value, expressed by use, is a more common and perhaps more appropriate measure of scholarly publication, information and libraries.

Integrating users into valuing process: value-in-use

The value-in-use concept refers to a type of extrinsic value that integrates the user and the valuer, into value itself. It is the user who determines whether or not to pay for something (value-in-exchange), so value-in-use proposes instead that if the item in question is not for sale in the usual way of things, what is its utility? The utility of an item or service to a user is determined by user behavior, user statements or through third-party impact for its value (Saracevic & Kantor, 1997a 1997b).

Value-in-use: user behavior

Libraries can utilize user behavior to assess use and subsequently attribute value to the use. Libraries tally reference questions, interlibrary loans processed, numbers of users at events such as author talks, story hours and the like, checked out books, photocopies, and search logs. Each of these user-formed trails can be totaled singly or together to form a picture of user behavior and an indicator of what users' value (Association of Research Libraries, 2007). While no dollar amount is exchanged for a checked-out book, the desire on the part of the user to take that book out, presumably to read and return becomes a measure of the book's value and importance. Check out that book over and over again, and others like it, and for anyone monitoring the activity, a measure of the usefulness of that book and collection appears.

User behavior forms a part of the written record. In scholarly communication, authors cite (indicate the use of) others' works in references in their own journal articles and books. An entire industry was spawned to track, examine and interpret the citations of one author of another. In spite of many cautions as to how to interpret citations, there is still a great emphasis on the value of being cited (to be cited is to be valued), the more cites, the greater the value (Garfield, Malin, Small, 1978). Being a highly cited author is to be an author whose work is highly valued, and conferring that value on the author him/herself.

Value-in-use: user statements

If not using user behavior to assess value, a logical option is to ask the user(s) directly. Library users can be asked if they value this service or that, if they use it, want more or less of it, and so on. Through interviews, focus groups and surveys, the researcher can find value through user statements. If we accept that the human valuer is a key element in value, this method is a reasonable method to follow. As libraries are often under pressure to justify the funding spent on them, paying close attention to what library users value, and presenting a clear picture of the library as a value in and to a community can be of critical importance (Griffiths et al., 2004).

Abels, Cogdill & Zach (2002) used a series of semi-structured interviews with twelve library directors and institutional administrators, a review of the literature and a focus group of health sciences administrators to develop a preliminary taxonomy. The taxonomy organizes the library and information services (LIS) contributions around the organizational mission and goals, which include clinical care, management of operations, education, research and innovation and service. The authors developed a set of 15 LIS contributions that detail the value of library and information services. Each of the 15 contributions fall within the larger organizational goals of

> providing excellent clinical care, promoting clinical learning, making sound management decisions, increasing profitability, meeting accreditation standards, reducing corporate risk, providing an organizational learning environment, fostering satisfaction among current staff, fostering institutional attractiveness, providing excellent educational programs, providing resources and services necessary for teaching and learning, fostering research, adopt innovative technologies and practices, improving lives of patients and families, improving lives of community members. (p. 280)

The impetus in part was for hospital and academic health sciences centers' libraries – particularly hospital – to prove their worth to administrators and maintain their libraries' existence. The authors make the point early in the article that various regulatory agencies require access to information (the collections) but not to the services of a librarian or information professional.

Saracevic and Kantor (1997a, 1997b) interviewed 534 (usable 528) graduate students, faculty or professionals at 5 large undergraduate research libraries to create a derived taxonomy of value in using library and information services. The taxonomy is organized into three major classes and associated subclasses. The three major classes are reasons, interaction and results. The subclasses of each are: reason for a task, personal, obtaining object, information or performing an activity; interaction is with resources, use, operations and environment; results of using a library service to include cognitive, affective, accomplishments, expectations, time, money.

Value-in-use: improved decision making

One study that examined the impact of a library service of a database search – a literature search of the database MEDLINE – found that the results of the search had a positive impact on patient care. The study used the Critical Incident Technique (first used with soldiers in the military) (Flanagan, 1954) to obtain information on the usefulness of MEDLINE searches (either conducted by a physician or scientist or for them by a librarian) as affecting the physician or scientist's professional work. A total of 158 reports were analyzed and 552 telephone interviews were conducted. The authors found that the results of the MEDLINE searches had a positive impact on patient care, either confirming a decision on therapy or diagnosis or otherwise having an impact on treatment of patients; and in other aspects of the profession (Lindberg et al., 1993).

Limits of value-in-use studies

As libraries generally do not sell products and therefore are not markedly successful in employing the value-in-exchange model, the value-in-use concept addresses much of the activity that libraries do. Consequently, libraries often use the currency of statistics to convey their value: number of users visiting the library, number of hits to the library web site, questions answered, books checked out, classes attended.

Value-in-use studies focus on what can be counted or measured through use; a little used book or journal article that reveals an insight to a library user might not be valued as highly in a value-in-use study. Value-in-use studies may focus on what is popular or known to be heavily used, creating an unintended bias.

Gap in the literature and identifying the research question

While there are studies of value-in-use or value-in-exchange for libraries, the studies on the intrinsic value of libraries or librarians are more expert-opinion articles than methodologically sound research. Though it is possible to determine what library users value through use studies, it is not as clear what the intrinsic values of our users are; the innate, intrinsic values that would move, motivate and compel their actions and form the basis of their belief systems. As libraries are curators of knowledge-based information, the question of what the knowledge-creators value, and what they value in the knowledge-creation process is an essential one to ask and answer.

Literature on librarians' intrinsic, professional values

Neither value-in-use studies nor value-in-exchange studies examine values inherent to the user, the institution that curates the user's materials or the communication system that facilitates the knowledge sharing. It is not enough to discover what an individual or group of individuals is willing to pay (value-in-exchange) or use (value-in-use) of a library or scholarly communication system. Values that underpin and motivate behavior extend beyond that of the economic, and are more likely to be found in the realm of ethics and right behavior. These values can also be found in professions, and may be part of the definition of what it means to be a professional.

The studies that do exist are written by authors who describe their methodology as "consulting experts in the available literature." Gorman (2000) discussed the enduring nature of a shared set of beliefs amongst librarians. Based on his reading and examining of library philosophy, Gorman found that what is intrinsically valuable to librarians is: "stewardship, service, intellectual freedom, rationalism, literacy and learning, equity of access to recorded knowledge and information, privacy, democracy" (p. 26-27).

Similarly, Zachert (1978) reviewed the medical library literature of the *Medical Library and Historical Journal*, 1903-1907; and every fourth year of the *Bulletin of the Medical Library Association*, 1911-1977 to identify values, some universal and some specific to medical librarians: professionalism, cooperation, a sense of community with health sciences practitioners and knowledge orientation (Zachert, 1978). The purpose of these studies that list values is to get at the underlying structure (the intrinsic nature) of what is or has value in society and in library and information services. The creation of taxonomies has that same purpose (Saracevic & Kantor, 1997a, 1997b).

There is a suggestion that there are professional values and ethics that may inform decision-making or action (Gorman, 2000; Prpic, 1998; Zachert, 1978). The values of librarians are an example: where librarians hold values such as democracy, identification with health professionals, service and privacy (Gorman, 2000; Zachert, 1978), in relation to their work and profession, the services and products they create are embedded with these values. Where democracy is held as a professional value, for example, librarians would be expected to offer similar services and products for everyone; and people's accessing library services could be seen as a way to promote democracy, by fostering an educated citizenry. Other researchers indicate that intrinsic value may extend beyond ethics to the values associated with learning (Knorr-Cetina, 1982; McMullin, 1982; Rooney, 1992).

Absence of studies on epistemic values

Libraries have a multiplicity of approaches in valuing their services. Often libraries use statistics – particularly counting – to assess their value. Libraries count books shelved, books circulated, e-books or e-journals accessed or number of answers to questions given. Libraries can also examine what they are, try to come to an understanding of the essence of ‘library’ and use that understanding of their values to understand that value in the context of society. Librarians find value in their work of upholding society values – privacy, democracy; or in upholding the values of their users – identification with the group that one serves. In identifying with the group that the library profession serves, it is reasonable to ask what the values are of that group, or organization or field. Those values motivate and are embedded in the actions of those who hold them.

There appears to be a paucity of studies on scientists’ values. Professional values in science have been described as the values of objectivity, verifiability, logical rigor, systematism, precision and originality (Prpic, 1998). Though these values are present and stated in the literature, there are few empirical studies that explicate the derivation of these values.

Similarly, the concept of “social values” or norms, are less frequently studied, and where an author has written about them, they are often in descriptive studies, or stated as norms, preceding an empirical study of another sort (Merton, 1965, 1968/1973; Price, 1971). Social values are also not well enumerated; though appear to be more closely aligned with the concept of intrinsic values (the nature or characteristic of something). Prpic (1998) posits that social values are ones that “describe collegial relations,” with students, patients or study participants, with research sponsors, with work organizations and with the larger scientific social environment. Other concepts of social values refer more broadly to the characteristic of a “larger scientific social environment”, hewing more to an idea of scientists’ moral responsibilities to society (Bulger & Reiser, 1993; Reiser & Bulger, 1997).

While both sets of values – professional ethics and social values – touch on epistemology, neither set directly address the issue of epistemic values, as embedded in the nature of scientists’ work and manifested in scientific behavior. A holistic approach is important, where the scientist him or herself is engaged in the research process that seeks to understand his or her motivating values in producing scholarly publications. Epistemic values may best be discovered through learning from scientists how they know and how they communicate what they know.

Role of community in scientific knowledge creation

In reviewing the literature, it is apparent that scientific work takes place within a community. Communal work, though, does not preclude levels of status – credit given – within the group, field or specialty. There are often elites within the community, creating groups within groups, often without a leader but sharing common interests and linked through those interests and informal relationships (Kadushin, 1968). The elites can have a positive impact on the adoption or rate of adoption of new ideas within science. The founding of the *Transactions* is one such example (Weller, 2001); it was an influential group of scientists and philosophers who began the journal, creating a forum for the dissemination and discussion of their own ideas.

Another example is a study by Cole (1970), in which he analyzed papers published in *Physical Review* in 1963. He evaluated the dissemination of the ideas contained within *Physical Review,* using citations as a measure of diffusion. Cole looked at the number of citations each paper had received in 1966, then looked at the highly cited papers (the 15% cited 6 or more times in 1966) and found that if a scientist was highly cited right after initial publication, the scientist would also be highly cited later. Cole also looked at department rank, membership status in the American Physics Society, honorific awards and age of the scientist-author. Cole found that departmental rank did play a factor in citedness, concluding that while quality of the idea or article matters, if quality is equal, then departmental rank determines credit, acceptance and diffusion (J. R. Cole, 1970).

Having an elite position within the scientific community can also permit higher levels of productivity, as defined by quantity of publications (Knorr & Mittermeir, 1980) and a higher degree of connectivity to other elites and to the larger scientific community (Price, 1971). A component of elite status within scholarly communication is the visibility and awareness of a researcher or scientist to other researchers or scientists. “Being known” is another indicator of success, and thus valued within the scholarly community. S. Cole and J. R. Cole (1968) surveyed physicists at universities asking them to rate the visibility of each other as demonstrated through good work, reception of honorific awards and presence at high-prestige departments. Good work was described as highly cited work (not just a lot of publishing). According to Cole and Cole, “Papers not judged significant by fellow physicists, who therefore do not make use of them in their work, are functionally almost invisible” (1968, p. 400). To cite someone else’s work is to acknowledge the role another’s work had in advancing the field and allowing the existing body of knowledge to reach a state where the citing author can now build or expand on that previous work. Elite status within the scientific community though does not always translate to an elite status in another community. Shepherd and Goode found that elite scientists working and writing about marijuana, were not elite (visible) within the popular press and in turn to the public (Shepherd & Goode, 1977).

The juxtaposition of a community of equals and elites within community are played out in scholarly communication channels (Phenix, 1964). Where each idea is examined and reviewed on merit by one’s peers, the possibility remains open to all within the community that their ideas will be used or adopted by others; here “use” is valued and desired. Use of one’s idea is indicated by a citation to the idea as published in a journal. Research indicates though that the more well-known, major researchers in a field are more likely to cite one another’s work; success (being cited) begetting more success (more citations) (J. R. Cole, 1970). Cole states that science is stratified, "with skewed distributions of productivity and of rewards for outstanding performance" (J. R. Cole, 1970, p. 379). However skewed though, Cole also tells us that “progress in science depends upon the rate of discovery and the efficiency with which discoveries are evaluated, diffused, and incorporated into the body of scientific knowledge" (S. Cole, 1970, p. 286-287).

Role of collaboration in scientific knowledge creation

Scholarly communication is not only a dialog but a dialog within a group. Be it a specialty, cluster, research area, paradigm group, theory group or a school of thought (Chubin, 1985), communication through articles moves the group forward in their collective and individual thinking. Currently published research articles represent the "research frontier" in any given field (Garvey & Griffith, 1967). The group regulates itself and its communication through peer review and most often through publication in a peer-reviewed journal. Peer review is an assessment of an article's worthiness – the worthiness of the idea, research, and methodology within the article. Publication within a peer reviewed publication is a mark of success and worth or worthiness (Weller, 2001). Where there are elites amongst the science-authors, so too are there elites amongst the channels used to publish in: journals with the highest impact factors (degree of citedness) within a specialty, then within the larger field are of greater importance than a journal with lower impact factors (Garfield, 1987). Prestigious journals can attract larger number of submissions of articles for review and can command a larger reading audience for its published articles.

Research published in non peer reviewed reports or other documents are suspect within the research community for not having gone through the process (Lasker, 1998; Mattlage, 1999). Sometimes the initial rejection of an article to a high prestige journal will be followed by publication in a specialty journal with fewer markers of prestige and impact (eg, impact factor) (Ray, Berkwits, & Davidoff, 2000). Or, in other cases, rejected submissions to journals are subsequently not published elsewhere at all (Abby, Massey, Galandiuk, & Polk, 1994). One study examined abstracts presented at two national meetings of four scientific organizations to see if the abstracts were subsequently published in a peer-reviewed journal. The author found that only 36% of the 296 presented abstracts were later published in a peer-reviewed journal (R. L. Gorman & Oderda, 1990).

Role of connectivity in scientific knowledge creation

Scientists are linked or networked within their “closely knit organization” through their publications (Price, 1965); and where each scientist can and does act independently, the collaborative nature of science is evidenced through multiple authorship of journal articles (Price & Beaver, 1966).

Twinned with the eliteness that citedness offers is the concept of credit within scholarly communication. Authors cite one another to identify previously used methods or ideas expressed in the literature; direct the reader to other work, not easily found or forthcoming or as background reading; as an additional form of dialog with the reader in the form of criticizing or correcting one’s own or another’s work and to provide credit to the pioneers in a field and to one’s peers, conducting similar or related work (Smith, 1981). Citation is a form of communication and dialog with one’s peers, leaders and learners in a field, acknowledging their role(s) and furthering one’s own role in the process (Cohen, 1995).

The decision to assign credit occurs at various stages in the scholarly communication process: in the decision as to who is listed as an author on a paper and in what order, what work is mentioned or not in a paper, who presents the work at conferences and meetings and who takes leadership role should the work merit attention from prize committees or the media. Obtaining authorship is essential to being cited, thus acknowledged, recognized and is on the pathway toward success, perhaps even economic success (Mirowski, 2001).

So critical is credit that the allocation of it – or not – can devolve into controversy and scandal, reported not only within a peer group but also in the general media (Cohen, 1995). The allocation of credit for the 1993 Nobel Prize in physiology or medicine – limited by Nobel Prize Committee rules to three people only – to two people effectively denied credit to the many other researchers involved in the process and ultimately was the source of discussion and review not only in a peer-reviewed publication, *Science* but also in a daily newspaper (Cohen, 1995). *Science* described credit for individuals as the “coin of the realm”, even while extolling the “unwritten rules” of science:

> “Credit is to be shared appropriately; the findings of others – even from competing labs – are to be cited; students are to be treated generously; materials and data are to be shared freely. Somewhere, somehow, every scientist learns those largely unwritten rules.” (Cohen, 1995, p. 1706)

Hagstrom surveyed mathematicians, statisticians, physicists, chemists and biologists at U.S. universities. He asked the scientists if they had been "anticipated" or "scooped" by having their research problem (perhaps not yet completed) written about by another scientist; if another scientist had published within a shared field of research without acknowledging their work and if the scientists felt unsafe in discussing their current research problem with others. In each case at least a portion of the responses were "yes" - yes that they had been scooped; yes that someone had written about a problem without acknowledging other work in the field and "yes" that there was some danger in discussing their current research problem with others, especially if they thought they would be scooped by someone else (Hagstrom, 1974).

Credit – Latour and Woolgar's study

One study that presents a comprehensive picture of how scientists work, publish and interact with one another was the work of the anthropologist Bruno Latour and the sociologist Steve Woolgar. Latour spent two years in a laboratory at the Salk Institute in the early 1960s to study the culture of the scientist. Together with the sociologist Steve Woolgar, he published the seminal work, *Laboratory Life: the Construction of Scientific Facts*, a sociological, anthropological analysis of the work of scientists conducting bench research. Through interviews and observation, Latour depicted the daily life, work and motivations of scientists.

One of their findings was that much of "doing science" was about constructing – and publishing – scientific facts. In the fourteen photos of the laboratory, two are of literature: one of a desk strewn with journals and one of a secretary typing the lab's "product": a paper.

Much of scientific motivation, they found, was in obtaining credit, most often expressed in the form of published papers:

This instrument can bring me ten papers a year (II, 95).

[My] ability to find a job in research again will be increased in one year when the paper we are writing now will be published… but if I wait one more year after teaching, I will be definitely screwed up (VI, 73).

In response to a question as to why he chose science, one person answered:

I want a very rare commodity: recognition from peers…

(Latour & Woolgar, 1986)

Latour and Woolgar described the milieu that scientists created as one of a complex integrated economic environment. Best expressed in the words of the scientists themselves, in economic metaphors to describe why they did what they did -- that an investment in one direction could produce rewards and then lead to greater opportunities. That the scientists in this one lab talked about credit in four different ways: as a commodity that can be exchanged; as shareable; as open to theft; and as an entity that can be accumulated or wasted. But credit could not be, and was not, the sole motivating factor for scientists' work:

> References to credit can frequently be found, but it only assumes prominence in discussions of the past, or of group structure, or of issues of priority. Consequently, credit as reward cannot adequately account for the behaviour of a scientist practicing science. …. Credit as reward refers to the sharing of rewards and awards which symbolize peers' recognition of a past scientific achievement. Credibility on the other hand, concerns scientists' abilities actually to do science. (Latour & Woolgar, 1986)

Latour and Woolgar pose the cycle of credibility as within a marketplace: there is a demand for credible information to enhance one's own work and therefore one's own credibility. They suggest this metaphor because they think it important to explain not only why a scientist would produce data but why a scientist would be a consumer of another's data. Credit for one’s work ensures that one can be considered credible; and allow that credit to be converted in the "marketplace" for more -- money, prestige, promising areas to work in, and so forth.

Epistemic value in scholarly publication

The evidence from the literature appears to develop the construct that epistemic value in scholarly publication includes the dimensions of community, collaboration, connectivity and ability to award credit and produce credibility of science and scientists. The value of the system lies in its ability to promote visibility and awareness of the work and consequently the scientists who have done the work. In their anthropological work into the production of scholarly literature Latour and Woolgar describe humans seeking value through the production of credit.

The literature review thus far is similar to the work of Gorman and Zachert: it is an expert reading and analysis of the literature in an effort to discern the epistemic values of scientists.

While the literature review provides some insights it does not fully explore the relationships between the epistemic value concepts and is not clear if there are not other epistemic values or if the values so far identified are not in fact values at all. In reviewing the available methodologies of the quantitative-qualitative continuum that can be used, the qualitative approach offers the best fit for the research question: in developing a theoretical framework of the perceived epistemic values of community, collaboration, connectivity and credit as present in the scholarly research group.

Methodologies used in studying scientists' values

Methodologies used in examining scientists' values have also used a range of methods from quantitative studies making use of questionnaires in obtaining scientists' values (Prpic, 1998) and other studies that use expert reasoning and logic to determine scientists' values (McMullin, 1982; Rooney, 1992). There has not been an empirical study that examines scientists' values as expressed in scholarly communication, and not one that makes use of qualitative methods and interviews to provide a deeper understanding of epistemic values, as this dissertation will do.

The literature reviewed traced the significance of philosophy of science, its epistemology dominating much of the late 20th century thought behind what constituted empirical knowledge; explored the existing concepts of value, where the limits are in value studies within libraries and the methodological challenges in ascertaining the intrinsic values of librarians, scientists and scholarly communication. The literature presents the compelling importance of science and scientific epistemology, the embedded nature of values within libraries and science and demonstrates the paucity of empirical studies that could provide a theoretical framework for further understanding of the epistemic values of biological scientists within scholarly communication.

Chapter 3: Methods

Introduction

There is a distinct gap in the literature and in the identification and understanding of epistemic values of scientists as expressed in scholarly communication through empirical investigation. This is significant as scholarly communication is the pre-eminent, dominant means of communicating the methods and results of scientific experiments to other scientists. The values of knowing within this context are compelling: what is to be known, acknowledged as known, is communicated within the scholarly communication system.

Although there is a body of literature that addresses the value-in-use and value-in-exchange values of the scholarly literature, there is little that addresses the epistemic values of the authors of the scholarly literature: the scientific author. In selecting a method to explore the epistemic values of scientists, several options were explored. Quantitative methods result in data that can be generalized to the larger population. Whether conducted by survey, interviews, or through other data sets, quantitative methods employ statistical techniques to relate the research data set to a larger population. When a researcher has an existing construct or theory to test, quantitative methods are a successful means of validating the construct and testing the theory.

Qualitative methods – in a phrase that describes ethnography, “thick description” – provide the methods that can be used to discover and develop a theoretical framework or deeper understanding of a field through a detailed and systematic analysis of data.

Qualitative methods emphasize an insider's (the emic) point of view; using field research to describe a culture (Creswell, 1998). Quantitative methods build theory in another way, starting with a priori hypotheses and testing them against data. On the methodological continuum of quantitative to qualitative methodologies, the investigation of epistemic values is best explored using a qualitative approach, particularly as epistemic values within scholarly communication is an emerging area; and not at the hypothesis testing phase that is most appropriate for quantitative methods because it seeks to provide a richer understanding on which theory development can be based.

This study is unique in using a qualitative approach to identify the epistemic values of biological scientists by speaking directly with the scientists themselves.

Selection of qualitative approach as study method

In selecting an appropriate methodology to study the epistemic values of scientists, the qualitative approach, using semi-structured interviews to generate data and deepening an understanding of epistemic values (Creswell, 1998) was selected as the approach most suited to the research question of the epistemic values of biological scientists. A qualitative approach is most suited for deepening an understanding of a field or area, which is the subject of this dissertation. The understanding to be achieved would come from the data (Newman, 1998; Strauss & Corbin, 1998) and offers a methodological procedure – constant comparative approach to the data – that allows for rich detail and a saturation of categories of data (Glaser & Strauss, 1967; Creswell, 1998). The data in this study were the interviews of biological scientists, in which the questions asked in the interviews were focusing on the social processes of scholarly communication. The selection of the research question could come from any number of sources: from knowing something about the topic beforehand, from one's colleagues, friends or mentors; (Ely, 1991) or from questioning the "unquestioned assumptions in the literature" (King, Keohane, & Verba, 1994). For the purposes of this dissertation, the approach used was one in which assumptions were drawn from the literature and explored using semi-structured interviews of participants to deepen an understanding about the scholarly communication of biological scientists and the epistemic values that underpin the process and outcomes.

The literature on values – from philosophy, to library literature and scientific literature – proceed with untested assumptions that the group (philosophers, librarians, scientists) agree on the existence of values and of group values. When lists of values exist, (Gorman, 2000; Zachert, 1978), the lists are derived from expertise or from expert reading and analysis of the literature. It was through the literature, albeit with the untested assumptions of the existence and types of values, that the initial research question was formed. For the purposes of this study, the literature was used to develop an initial theoretical framework. Qualitative researchers suggest validating an initial theoretical framework through data collection (Newman, 1998).

A number of biases needed to be addressed in the study: the author's bias and the bias introduced by using the literature to develop the initial theoretical framework. The author's experience as a practicing health sciences librarian introduced both a bias and a strength; it was the strength of her experience that aided the purposes of the study, to obtain participants using an established professional network. For the purposes of this study, given its emphasis on scholarly communication, it was appropriate to use the published scholarly literature to frame the initial framework and interview guide.

Interviews – Justification

A qualitative study has a number of data collection techniques available to use: field observation, participant observation, focus groups and interviews (Berg, 2001; Lindlof, 1995). For this study, data were collected from interviews with biological scientists. Data were collected to the point of saturation (Creswell, 1998). Saturation occurred when phrases, concepts and stories began to be repeated from interviewed scientist to interviewed scientist; and when no additional new concepts or stories emerged. The data generated from the interviews – transcripts and notes – were micro-analyzed, first using open coding to compare the data and identify themes within them. After open coding, the data were analyzed again to locate relationships amongst the themes and contextualize the data. After axial coding, selective coding takes place, where the researcher identified a "story line" integrating themes and relationships (Creswell, 1998).

The weaknesses of using interviews are that they are structured, potentially not allowing for richness in detail, or for discovery outside of the pre-determined question set. Semi-structured interviews do not allow the researcher to permit the participant to direct or lead the conversation. The researcher does not follow the participant's inclination to lead the interview on unintended paths of conversation. An open conversation may be too open and not address points that the researcher wants covered. One strength in using interviews is that the researcher is ensured that most or all of the questions will be answered, and that the answers to those questions will cover the desired topics as will each subsequent interview, ensuring that the researcher has a similar set of rich transcripts to examine and analyze.

Other weaknesses were in not using multiple methods to confirm the data found. Other qualitative methods include participant observation and focus groups. Participant observation was not a viable option given the time available to the researcher. The author was able to draw on a rich participant observation study conducted by previous researchers, particularly the work of Latour and Woolgar (1986) in observing scientists within a lab and the production of published papers. The disadvantage of using focus groups as a methodology is that while they can elicit viewpoints from a group that may not emerge in an individual interview, the group viewpoint can eliminate the individual's view and not provide that same detail desired for this particular study (Krueger, 1994). In this study, the researcher entered the field with a research question in mind, as well as a set of interview questions (Figures 2 and 3) derived from the literature. The choice of what to study – what field to enter, so to speak – emerged from the literature itself. The researcher went "to the literature for source of questions and comparisons" (Newman, 1998). Asking questions in the interviews requires background knowledge (Krueger, 1994), and as the researcher lacked knowledge of an insider of the field, and the time available to undertake prolonged observation, the literature review served as a background builder. The task of writing for peer-reviewed publication may be ordinary, but the meaning and value system beneath the actions requires thoughtful reflection to bring the concepts to the surface (Stewart, 1998).

The focused questions on communication, collaboration, connectivity and credit that emerged from the literature served as a focal point in writing questions to ask the interviewees. These focused questions permitted a saturation of data that open-ended interview questions would not. The focused questions also ensured that the interviewer would meet the criteria of “know[ing] what areas need to be explored and see[ing] to it that this occurs” (Krueger, 1994).

This study uniquely employed both an emic and etic approach to framing the research question, developing interview questions and gathering data from interviews with scientists. The etic approach, which draws on literature derived categories, then analyzed qualitatively, allowed the study to pull in the rich resources of information science studies. In particular, the studies of sociologists of scientific literature and researchers who used bibliometric methods to define a subject domain, identify a community of scientists and describe how that community interacted with each other through the publication process are used to provide an initial understanding of the parameters of the field and the behaviors of scientists in scholarly publishing (White & McCain, 1998). The emic approach, drawing on meaning from statements that scientists made through one-on-one semi-structured interviews, allowed the participants in an active process – scholarly publication – to provide their own view on what they were doing, how the process worked and how they interacted with others in publication. A purely grounded theory approach would use only the emic – drawing only from the data produced by the participants in the process itself. While this method produces invaluable insights and understanding, this two-step and two-fold approach of drawing from the literature and validating through interviews strengthened the findings of each and gives greater confidence in the knowledge claims made.

Figure 2. Pilot Study Questions

Pilot Study Questions

What led up to the event of writing the paper?

> Did you consider communicating the results of your work in other ways? For example, through a web site or conference or talk? (Community, credit)

Who else was involved in writing the paper? (Community)

> How and Why? (Collaboration)
>
> How did you determine the order of authorship? (Community, credit)

Who is the paper written for (audience)? (Community)

How will you know if the paper has had an impact/reached your audience? (Connectivity, credit)

What would the best possible impact be? What would be the worst? (Credit)

Are there other ways that you could or would communicate your work to your intended audience (besides writing a paper)? (Other values)

Figure 3 Main Study Interview Questions

Main Study Interview Questions

Introduction:
I am a doctoral candidate at Rutgers, the State University of New Jersey, and this interview is part of my dissertation. I'm interviewing scientists such as yourself on what you value in scholarly publication. So I'm interested in what you think is of value in publishing your work. Or if publication – and here I'm talking specifically about peer-reviewed scholarly publication – is necessary or not.

1. My first question is about your work. Could you tell me about your research, the work you do? [Potential follow-up questions]:
   - What led you to this line of research?
   - How did you first learn the field?
   - What interests you about your field? (What keeps you interested?)
   - Can you successfully do research and not publish the results?

2. My next question is about publishing your work. If you would, recall a recent paper you wrote and had published. What led up to the writing of the paper?

3. Who else was involved in writing the paper? [Potential follow-up questions]:
   - Are there usually multiple people involved in writing a paper? Why?
   - Would you ever have a single-authored paper? Why?

4. How and why were they involved?

5. Who determined authorship and the order of authorship? [Potential follow-up questions]:
   - Who would usually determine authorship of a paper?
   - A senior person? The person whose idea it is?
   - Are there ever any issues about who is an author and who isn't?

6. Where did you publish the paper?

7. How did you decide where to publish?

Question justification

The interview questions combined the strength of the literature review, with the focusing technique of an event (the writing and publication of a peer-reviewed paper), to elicit the depth and richness of detail necessary in a qualitative study, and one in which the interviews are the data upon which the knowledge claims were based. The chronological approach (recall a recent paper), that expanded from the interviewee to his or her colleagues (other authors on the paper), extended college network (intended audience), and effects (impact of paper), allowed for a single event (the publication of the article), to encompass the entire field (potential readers of the article), by the end of the interview.

Modification introduced after the pilot study further strengthened the interviews: participants were encouraged to first share their research interests. Asking scientists to share their own research interests first created an interview environment that began on the scientists' own "turf" both physically and through the nature of the question, thus increasing the potential for comfort on the scientists' part. There were not changes in the subsequent questions other than to add additional follow-up questions that the interviewer might ask. These questions served as prompts when the scientists' responses were limited to the initial question. The additional follow-up questions also were created from the initial data obtained from the pilot study scientists. For example, the question asking about authoring a paper in the pilot study used a vaguely open-ended follow-up question, "how and why?" In the main study questions, the follow-up questions became more specific asking about multiple authors and why; and about single authored papers and why. Data gained from the pilot study indicated that there would be multiple authors and that questions about those authors would yield a rich answer; possibly an answer with one or two stories about the experience of multiple authors. Similarly, the single author papers were less likely to occur but the question was important to ask to underscore the usual practice of multiple authors and to confirm the scientists' viewpoint on single authors.

Selection of Participants for Study

Life scientists

The long-standing importance of the life sciences to humanity, coupled with the fast-moving changes in the field, made the selection of biological scientists as a group to study for their epistemic values a significant one. The rich publication history of biological scientists aids in the identification of the scientists' epistemic values. Biological scientists work in the fields of anatomy, physiology, biochemistry, biophysics, neurosciences and the biology of animals, plants and microorganisms; any aspect of the phenomena of life and vital processes (MeSH, 2008). As such, biological research is fundamental to the understanding of human life, from the single human genome to breaking the genetic code. Biological scientists have researched and published in the peer-reviewed literature for centuries, with a biological article appearing in the first volume of the first English language peer-reviewed journal, the *Philosophical Transactions of the Royal Society*: Some Anatomical Observations of Milk Found in Veins, Instead of Blood; And of Grass, Found in the Wind-Pipes of Some Animals Philosophical Transactions (1665-1678), Vol. 1. (1665 - 1666), pp. 100-101.

Reasons for selection

The extensive publication by biological scientists was one reason to select them as a group to be interviewed. And while the interviewed scientists came from a defined group (biological scientists), the wide range of fields within life science or biology, meant that it was unlikely that the group formed a predetermined community. The large number of scientists within the biological sciences and its fields and subfields and the amount of publications produced indicated that there would be a relative ease in accessing peer-review published, biological scientists and scheduling interviews.

Participant selection criteria

Three selection criteria were employed to select participants for the study: that they were actively engaged in research, currently having active grants either externally funded or have documented institutional funding as a principal investigator or named on a grant; have authored at least one peer-reviewed paper, and one of those peer-reviewed papers were written in the last year as identified in a bibliographic database such as MEDLINE, Web of Science (Science Citation Index), Scopus, Biological Abstracts, Chemical Abstracts.

The question of active engagement of research was confirmed during the course of the interview, authorship and currency of publications were determined by the researcher prior to the interview taking place. As participating scientists were obtained through a network of professional contacts, no attempt was made to obtain a representativeness of scientists by gender, age or field within the biological sciences.

Identification of potential participants.

The potential participants identified for both the pilot and main study were identified through non-probability sampling techniques. The biological scientists selected to be interviewed were obtained through asking health sciences librarian colleagues, and other professional acquaintances, including acquaintances of committee members, for introductions to biological scientists meeting the above criteria. The stated criteria of the study were given to colleagues when asking if they knew of anyone who would be eligible and willing to be interviewed. After obtaining the name and contact information of a scientist, it was confirmed that a scientist had published in a peer-reviewed journal in the past year by checking for the scientists' publications in a database such as PubMed or Biological Abstracts. Each scientist was then approached by email, with the subject line stating "X referred me to you," requesting an in-person interview at a time and location convenient to the scientist and outlining the time needed (an hour) and other requirements (that the interview be audio-taped).

Sampling

Occasionally an interviewed scientist would offer to connect the researcher to another scientist to interview, but ultimately, each interviewed scientist came through a referral from a professional colleague of the researcher. The benefit of this method of sampling was that it allowed for a wider range of types of scientists, and the researcher didn't end up interviewing everyone in a single laboratory, for example which might have led to interview data of similar viewpoints or at the least a naturally occurring community through default work location. The limitation of this method was that each scientist was known to librarians, and as such may have been more sensitized or aware of the issues of scholarly communication; certainly in one case, one of the scientists was quite reflective of the issues surrounding scholarly communication, bringing up Harold Varmus, the progenitor of the public access movement and former Director of the National Institutes of Health.

Participants

There were eleven male scientists and four female scientists from seven academic institutions in 3 states in the Northeast United States in both the pilot and main studies. Most of the interviewed scientists were the principal investigators or heads of a lab. In three cases, the scientists were not currently heads of labs.

Figure 4 Participant Scientists' Demographics

Scientist	Field	Gender	PI/Non-PI
Pilot scientist #1:	Neuroscience	Male	PI
Pilot scientist #2:	Obstetrics and Gynecology	Male	PI
Pilot scientist #3:	Pathology	Male	PI
Scientist #1:	HIV Vaccine	Male	PI
Scientist #2:	Lung injury	Male	PI
Scientist #3:	Systems Biology	Female	Non-PI
Scientist #4	Science of Aging	Male	PI
Scientist #5	Infectious disease (Lyme disease)	Male	PI
Scientist #6	Infectious disease	Female	PI
Scientist #7	Molecular Biology	Female	PI
Scientist #8	Cell-Cell Communication	Male	PI
Scientist #9	Infectious Disease	Male	Non-PI
Scientist #10	Neural and Behavioral Science	Male	Non-PI

Scientist	Field	Gender	PI/Non-PI
Scientist #11	Neuroscience	Female	PI
Scientist #12	Molecular and cellular neurobiology	Male	PI

Ethical Considerations and Informed Consent

The study was reviewed by the Institutional Review Board at Rutgers, the State University of New Jersey. Each participant agreed to the interview, signed an informed consent form and agreed to be audio-taped and their resulting transcript used for in data analysis and for the purposes of the dissertation. Each participant also had the opportunity to withdraw at any point.

Confidentiality

The participants' identities were held in confidence, with only the referring colleagues, research and committee members aware of who actually participated in the study. The interviews were transcribed by the researcher, one volunteer, and one paid transcriber. In both cases of the volunteer and paid transcriber, the tapes and notes of the transcriptions were returned to the researcher and no additional copies were kept. Several scientists indicated some misgivings prior to the interview that were addressed prior to the interview. The misgivings were not articulated, but seemingly resolved upon the researcher indicating the purpose and intent of the study. One scientist expressed a concern during interview, having had his/her work misrepresented or misquoted by a student reporter for a student newspaper. Once the researcher made it clear that no individual attribution would be made to interview quotes and that no individual names or identifying characteristics used, the scientists who had reservations were willing to proceed.

Pilot Study: Development of interview guide, Interview process and Revisions

Introduction

The interview guide was developed by listing all proposed epistemic values that applied to the study and then generating questions around those categories. With the exception of “throwaway” questions at the beginning of the interview, all questions asked pertained to the proposed epistemic values (Berg, 2001). The questions were based on the four epistemic values identified in the literature: community, connectivity, collaboration and credit (Latour and Woolgar, 1987; Polanyi, 1962). Additional questions were asked to explore any additional epistemic values that had not yet been identified in the literature or missed in initial readings.

The interview guide adapted the critical incident technique (Flanagan, 1954) in exploring the epistemic values of life scientists in the context of writing a peer-reviewed paper. The critical incident technique has been used in the library and information science field in assessing the value of information for physicians (Lindberg et al, 1993) and in evaluating a schools and libraries project (Radford, 2006). The critical incident technique invites participants to recall an event, describe it; and then describe what made it successful or unsuccessful (Radford, 2006). The critical incident technique offers a focused approach to the interview, where questions to participants are around a specific event. In this study, the “critical” event is the writing and publication of a peer-reviewed paper. The selection of paper writing and publication as a critical event presumes that while it may occur often and be a routine part of being a scientist – indeed, the essence of science – it also is a critical event in the fundamental development of a scientist’s career.

The possible weakness in using the critical incident technique is that paper publication may not be as critical as presumed and that focusing on paper publication as a single event may miss observations and data that a more open-ended technique would include. Given the fairly large scope of the dissertation on the epistemic values of scientists, the benefits of using a technique that focuses the interviewer and allows for coherent and cogent data collection are apparent in the use of the critical incident technique. This method does rely on the memory of the participants; the focus on a recently published paper was intended to address this potential weakness.

Pilot study method, process and revisions to main study

The interviews for the pilot study all took place in Fall 2006; two were within a week of each other, the third two months following. Interview questions can be found in Figure 2. The questions developed for the interviews incorporated the epistemic values identified in the literature as well as taking the participant through the chronology (the “critical incident”) of the publication of a paper. The time between the first two interviews and the third allowed for an initial analysis of the interview process, questions, question order and description of the study to the participants. Interview questions were expanded and specific follow-up questions were made part of the interview protocol. The question order remained the same but the additional initial question asking researchers to describe his/her work resulted in a much smoother start to the interview. Questions were answered in a more focused manner and at a greater length for the third interview than the first two. This change was attributed in part to sending the questions to the participant in advance of the interview and to the initial question asking about the researcher’s work.

Some hesitation on the part of the participants that had been made clear in the first two interviews was allayed by the process and question changes. Pilot scientist #1, lacking questions in advance or an initial question about his work and a clear understanding of the purpose of the interviews used part of the interview time to hypothesize as to the author's study:

Out of this you hope to glean some information to find out what other people are doing in relationship I guess with regard to um how they undertake their studies. I guess that's what you're --

The third interview, with Pilot Scientist #3, was more focused and comprehensive, and the answers were more in-depth than the first two producing richer data. The greater depth of the interview with Pilot Scientist #3 is a validation of the changes made to the interview process and questions. In the first interview, the scientist did not have the questions in advance, though the scientist did have a description of the study. The answers to the first question asked in the study – of both pilot scientist #1 and pilot scientist #3 – show the more direct and specific answer provided by pilot scientist #3 compared with the more general answer given by pilot scientist #1. The overall interview of pilot scientist #3 was more focused and to the point. The more focused answers held throughout the other interviews, indicating that sending the questions in advance was beneficial to producing richer and focused transcripts.

Figure 5 Change in questions between pilot scientist #1 and #3

Pilot Scientist #1	Pilot Scientist #3
Q: Ah, no, I tested it and it picks it up. Ok. I'm just get a pen. So, um, I'm ask about the last paper that you wrote or the last paper that you remember writing um, and what led up to writing the paper.	Q: Um, so my first question is, um if you recall the most recent paper you wrote and published and describe what led up to the writing of the paper.
A: Well, research results of a particular uh, subject – meaningful results – you can't really write a paper without having a result that is uh some advancement of science. Um, you do research in an orderly way and you have uh some ideas in mind.	A: Ok, this was a paper looking at tissue resected from patients who have received gamma knife radiosurgery for brain metastases and who require surgical excision of expanding masses in the site of the radiation therapy. And the idea of the paper was to see what these expanding masses were. Was it radiation-induced changes in the brain, which are well-documented or was it recurrent tumor, in other words a failure of the radiation to kill the tumor. This was a study of quite a number of cases. I can't remember the number now but it was something like 30 cases,

Pilot Scientist #1	Pilot Scientist #3
	um, studied over about a two-year period. Um, looking at the pathology with the radiation therapists' collaboration. It was their idea to begin with.

Interview process

The participants were contacted by email, with an explanation of the proposed interview, and the reason why they were contacted. The author's committee member's name was mentioned so that the participants were aware of how they were identified. Participation in the interview was voluntary. All participants who were contacted agreed to be interviewed, with only one interview not taking place due to scheduling difficulties. The interviews took place at the participants' offices or labs, at their convenience. There was a high degree of privacy and quiet for each interview, which was essential for a clear and usable audio recording. All interviews were conducted by the researcher who brought a tape recorder, notes and the list of questions to each interview. The second interview was shorter than the first because a technical difficulty resulted in no recording of it. The participant – scientist #2 – was visibly more comfortable and relaxed in the second (taped) interview. Though the interview was shorter, the answers were more focused and to the point, while still including anecdotes and stories as part of the answers, which provided rich detail in the transcripts and analysis.

Based on that experience, and some of the comments made by scientist #1, the interviewer modified the preparation and interview process for the third scientist. The author emailed the third scientist the list of questions a day in advance of the interview and spent more time at the beginning of the interview asking how scientist #3 began his research. Emailing the questions in advance allowed the scientist time to prepare if he or she wished to do so. Several scientists did look at the questions in advance with two reporting conversations with their spouses as to the questions, resulting in a reflective interview.

Interviews

Following the results of the pilot study, interviews were confirmed as the best method of obtaining in-depth data and reflection on the process of scholarly communication, and the best and worst impact of the process. As a method, interviews allowed data to emerge from a semi-structured conversation, rather than a more tightly controlled framework such as a survey. The interviews also permitted the participants to reflect and offer insights beyond the stated questions, and to clarify or re-direct questions as they chose. Semi-structured interviewing provides a general framework for the course of the conversation while still allowing the researcher to conduct follow-up questions and permit other viewpoints and opinions from the interviewed scientists to emerge.

Refining the Interview Process

The interviews and interview process were refined post the pilot study. Questions were emailed in advance of the interview in each case and additional questions were added to the beginning of the interview, asking scientists to describe their research and field. This change smoothed the interview process, allowing the scientists to start on familiar ground before moving into the questions about publication. The author also included a more detailed description of the proposed study. The description was similar to that of the description in the informed consent form but had the advantage of being sent prior to the interview beginning, when the scientists might have felt more obligated to continue with the interview. The researcher saw that participants were at times hesitant, at times trying to understand her research within the context of their research world (science):

Scientist #1: … In other words, ordinarily, you think of, in your study for example you have some hypothesis or some question you're trying to answer I guess it's the usual way. Maybe it's a bit looser [laughter] too.

Interviewer: It's a little different. I'm trying to get the data to be able to ask a question.

Scientist #1: Uhm, that's what you're doing now?

Interviewer: Yes.

Scientist #1: Right. Out of this you hope to glean some information to find out what other people are doing in relationship I guess with regard to um how they undertake their studies. I guess that's what you're. And then you're trying to go to other people and get some statistic which would [inaudible] some percentage are doing whatever.

The scientist saw research in the context of a hypothesis, finding relationships and getting a statistic. The scientist's viewpoint did not seemingly cause any problems in conducting the interview or in providing the answers. The viewpoint suggested the scientist had a strong orientation toward a quantitative approach in research as opposed to the qualitative approach the researcher was taking in this study.

The pilot study enabled the researcher to recalibrate her approach, providing a more detailed description of the research, including the main purpose, that of the values of scientists as expressed in scholarly communication, kept the scientists focused, and more relaxed during the interview. Informed Consent Forms and Pilot Study Questions are in Appendix A and Figure 2, respectively.

Revised interview guide

The three pilot study interviews in addition to the twelve structured interviews in the dissertation are within the recommended number of 15 – 20 interviews for qualitative studies (Creswell, 1998). With data collected for a total of fifteen interviews the proposed categories of community, collaboration, connectivity and credit were explored, while still allowing for additional categories to emerge (Creswell, 1998). Using a constant comparative process, (Glaser & Strauss, 1967) the researcher obtained data, analyzed the data and process until reaching a saturation point. The interviews offered participants an opportunity to reflect on topics that are “below the surface”; the substrate of the field (Bates, 1999) as it were; and on topics that are not likely to come up in the day to day.

Analysis and Developments during the Interview Process

The interviews, transcription and analysis took eighteen months to complete. The process involved obtaining the name of scientists, confirming that they met the criteria, introducing the researcher via email and arranging for an agreeable time and location for the interview. The length of time between interviews allowed for some initial transcribing and analysis, and review by colleagues. The interview process also confirmed when to press forward with questions and how best to be aware to follow-up with open-ended questions. The researcher grew in skill and confidence over time. Repetition of themes and even similar wording amongst the scientists, for example, “complete story” and “not just a pair of hands” led the researcher to have a degree of confidence in the data and in the interview process in identifying the data.

Interview length

The interviews were typically an hour in length, with the shortest interview at 40 minutes; and the longest at an hour and 45 minutes. Each scientist was interviewed in his or her lab; or in his or her office, often located near his or her lab. There were no other scientists or individuals present during the interview. The interview was followed with a thank you for the interview and contact information for the researcher (also provided on the informed consent form) for any additional questions.

The findings of the pilot study are presented in Appendix B.

Coding and Transcription

Each of the interviews was transcribed from a digital or tape recording. The transcripts were then moved into a table format. The table was divided into three columns with multiple rows. The first column held the text of the interview, with each question or answer in its own row; the second column and third columns contained separate codes of the data. Analysis occurred at the single question or single answer level.

The two types of coding employed were descriptive and thematic. The descriptive coding focused on providing brief meta phrases or words that described each line of the participants' responses. The attention to detail in descriptive coding ensured that the author did not merely identify and verify the expected findings of community, collaboration, connectivity and credit themes but that the fullness of the transcript was aptly and accurately described. That is not to say that the researcher ignored the four literature-identified themes but rather that in descriptive coding she was guided by the questions:

What is this [answer] saying?

Why?

How do the concepts of community, collaboration, connectivity, credit fit?

Each segment (answer to a question) of a transcript was coded first with detailed, descriptive coding and then a second review of the data determined broad concepts from the detailed concepts. The thematic codes were originally derived from the literature review but they were compared and confirmed against the descriptive coding to ensure confidence in the data. At this stage analysis also identified themes that were not from the literature but instead originated solely from the data.

For the first review of the data – the descriptive coding – aimed solely at pulling out the main concepts, without regard for the initial research questions; the guiding question in the analysis was, “What is this [fragment, sentence, paragraph] saying? The researcher assigned 2-3 words to describe what the segment meant. The researcher then derived broader concepts to the detailed concepts coding a segment. These codes were entered into the second column in a table. A sample line in a transcript table would have a segment of a scientist’s answer to a question, followed by a column with the detailed concept and next to that a column with the broader concepts. The third column of the broader concepts was used for coding that reflected both the units of meaning already assigned and the theoretical framework suggested by the literature review and the research questions. For the most part, single codes were applied, with subcodes added. For example, the code, “credit” might have the additional subcode of authorship applied, where credit is the code for that portion of the interview, and authorship is the type of credit received or given.

The results were written with a focus on the coding of the second column: the codes from the theoretical framework. Codes of collaboration, credit, connectivity and community were all used; in addition codes such as competition and controversy also emerged from the data, though were not originally suggested in the literature review. One of the goals of the pilot study was to develop a coding framework that could be reliably used in the data collection for the dissertation itself.

Development of the Coding Framework

Coding Principles.

The approach used in coding was one of constant comparison, where data were continually examined and re-examined; codes were then compared and refined (Charmaz, 2006; Miles & Huberman, 1994). The researcher's advisor reviewed the coding process in the early stages of data analysis and suggested framing questions for several levels of coding; to ask the questions "how does this relate to community, collaboration, connectivity, credit?

Descriptive coding.

The descriptive coding focused on themes, and creating detailed description (Geertz, 1973; Denzin 1989). The initial coding focused on answering the question, "What is the answer section about?" and summarizing the answer section in a succinct manner that captured the essence of the transcript section. Each individual scientist's interview transcript was first coded with a descriptive coding before any thematic coding took place. Figure 6 delineates the process of descriptive coding through generation of themes and knowledge claims.

Thematic coding.

Thematic coding was the second level of coding used. Thematic coding asked the question, “how does this relate to community, collaboration, connectivity, credit?” In identifying themes, the researcher examined both the descriptive coding and the chunk of transcript text with the descriptive coding.

Coding and Reductionism

Descriptive coding and thematic coding conducted on each transcript and all the scientists’ transcripts were compared against each other. The researcher repeatedly returned to the original transcripts, reducing the possibility that knowledge claims emerging from the analysis would be based solely on codes of codes. This continuous return to the original data avoided a reductionism of the data and ensured that analysis remained rooted in the original transcripts.

Figure 6 depicts the coding process and generation of knowledge statements from the transcript level, to confirmation of the knowledge statement by returning to the data (transcript). Scientist statements were examined at the level of an answered question, whether the answer was a fragment, sentence or paragraph. If the answer was lengthy, it was coded as the full answer level and then with multiple codes to address all of the aspects contained within the answer. Scientist statements were first described in broad concepts or at the meta level, answering the question, “what does this fragment/sentence/paragraph mean?” Detailed concepts become broad concepts and then broad concepts emerge into themes. In the example given in Figure 6, a scientist talks about the need to publish to have a job and to get grants and about publishing being a way to give back to the scientific community. The detailed concepts from the statement focus on publication as a source of job-acquisition and funding. The broad concepts emerging from that detailed statement was that publication was a kind of credit: credit for the actual publication that in turn could be used for jobs and grants. A knowledge statement taken from the broad concepts of that particular statement – and the statements of other scientists from the study – describes credit as leverage for jobs, funding or graduation. The scientists, identified by number, whose statements support the knowledge statement, are listed.

Figure 6 Coding Process and Knowledge Statement Generation

Scientist Statement	**Statement:** *A: No, if you don't publish you are not going to have a job. The expectation is at least a paper a year and yeah, if you don't publish…Two things: one, if you don't publish than you really have never given anything back to the scientific community because nobody can see your work if you don't publish it. So in a sense your research is a dead end if it doesn't get published. And two, you know, just self preservation. You have to publish to get grants. You have to publish to get a job. You have to publish to do anything. Scientist #6*
Detailed Concepts Derived from Scientist Statements	**Detailed Concepts:** Having a job requires publication; Expectation = paper a year; Publication is a way of giving back; Publication = 1.grants, 2.job, 3.anything
Broad Concepts Derived from Scientist Statements	**Broad Concepts:** Credit – through publication = 1.job, 2.grants, 3.anything 4.money; Community – standards in quantities of publications
Broad Concepts Developed into Themes	**Themes Derived from Broad Concepts:** Credit – what it does Credit – through publication – adds to competitiveness Credit – through publication – bestows credibility Credit – through publication = anything Credit – through publication = grants Credit – through publication = job Credit – through publication = money Scientist #6
Knowledge Statements Generated From Themes	**Knowledge Statements generated from Themes:** Category: Credit - what it does Statement: Credit is leverage, allowing a scientist to graduate, obtain a job and obtain funding.
Knowledge Statements Confirmed by Returning to Data and Scientist Statements	Scientists #1, #6, #7, #8, #10, #11 Credit is leverage, allowing a scientist to graduate, obtain a job and obtain funding. 6 (50%)

Lessons Learned

The pilot study methodology of individual interviews using a focused interview protocol with questions derived from the literature proved productive and workable. The pilot interviews also developed the researcher’s skill and confidence in conducting an interview. The pilot study also identified weaknesses in the interview protocol, allowing for the modification of the interview protocol, to improve its use in the larger dissertation study. Specific weaknesses were: lack of an introduction or explanatory portion of the interview to provide context and understanding for the participants and a lack of follow-up questions that the interviewer could draw on, if the initial question resulted in a brief or too brief answer. The interview protocol also now begins, after the introduction, with a question as to the participant’s work, allowing the participant to start with a question that is of a high comfort level. The introduction of the question about the participant’s work also led to a quicker rapport with the participant (it was introduced with pilot participant scientist #3), as well, the interviewer found the answers provided an interesting glimpse into the scientist’s world.

Limitations

There are a number of limitations inherent in this study. The sample size was relatively small with a total of fifteen participants (pilot and main study combined) and located through a non-probability sampling technique. The participants were primarily obtained through referral and the referrers were colleagues of the author; and those referrers were primarily librarians by occupation. This process of depending on librarian-colleagues to identify participants may have introduced bias into the sample, with the participants inherently more predisposed to the existing scholarly communication system, or more reflective and thoughtful in their responses due to their relationships with librarians. Though an effort was made to obtain participants from a variety of fields with the biological sciences, both male and female, and levels of seniority within science, it was not a deliberately random or stratified sample.

There were only minor problems in scheduling and interviewing scientists for the pilot study. One scientist, who split his time at two different locations, proved too difficult to schedule and so another scientist was selected and interviewed. There were technical difficulties in the second interview, with the microphone turned off for the bulk of the interview. The participant offered to be interviewed a second time, but understandably, the second interview was shorter than the first; and shorter than the other two interviews conducted for the pilot study. Of the 14 scientists approached to be interviewed for the main study, two said no. The two who said no were both women. This occurred early on in the interview timeline. Ultimately, four of the twelve interviewed scientists were women. Initially, the researcher had not thought that gender would be an issue, and that was borne out in examining the data, as the responses and transcripts of the women scientists were not remarkably different from that of the male scientists. None of the interview questions addressed gender, nor did any of the women scientists spontaneously remark upon the difficulty or ease of being a woman in science.

The interviewed scientists were obtained through a purposive process using a network of professional colleagues. The process was successful in gaining access to biological scientists and attaining an interview with them. The scientists were mostly senior in status within the scientific community, with several either working as principal investigators of a lab, or had been principal investigators and now were program directors or advisers. Only one scientist was clearly identified as a junior person, having only recently, at the time of the interview, obtained tenure at her institution.

Chapter 4: Analysis and Findings

Data Collection and Analysis

Data were collected to the point of saturation (Creswell, 1998; Weiss, 1994). The data generated from the interviews – transcripts and notes – were micro-analyzed, first using open coding to compare the data and identify themes within them. This first review of the data used descriptive coding, which required little interpretation but permitted the first selection of material and assigning of meaning to the interview data (Miles & Huberman, 1994). After the open or descriptive coding, the data were analyzed again to locate relationships amongst the themes and contextualize the data. This analysis developed a theoretical framework using the literature review and interview data to code the interview and descriptive codes at a more meaningful level. The codes also identified patterns within the data; and from the data in one interview to another (Creswell, 1998; Miles & Huberman, 1994).

The richness of data from a qualitative study is in the detailed responses of the participants to a set of focused but open-ended set of questions. The scientists who were interviewed provided thoughtful answers to the questions asked and to the follow-up questions. They in turn expressed an interest in the author's work and at points the interview became conversational in nature.

The data from the main study totaled 12 interview transcripts with an average of 28 pages each, with a low of 19 pages and a high of 47 pages. The analysis was conducted by the researcher without the use of software. The interview schedule is presented in Figure 7.

Figure 7 Interview Schedule

Scientist	Interview Date	Length of interview
Pilot scientist #1:	8/24/06	0:45 minutes
Pilot scientist #2:	9/1/06	0:32 minutes
Pilot scientist #3:	11/6/2006	0:26 minutes
Scientist #1:	1/16/2007	1:25 minutes
Scientist #2:	1/16/2007	1:00 hours
Scientist #3:	2/27/2007	1:19 hours
Scientist #4	3/28/2007	1:23 hours
Scientist #5	4/24/2007	0:47 minutes
Scientist #6	4/24/2007	0:23 minutes
Scientist #7	5/29/2007	0:34 minutes
Scientist #8	6/7/2007	0:55 minutes
Scientist #9	8/4/2007	1:03 hours
Scientist #10	8/28/07	0:48 minutes
Scientist #11	8/30/2007	0:55 minutes
Scientist #12	9/28/2007	0:50 minutes

The inductive approach in reviewing the transcripts to identify themes was informed by the literature review conducted prior to the interviews and the literature-identified themes of collaboration, connectivity, community and credit. The qualitative approach used in this study allowed for a focused approach both in asking questions and in reviewing the data for specific, previously identified value-themes. The potential limitation of this approach is that other themes that emerged in pilot or main study data would not be discovered or made visible in the main study. Knowing that this was a possibility, the data were reviewed a third time for the possible emergence of other themes.

The literature review provided a framework and an approach to deepen an understanding of epistemic values in biological scientists within scholarly communication. Analysis of data began with knowledge gained from the literature, but in selecting the techniques used to analyze the data, it was important to choose techniques that maximally made use of the transcript data, and that allowed for new concepts and values to emerge from the data; or disconfirm the proposed values.

Findings

In presenting the findings, the chapter will confirm, disconfirm and/or validate the conceptual framework proposed at the start of the study. The conceptual framework proposed identified epistemic values in scholarly communication of community, collaboration, connectivity and credit. The findings will also identify relationships within the data, relationships between and among the epistemic values.

For this study, scholarly communication is operationalized as: publication of articles in subject specialty journals subject to peer review. The purpose of scholarly communication is to inform other scholars of theories, results of experiments, compilations of literature reviews, opinions or suggest corrections, commentary or refutations of others' work. Scholarly communication is a process, producing a product for and by scientists.

In this research study, scholarly communication serves as the lens through which the researcher can see the epistemic values of scientific knowledge communication. Scholarly communication – publication of peer-reviewed journal articles – is common to all of science and while individual experiments may be markedly different and trying to find some common elements to the experiments could be difficult (as they may require different equipment, skill sets, numbers of people), articles written for journals are similar in their structure and presentation. Journal articles are a record of scientific work and scientific experiments and there is evidence of widespread participation in the scholarly communication process of authors, editors and peer reviewers, not to mention readers.

Statement of knowledge claims

Knowledge claims made in the presentation of the findings arise from the interview data. Knowledge claims are statements supported by the evidence in the data; they reflect a synthesis of the data. The number and percentage of scientists whose statements evidence the knowledge claim are listed below the knowledge claim. Each of the scientists did not make statements that supported every knowledge claim. Unless otherwise noted, if a knowledge claim did not have 100% of scientists' supporting the claim through evidence from the interviews, the non-supporting scientists' were silent on the topic, neither agreeing nor disagreeing. All of the knowledge claims and sub-claims can be found below, with number and percentage of scientists' statements validating the claims.

Figure 8 Knowledge Claims Validated by Number of Scientists and Percentage

Knowledge claim or sub-claim	Number of scientists' validating statements	Percentage of scientists' validating statements
Scholarly communication transmits and manifests scientific knowledge.	8	67%
Scholarly communication tells a complete but open-ended story that advances science.	5	42%
Scholarly communication is about transmitting discovery to a knowledgeable audience.	8	67%
The peer-reviewed articles produced in the scholarly communication process are products.	9	75%
Training provides a process framework for perpetuating the scientific community.	6	50%

Knowledge claim or sub-claim	Number of scientists' validating statements	Percentage of scientists' validating statements
Scholarly communication seeks to achieve a positive outcome or impact of publication on humanity.	8	67%
In scholarly communication publications attest, in part, to the credibility and capability of an author.	8	67%
Community is comprised of roles within the context of being an author: deciders of authorship, senior people/people in charge, authors, junior people, gatekeepers, colleagues, technicians.	12	100%
Community roles determine order of authorship.	12	100%
First authorship signals the most (major) responsibility for the work conducted and then written about in the paper.	6	50%
Senior authorship is the last author in a list of authors on a publication.	10	83%
Middle authorship is any author listed in the middle of a list of authors on a publication.	4	33%
People ineligible for authorship are community members who do not make an intellectual contribution to the scholarly paper.	4	33%
Knowledge of the scientific literature demonstrates one's	7	58%

Knowledge claim or sub-claim	Number of scientists' validating statements	Percentage of scientists' validating statements
capability in conducting scientific work and one's credibility as a scientist.		
Community is organized through relationships within a lab or larger scientific group, defined by subject area, field of work or methodology.	7	58%
Participating in and recognizing peer review is a task and responsibility of scientific community.	8	67%
Collaboration is work accomplished through relationships.	8	67%
Collaboration requires data, ideas, resources, expertise, and relationships.	6	50%
Collaboration is enabled by scientists' expertise, trustworthiness and approachability.	6	50%
The purpose of collaboration is authorship and publication.	5	42%
Contribution is the criteria of authorship.	6	50%
Contribution is either or both data and ideas that lead to publication.	6	50%
Credit is being published (becoming an author) and being referenced (cited).	10	83%

Knowledge claim or sub-claim	Number of scientists' validating statements	Percentage of scientists' validating statements
Credit brings tangible rewards.	10	83%
There are two primary and polarizing types of credit, "best" and "worst"; best credit is recognition of good work; worst credit is recognition of bad or fraudulent work.	8	67%
The best credit is to be recognized for one's work, either through citation or through new or additional funding.	8	67%
The worst or bad credit is for a paper to be published with a fatal flaw or mistake in it.	3	25%
Competition is a key element in scholarly communication.	6	50%
Competition arises when there is disagreement or controversy over becoming an author or the order of authorship.	9	75%
Community members can make a choice not to compete or choose a non-competitive area in which to work.	2	17%

Discussion of claims within scholarly communication

The epistemology of scholarly communication that emerges from the data is suggestive of a highly organized publication process, tightly connected socially, with communally agreed-upon standards and rewards. The scholarly communication process describes the way that science is known but the values in knowing – the epistemic values – are elucidated in the interviewed scientists' collected statements supporting values of community, collaboration, contribution, competition and credit.

An initial analysis confirmed the presence of the epistemic values of community, credit and collaboration. The literature-identified epistemic value of connectivity was not as clearly identified in the interview data. New themes and possible epistemic values of competition and contribution, however, did emerge.

The scientist represented him/herself in relation to a community of scientists, with roles, responsibilities, and standards. The scientists' representation of how the community conducted itself in scholarly publication was through publication standards, the following of rules or conventions and acknowledgement that violation of the rules did take place. The community of scientists competed within the community to achieve roles (author, principal investigator) and to receive the reward (credit for publication) offered by the community. The interviewed scientists were each directly asked about the process and benefits of publishing a paper so was expected that the data were rich in information about scholarly communication.

Knowledge Claims about Scholarly Communication.

This section is a series of knowledge claims about scholarly communication and epistemic values with evidence to support the claim. The purpose of the study is to identify epistemic values within scholarly communication. Though the main focus of the findings is on the epistemic values, knowledge claims about scholarly communication and its relationships to values were present in the data and set the stage for an understanding of epistemic values.

Knowledge claim: Scholarly communication transmits and manifests scientific knowledge.

Scholarly communication is the 'how,' the process of how scientific knowledge is made known to other scientists.

Number of scientists whose statements validate all or part of the claim: 8 (67%)

Evidence from the interviews.

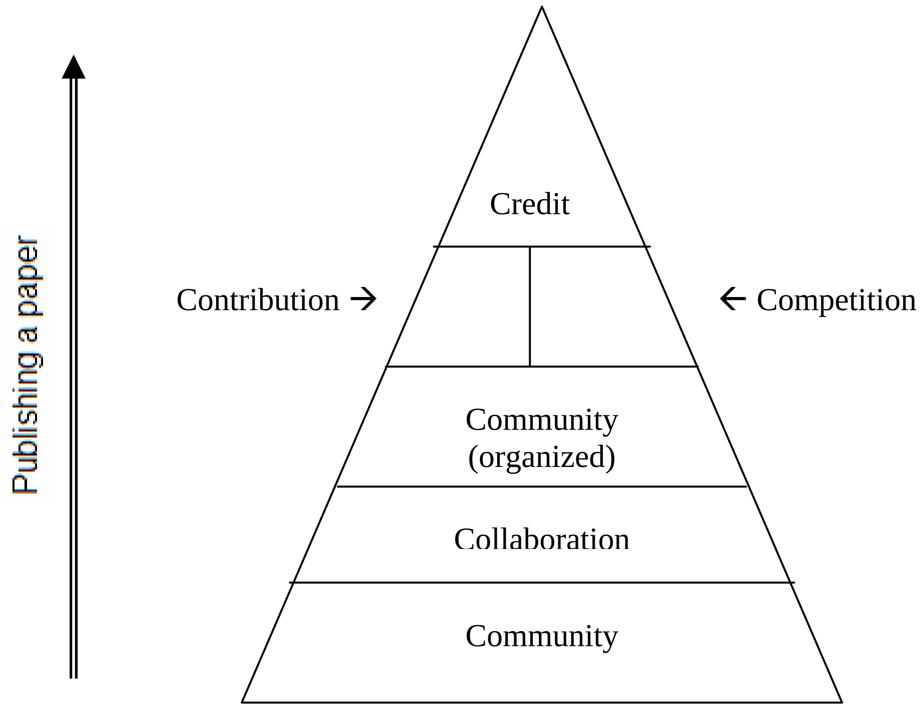
Eight of the interviewed scientists supported the claim of that scholarly communication transmits and manifests scientific knowledge. Five of the twelve scientists explicitly stated the essential nature of publication to science and to the scientific community. One scientist referred to the publication of an article as "our product" in science; the product of knowledge. Articles manifest science; or to put it another way, science hasn't occurred until it is known by others. A scientist publishes to produce and disseminate knowledge; and to share knowledge with the larger community.

if you don't disseminate knowledge than it is almost if you have not generated the knowledge in the first place. So you have to disseminate the knowledge and in our field that is by publication Scientist #12 if you don’t publish than you really have never given anything back to the scientific community because nobody can see your work if you don’t publish it. So in a sense your research is a dead end if it doesn’t get published. Scientist #6

Figure 9 represents the epistemic values drawn from the interview transcript data as expressed in scholarly communication. Though not an epistemic value, perhaps better characterized as a process value, the scientific community has an imperative to publish. Publication is a process, a culmination, a product, a manifestation of science complete.

The scientific community has an imperative to publish, and meets that imperative by publishing, by training its members in how to publish, in establishing scientists’ credibility by publishing, and in affirming scientists’ expertise and capability through their knowledge of the scientific literature. The epistemic values of contribution, community (order), and competition form the activities of publication, the social organization of publication and the community in disagreement, respectively. The epistemic value that caps scholarly communication is credit. Credit is the epistemic value that manifests the scientific experiment and work that culminates in a publication. Credit is the visible epistemic value of scholarly communication: its underlying themes are that of community, collaboration, competition and contribution.

Figure 9 Epistemic Values of Scholarly Communication



Knowledge sub-claim: Scholarly communication tells a complete but open-ended story that advances science.

Scholarly communication is publication of peer-reviewed journal articles (primarily journal articles). One aspect of the nature of scholarly communication is that it is story-telling: not just the recitation of facts but the presentation of data as a story that advances science.

Number of scientists whose statements validate all or part of the claim: 5 (42%)

Evidence from the interviews

Scientific knowledge has both form and content before it enters the published form of an article. The form referred to by three of the twelve scientists was a “complete story”, a story that has sufficient data to advance science. The story document discovery, an experiment or a step in the scientific process. The story must be complete enough that another scientist can use that knowledge in his or her work. The evidence also indicate a larger more continuous story taking place, where there’s a “complete story for each project” but still a larger story that must regularly be advanced.

I tend to wait a little longer and to have a more complete story for each project. Scientist #8

So you try to publish as soon as logical. You don’t want to sit on anything any longer than you have to. … So you always want to do something that’s going to advance the story so you can publish it. Scientist #6

So it is really very bad not to publish but I mean I see publication as a completion of the work. You don’t - people don’t know about it, it is not done. It has to be published. Scientist #7

So when, when we do experiments, we try to do an experiment that will tell a story or answer a question. Scientist #10

So they're like "you know that data you have." -- I would have sat on and collected other kinds of data and made like a mega-paper and they're like "no, don't make a mega-paper, just make a paper." And I'm "okay". Because you know its tenure time so it's like okay, all right. So I'll just -- because it's a finding. You know, it's not as much or as thorough as I'd like it to cover all bases, but people can use it. Scientist #3

Of the interviewed scientists, one indicated that some findings were not publishable, and that much good information existed outside of the scholarly communication system. After making that statement the scientist then qualified the statement, indicating that s/he might not publish a finding, because “people will not be interested”:

Where the immigrant populations are taking the vaccines, where they're not taking it and because you have an outbreak of measles there, then you tie the vaccination to that group. You might never want to publish that. You know, because, and it would have an impact, because the health of the population would be better or worse. And people will not be interested. Scientist # 5

This statement, though expressed in the negative, appears to confirm the claim of that story-telling is part of advancing science and that its “telling” takes place within the scholarly communication system for the benefit of others who can use the information.

Knowledge sub-claim: Scholarly communication is about transmitting discovery to a knowledgeable audience.

Scholarly communication is about transmitting discovery of new and novel findings.

Number of scientists whose statements validate all or part of the claim: 8 (67%)

Evidence from the interviews

The content of the article should have an element of novelty to it; science is about discovering and then telling that story of discovery. Seven of the twelve scientists talked about discovery as something they liked and something they wanted to achieve in their work.

So that will be the two things you want: new and unexpected. Um, and that's very, very rare. Most of us will never do that. Scientist #1

I like the discovering something new that no one has seen before. Scientist #6

You ask new questions that lead to new answers that lead to new methods and you sort of let the work pull you. Scientist #7

And I think what I liked about it was the sense of discovery.   Scientist #8 it's that excitement of discovery I think that's in science whether it's medical history or virology. Scientist #9

So as much as I may be able to make discoveries and say that patient care ought to be altered in this way or that way, nobody's going to pay for that. Scientist #10

Knowledge sub-claim: The peer-reviewed articles produced in the scholarly communication process are products of discovery.

The evidence of scholarly communication is a publication, most often a journal article. The article is a type of product within the scholarly community.

Number of scientists whose statements validate all or part of the claim: 9 (75%)

Evidence from the interviews

One scientist referred to publications as academic "currency". Similar to the concept of a "product" in science, "currency" translates the product into a type of monetary instrument that can be used to obtain things in the scientific world. The published scientific articles are the representation of a completed experiment; standing in for the experiment in a published format. The publication is evidence of completed work (productivity). Publications – most often articles – are the tangible evidence that scientific work has taken place. Publications are important for getting jobs, keeping a job, being allowed to work on the kind of projects you want to work on and getting funding.

Because if you don’t publish then you would not be in the job much longer. Scientist #12

No, if you don’t publish you are not going to have a job. The expectation is at least a paper a year …Scientist #6

…if they leave the lab, but they have to be acknowledged for what they've done. And the currency of academics is publications, and most of these people go off to some other academic job, and it wouldn't be right not to acknowledge what they did for you during their training. Scientist #2

… they need to publish. At some point up until your mid-to later career when you apply for jobs or get reviewed for tenure when they look at your publications among many other things they look at your authorship. Scientist #8

You have to publish to have the money, to be able to have the supplies to be able to do the continued work. Scientist #7

They -- it's like an entomological society of Europe wanted somebody to go to Europe, but actually it's going to be held in Turkey, and she was like. And she thought you know maybe she should tell them to have me instead because I'm the entomologist, not her. Scientist #3 [invitation to present, after publishing a paper]

The need to publish can be driven by tenure, or the desire not to be "scooped" by another scientist. So you had to wait till the print journal came out before you could categorically say, "Oh shoot, we've been scooped." And the value of your data then just crashed, right. So you can't submit it to any of the high-profile journals. You're looking at mid-tier and below because it's not new anymore. Scientist #1

I mean, I have a number of publications but they just want me to have a lot more. Even though I think it would be enough for tenure, but they're sort of like more more more more. Scientist #3

The idea that publications are products of the scientific community makes a connection with the proposed epistemic value of credit. Credit is received for being an author of a paper or for being cited by another author. The credit received, then, is credit for the scientific product. The introduction of the concept of "currency" though indicates that a publication can also serve as an instrument, a means to an end. If one is in possession of multiple publications (it will be later argued that possession of publications is attainable through authorship only), one presumably has greater authority than someone with fewer publications. The manner in which the scientists explicitly and implicitly refer to publications as currency indicates that the publications have many of the characteristics of actual (monetary) currency: a scientist cannot get a job without publications (buy a position); or get more money (grants) to conduct more experiments (venture capital).

Knowledge sub-claim: Training provides a process framework for perpetuating the scientific community.

Scholarly communication is an active process requiring new members to be trained in the process; and demanding of existing members that they participate in a mentoring role to perpetuate the activity of scholarly communication. The scholarly communication process of training new members of the community is part of the maintenance of the system itself and adds to its sustainability and longevity.

Number of scientists whose statements validate all or part of the claim: 6 (50%)

Evidence from the interviews

Part of the process of publication for a scientist is in knowing when to publish. More senior scientists advise junior scientists who signal their assent and agreement with the community in accepting and acting on that advice.

"You'd better publish or perish." And I'm like "okay." Scientist #3

"no, don't make a mega-paper, just make a paper." And I'm "okay." Scientist #3 what I have observed is that from the very day they walk in to their graduate program at least in the life sciences, the expectation is they're going to do a dissertation. It's going to be original research, and that is the big hurdle that they have to overcome to do that dissertation. And they know that when they walk in the door, and they start thinking about it and they seek out people who are going to help them figure this issue out. Scientist #2

And, you know, one of the first things you learn as a student is the rules, getting back to rhetoric. What kind of evidence do you have to have before you make a certain kind of claim? Scientist #4

But we have courses in the graduate school where, and as program director, I remind them that it’s important that they discuss authorships. They should expect to be first author on at least one of their papers and, and, they should have discussions about that. Scientist #10

So we train students. We have training programs for students. Those are less well-developed for post-docs and – much more ambiguous career period. Um, though by and large again you would feel very uncomfortable having the post-doc leaving the lab with no first author papers would be a very poor outcome for that individual. Scientist #1

Knowledge sub-claim: Scholarly communication seeks to achieve a positive outcome or impact of publication on humanity.

Scholarly communication has an intermediate endpoint of producing a publication (usually a journal article). The outcome, though, of publication – and an endpoint in the scholarly communication process – is to achieve an impact or outcome with that publication. Positive impacts named were curing a disease, opening up a new field of study, having a great insight or at the least, not doing harm.

Number of scientists whose statements validate all or part of the claim: 8 (67%)

Evidence from the interviews

Beyond the immediate need to share knowledge with others in the scientific community, the outcomes of publication are to have a positive impact on humanity. The goal of a positive impact is a goal that is something of a "stretch," that is it may not "happen that often" or it is in fact "groundbreaking" but it is what the community agrees should be aimed for, should be achieved.

You want to cure that disease or give that insight that nobody had before. I don't think it happens that often, but it should be your goal. Scientist #2

you want to provide a way of looking at a problem in a way that no one else has thought of in a way that is groundbreaking.   Scientist #2

Best possible impact for me probably would be if it was such a ground-breaking area that it opened up an entire area of grant funding. (Laughs) Scientist #6

That is the absolute best. There is no more than that you are in the international news for your discovery. Scientist #12

Well the best possible impact would be if you make a finding that affects human health. Scientist #1

There are papers that give people the Nobel prize so that's you know, I guess can't be better than that. Scientist #8

this is just a personal opinion I think for me the best possible impact is that people react one way or another to what I've written Scientist #9

Uh, that the paper's cited widely. Um, so as an example, not that paper but some other things, so there there are – some recent textbooks where, I think we counted, five or six of our figures within the papers are in those textbooks. Scientist #10

Knowledge sub-claim: In scholarly communication publications attest, in part, to the credibility and capability of an author.

In scholarly communication, the publication of a peer-reviewed article signals credibility and capability of an author. The author takes responsibility for the work within the publication.

Number of scientists whose statements validate all or part of the claim: 6 (50%)

Evidence from the interviews

Publishing, in any case, is part of a scientist's credibility. Part of what makes a scientist a scientist. The sooner you publish, and the more often, with a "complete story," the greater your scientific credibility.

Knowing you need to publish to actually have any credibility. Scientist #6

And without that credibility, it is more difficult for a scientist to acquire the funding to do the work that he or she wants to do. A scientist proves his or her capability in conducting experiments by having publications that demonstrate that he or she did the experiments. A scientist proves his or her knowledge as an "expert" by being an author on publications in a particular area. And that particular area can be quite particular.

One scientist commented that, "You might have 50 papers on brain slices and nothing on whole animal research and you're proposing to do whole animals and so you don't have any idea how to do whole animal research. So those 50 don't count. Um, in terms of demonstrating that you're qualified." Scientist #11

And you need your name on the papers when you're writing grants so people know you're capable of doing certain kinds of experiments. Scientist #11

you establish a few publications in your area and that makes it a little easier to become credible as an expert. Scientist #1

But we have courses in the graduate school where, and as program director, I remind them that it's important that they discuss authorships. They should expect to be first author on at least one of their papers and, and, they should have discussions about that. And one of the reasons why I do that, sort of, start the idea in their heads is I don't want there to be too many cases where multiple students end up doing small bits of work and appearing on one paper where you can't really tell which student did what.

It's important for a thesis project that the students can say even in their thesis if they can't do it on a paper but somewhere, "I did this."

And so, if if they're used to just working all the time together, you know, I, I, get the brain slice out, and you make the recording and you analyze the data then nobody really did anything start to finish and it's a bad training experience.

So as program director, I've tried to discourage that by prompting students and say, "Look, you should be able to do everything yourself in a project,"

And make sure you discuss authorship because it's reasonable for you to be first and it's a way of getting them to understand that they're not part of a factory assembly line, they're supposed to be doing something from beginning to end, so –

Scientist #10

One scientist described the reasons scientists publish quite simply in terms of survival: “publish or perish” for younger scientists and as a means of “staying connected with the cutting edge of thought” for older scientists.

almost everybody in science is part of a community and they do publish and the reason people publish is multiple. For younger people, it's cause they'll perish if they don't publish for older people I think it is in part because they want to stay connected with the cutting edge of thought. Scientist #9

Scholarly communication is a formal process in which scientific knowledge is communicated to other scientists. Publication is essential to scientists, to continue their work, and to give back to the larger scientific community. Statements from the interviewed scientists provide evidence to the knowledge statement and the importance of publication to science. The knowledge sub-claim – about transmitting discovery to a knowledgeable audience – complements the knowledge claim about publications telling a story to scientists. The interviewed scientists referred to publication as telling a story; or publishing when s/he had a story to tell. Their discussion of a story did not include any statements as to what might comprise the story. The idea of discovering something new provides scientists with something to tell (a story) through publication in a scholarly journal.

There is something elemental about story-telling. Stories have a beginning, middle and an end; an arch. Stories have the ability to convey multiple points in an integrated manner, not just offering a series of facts. Publication of scientific work occurs when a ‘story’ is ready to be told. Scientists are relaying stories to each other through publication and, as such, the published story must be able to advance a larger story. The interviewed scientists indicated that a story is publishable when it’s complete or has reached a logical point. The scientists were not clear about what constituted a ‘story;’ given the evidence from the data, the researcher interpreted their statements about stories to mean a publication that has a robust hypothesis, sufficient data to affirm or deny the hypothesis, and discussion of the data with an indication of what next steps to take to advance science. The advancement of science is the ongoing story; there is the continuous story of science punctuated by the smaller stories of individual scientists or scientific groups contributing to the whole.

There is an emotional aspect to discovery – “excitement,” “a sense” – conveyed by the scientists describing novelty needed for publication. Achieving both the ‘new’ and the ‘unexpected’ is rare but desirable.

Epistemic values: community, collaboration, competition, contribution, credit

Though the research study took an open-ended approach in asking scientists about writing and publishing an article, the initial literature review shaped an understanding of the process. The literature review found that scientists published within and for a scientific community, did so in collaboration with other members of the community, thereby connecting one to each other. The process of community connected and collaborating together to produce a publication that results in credit for those involved.

These elements were identified as epistemic values within the scholarly publication system.

Epistemic Value: Community

The purpose of the research study is to confirm or disconfirm the presence of literature-identified epistemic values in scholarly communication. The interview data did confirm that community is an epistemic value in scholarly communication. Community was first identified in the literature, with specific references to a “scientific community” and that scientists within a particular field referenced each other’s work, indicating some familiarity and acknowledgement of each other.

The epistemic value of community arising from the interview data is indicative of how scholarly communication takes place and the knowledge values embedded within that process. The first knowledge claim arising from the data shapes community within organized relationships.

Knowledge claim: Community is comprised of roles within the context of being an author: deciders of authorship, senior people/people in charge, authors, junior people, gatekeepers, colleagues, technicians. These roles establish explicit and implicit rules related to authorship.

Number of scientists whose statements validate all or part of the claim: 12 (100%)

Community is well-defined and organized through roles for community members within the context of authorship. The roles are not exclusive and can overlap, with a senior author also serving as a reviewer or a decider of authorship order. The roles are both hierarchical: senior to junior; and task-based: authors, reviewers, decision-makers. The community roles revolve around the criteria needed to become an author and to determine authorship. If you are not yet an author, you are in training to become an author (scientist) and if you are not in training to become a scientist – an independent producer of knowledge – then you're not part of the publishing scientific community.

Evidence from the interviews

The community roles – revolving as they are around scholarly communication – also connect with the epistemic value of collaboration. These same roles of junior and senior; authors and decision-makers of authors, come into play when collaborating to achieve a successful scientific experiment. The roles are spoken of matter-of-factly, and appear not to be particularly questioned. The hierarchy in publication and science also emerges here, with bosses making decisions, junior community members needing training or transitioning from being in training to becoming an independent researcher.

So the way it works in academic publications as you probably know is, you know, you've got a first author, which is the person who actually did the work and then you got a senior author, who is usually the person who may be thought of the project, originally and runs the lab, that's me and then you've got usually several people in between, who helped the project along in one way or other. Scientist #4 you take the view that a post-doc is more of a grown-up, scientifically. And so if they sink or swim, one may feel less responsible for that. Scientist #1

so junior faculty do need help trying to figure this out. And what I usually do is I let them go through the process of send it to wherever you want and then they find out how difficult it is and the questions that come back from the reviewer's, sometimes, you know they would have to do a whole new set of experiments or whatever that would be very difficult for them to do to qualify it for whatever journal they thought they would send it to in the first place and they get a pretty good idea about how difficult it is to get into one of these really high impact journals. And then you get down to the journals that most of us publish in and it's a question of rank ordering. Scientist #2

And they gave like this whole talk of how do you figure out which journal. Because like I had this microscopy paper, and I'm not a microscopist so it's like where do I put this technique paper. Scientist #3

And so many times you write a paper or the papers under review, they're so badly written that you antagonize the reviewers. You know, no one wants to read something that is incoherent, with bad figures, you know that there is no relationship between the text and the figures or the text and the tables. It's just a waste of time, you understand what I mean? Scientist #5

And that’s because I consider myself the boss. Um, I’m the one paying the bills. I’m the one who would have hired the student or hired the fellow. But that’s really as far as it goes. When my colleagues, my peers are involved then it gets a little trickier, okay? So um, I have a colleague who is slightly higher in terms of seniority than I am and we sort of work together on projects and we’ll discuss whether or it’s more of a computational project or more of a biological project that we’re writing up. And if it’s more biological that means I by default had more to say about how the experiments went and I’ll be senior author. If it’s the other way around, he’ll be senior author. Scientist #10

But he's a full-time administrator he doesn't really have much time to publish completely on his own. He has to have people to help him do it. And so uh, I'm interested in doing those things. I like to do the research. I don't mind writing and you know, whatever. So it was like a win-win situation. He said we need to get this done I said this is a great thing I'd like to do so it worked out. So that was one of those things where in essence he knew my interests and skills but he decided what needed to be done and I said yes I can do it. Scientist #9

Knowledge sub-claim: Community roles determine order of authorship.

Number of scientists whose statements validate all or part of the claim: 12 (100%)

The order of authorship is related to the roles held in community. Order of authorship refers to first, middle and last authors. The distinction of first, second, third, fourth is not significant; order primarily refers to first, middle, last. The order of authorship signals a relationship to a community role manifested in the scholarly publication.

Evidence from the interviews

The order of authorship is explicitly stated for new members of the community so they understand the roles they play and in what order they can expect to be authors on a paper. These roles and authorship order are referred to as rules. The importance of first author is carefully laid out and the conditions required to obtain it are also explained. Author order reflects one's role in a hierarchical community, whether it's going from junior to senior. Junior members of the community do not have the ability to determine author order or even ability to determine who is an author or not. Junior community members follow rules set by senior members, in particular by the principal investigator or head of the lab.

What I do when somebody comes in to my lab I sit down and talk to them about authorship. And I tell them that the rule in my lab is any paper, if you write the first draft, you will be the first author. Scientist #11

So the way it works in academic publications as you probably know is, you know, you've got a first author, which is the person who actually did the work and then you got a senior author, who is usually the person who may be thought of the project, originally and runs the lab, that's me and then you've got usually several people in between, who helped the project along in one way or other. Scientist #4

The principal investigator, that last author is usually the critical person in making this determination. There are guidelines, but it is really that last author who makes that determination. They might ask the first author if they think, you know, this person belongs on it or vice-versa and get opinions but the final say goes to the last author. Scientist #6

Knowledge sub-claim: First authorship signals the most (major) responsibility for the work conducted and then written about in the paper.

Number of scientists whose statements validate all or part of the claim: 6 (50%)

First author is a position on a paper that signals that the person has done the most work associated with that paper. While an entire lab may have been involved in the experimental work that led to the writing of the paper, the first author is the one who has completed the most work, who takes the most responsibility for the figures, the text, and the details within the paper. The story told in that paper is the story of the work of the first author.

Evidence from the interviews

The first author is most commonly characterized as the author who did the most work. “The most work” might be further specified as “did most of the work, physically, experimentally” or “has done the bulk of the work within the lab”. Alternately, the first author was described as the one who writes the first draft.

you've got a first author, which is the person who actually did the work Scientist #4

The person that did most of the work, physically, experimentally, would be the first author. Scientist #12

it's supposed to be the person who does the most work first Scientist #3

Who put the most work into it with the first author being critical Scientist #6

And that’s that’s really where it’s at if you’re a student or a post-doc, first authorships count, second authorships are nice but they’re icing on the cake. If you don’t have first author papers, you don’t have any of value to you if you’ve already got first author stuff. Scientist #1

And I believe a person who does the work, who does the most physical work on the paper deserves to be the first author. Especially if they are involved in the writing also. Scientist #7

Knowledge sub-claim: Senior authorship is the last author in a list of authors on a publication.

Number of scientists whose statements validate all or part of the claim: 10 (83%)

The last author is a position on a paper signaling that the author is responsible for the scientific work on which the paper is based, and most likely is the principal investigator of the project or is in charge of the lab. He or she is in a senior position relative to the first author.

Evidence from the interviews

The last author is the person who is the “head of the lab” or in “whose lab most of the work was done”. The senior author is also the person who “thought of the project” or “initiated the work”.

you got a senior author, who is usually the person who may be thought of the project, originally and runs the lab, Scientist #4

Usually because the last author in my field is usually the lab where the work was done. Scientist #6

And traditionally in our field the sequence of authors is that the PI, who initiated the work and whose lab most of the work was done, is typically the last author. Scientist #12 and the last person is a head of the lab   Scientist #3

And so ideally you want to have a lot of first authorships but it tends to be in a big lab the last author is the guy who runs the show he's the conductor of the orchestra, he's probably not doing the work. He's a professor who sort of you know keeps the whole operation running. He's not on the cutting edge of the science. He's sort of the wise elder, who manages the research, in an indirect way very much like an orchestra conductor who waves the baton but doesn't play the instruments. Scientist #8

Last author usually means that you’re the senior person it’s essentially your research focus that’s being addressed in one way or another with the experiments and the paper. Scientist #10

Knowledge sub-claim: Middle authorship is any author listed in the middle of a list of authors on a publication.

Middle authorship is every other author who is not first or last. There can be one middle author or hundreds. The positions of 2 or 222 are each similar: they are in the middle. The middle author(s) have contributed data or ideas to a paper but not the most (position reserved for the first author) and are not the leader (position reserved for the last author).

Number of scientists whose statements validate all or part of the claim: 4 (33%)

Evidence from the interviews

The data did not suggest any additional differentiation after establishing the significance of first or last author. The middle authors are described as “several people in between” or “intermediate people” but not described any further.

you've got usually several people in between, who helped the project along in one way or other. Scientist #4

and then the intermediate people are you know, like the closest to the first did the second most work. Scientist #3

second author the next critical, third, fourth, fifth so the more people you get the more it dilutes out the people in the middle. So if you get a three author paper that middle person may have been very significant. If you get a six author paper and the fifth person is probably not too significant. Scientist #6

So, almost any place that will evaluate you based on your track record, will value most highly a sole author paper, secondly they’ll value first author paper, thirdly and sometimes equivalently, they’ll value senior author paper, where you’re last and finally you’re stuck somewhere in the middle of a group, that has the least value. Scientist #10

Knowledge sub-claim: People ineligible for authorship are community members who do not make an intellectual contribution to the scholarly paper.

Number of scientists whose statements validate all or part of the claim: 4 (33%)

Four of the twelve scientists commented specifically on the role of a technician as an author. Three indicated that hard work alone was not a qualifier for the role of author within the community.

A technician may conduct scientific work but is unlikely to make an intellectual contribution to the paper.

Evidence from the interviews

There are also technicians, who, while they may occupy a role in the scientific community at large, within the context of a scientific community that publishes (authors), their role as an author is sometimes ambiguous. A technician is sometimes referred to as "just a pair of hands"; lacking the critical intellectual contribution as well as that of hard work that can earn authorship within the community.

So sometimes somebody doing a technician job if they have only been a pair of hands, they would not be an author in it. Scientist #6

Because if you're just like you now pipetting something for somebody or whatever, that's not really an authorship. You have to at some level contributed in theory some kind of intellectually important contribution not just a pair of hands. Scientist #4

So a person whose only contribution is their hands and they don't contribute in any substantive way, I acknowledge their work. Scientist #11

This sentiment was not universally shared by all of the scientists. One scientist indicated that data contribution alone might be enough to earn authorship but acknowledged that the decision would be made by the senior person, the lab where the work is being conducted:

So technicians in most labs, they don't contribute ideas. Now they would do some you know experiments. But again, in my opinion, if this technician contribute data, that's used in this paper he or she should be an author. But again -

Q: It depends

A: Yeah, this again, this depends on which lab. Scientist #8

Knowledge sub-claim: Knowledge of the scientific literature demonstrates one's capability in conducting scientific work and one's credibility as a scientist.

Number of scientists whose statements validate all or part of the claim: 7 (58%)

Seven of the twelve scientists described the importance of being knowledgeable about the community's work and demonstrating that knowledge. Knowledge of the scientific literature is seen as integral to a scientist's credibility and capability.

One role in the scientific community is that of author; a little mentioned role is that of reader. The role of reader is signified through citing others in one's own work. A citation is a way of indicating that one has read the article and found it significant in one's own work.

Evidence from the interviews

The professional scientific community expects its members to acknowledge the work of others in the community: It would have to be blatant for them not to reference it [the paper]. Scientist #11. Failure to cite can mean that you've pissed people off or really ticked them off, Scientist #1 Evoking annoyance in failing to cite can have repercussions on one's own ability to publish:

So if you write an article and you cite the wrong person, the person who didn't make the original observation and you cite for example, you could cite their arch rival and deadly enemy. And you really ticked them off, you know. So you not only don't cite them, you cite the person they hate most in the world. Um, and they happen to be reviewing your paper you can hear it meeting the shredder. Scientist #1

Knowing what is being written and published allows a scientist and others working in the same field to further their own work.

You will know if somebody working in your area thought that what you did was useful because they will build on it. Scientist #2

Yeah, because they'll ask me and I have to send them the reprint and then some people will be like, "oh, if I tried this technique will you help me?" Or something like that. You know if somebody's really interested, because they contacted you to get reprints so you know that they're going to read it. It's not like you walked up to somebody and you coerce them into taking one of your papers. Scientist #3

You know, if the people -- this just got published so like in a few years I'll know if people caught on because they'll cite the paper. And maybe extend our observations or something like that. Scientist #4

First is that people confirm your results and second that they use them to do something else. Scientist #5

One is you personally hear from colleagues. That they may send you an email and say, 'hey – this was good. Can I have this [unintelligible] that you described, I want to do this with it?' You exchange material because you publish it. Or at a meeting you hear, 'I read your paper and I want to talk about it with you.' Scientist #12

Knowledge claim: Community is organized through relationships within a lab or larger scientific group, defined by subject area, field of work or methodology.

Number of scientists whose statements validate all or part of the claim: 7 (58%)

Community is an organized group of scientists bound by either work relationships, subject area relationships or relationships around methodologies.

Evidence from the interviews

Seven of the twelve biological scientists referred to a community in which they worked, whether it was a single lab, or a larger group, defined by subject area, field of work or chosen methodology within the context of publishing an article. The pronoun "we" was frequently used – when I say "I" you have to understand it's really "we" because I always work with a group. Scientist #11 – and the interviewed scientists referred to colleagues, students, post-docs, and other labs. Scientists are aware of the size and potentially the names of the other scientists who are working in their field – it's a large community and also for people working in bacteria. And for that reason, you go and read the literature on Borrelia you have to read all the microbial literature. Scientist #5

cutting-edge science is done by large teams of people now Scientist #9 for example, one of the most recent papers published yesterday involved several international teams. This was to map several genetic diseases to find out ok, where in the chromosome. Scientist #8

And I’m one of the only people in the world who have done that because my lab was a multidisciplinary lab. So we did anatomy, behavior, electrophysiology, molecular biology and biochemistry. Which is very unusual – you don’t find usually a lab that where everything is done. Now today, that’s less true. But at the time, it was very true.

Scientist #11

Some people go on a sabbatical then mid-career. Take a year off or half a year, learn something new – but at the same time they have a running lab. So it’s not that they are starting from total scratch. They are not giving everything up, firing everybody (laughs). Once you have a lab with people working in the lab, then you can switch directions. Scientist #12

Knowledge claim: Participating in and recognizing peer review is a task and responsibility of scientific community.

Number of scientists whose statements validate all or part of the claim: 8 (67%)

Peer review is examination of one's work by one's colleagues, meaning fellow experts in the reviewed article's subject area or methodology.

Evidence from the interviews

Peer review is a review by one's colleagues (fellow experts on one's work) of one's work before it can be shared with the larger community in publication in a journal. The scientists made statements about peer review in relationship to their own work but also made statements about the overall role of peer review in science and publication. most scientists regard the peer review process as absolutely, fundamentally essential to moving forward in science Scientist #4

I think most people in in the basic sciences would require some form of peer review. Scientist #10

Peer review benefits the paper - I think it helps because somebody usually reads your things thinks of ways to like you know improve it Scientist #3 – even though it adds pressure to the publication process:

Yeah, the pressure, again, the pressure in this case may be a good thing although no one wants that. The benefit of pressure is that it forces you to think about ideas, do some good work, publish. Scientist #8

The peer review paper knows that somebody's gone over it and looked at it carefully. Scientist #7

Peer review is dependent on community members assenting to the process, and submitting not just the article to a journal for publication, but submitting to the critique of other scientists: They said, you know, 'this is a very important work and this and that, and it's nice, but it would be good to have this, and did you show that? And we said, 'okay, well, alright.' Scientist #7

Scientists also agree on the standards of what constitutes peer-reviewed literature. A poster, for example, is not considered of a high enough standard for a faculty member.

Q: So posters don't count as being published?

A: No, not in a meaningful sense. Maybe for a student, but not for a faculty member. Scientist #1

The community rewards scientists for participating in the peer review process, with the ability to move up to higher levels of credibility and authority within the community: I need reviews for getting full professor Scientist #3

While peer review can be tough on individual scientists' emotions: a mean editor's letter, Scientist #7, or evoke a defensive response:

"Are you saying I didn't do anything right to begin with?" Scientist #3

The emphasis is on informing the article author and submitter of a different way to approach or improve his or her work: "did anybody think of just looking this way?" Scientist #3.

You know, it's very sad when they say, "the paper is unfocused." You know, "the papers leaves out too many details", "the figures are no good" Scientist #5

Summary

Scholarly communication occurs within a community, and for the scientific community, one which is highly organized, with assigned roles, responsibilities and order. The knowledge claims and sub-claims about the epistemic value of community emerged from the data with established criteria for the order of authorship and its importance to a scientist-author and the role of the community in producing and reviewing each other's work.

The knowledge claim about community and authorship described an environment of different roles and relationships in relation to a publication. The concept of authorship figured greatly in the interviews. This is not unexpected, as the questions were focused on what led up to the writing of a publication. Often, the scientists shared stories that illustrated their points: stories of authorship that did not meet community standards – gratuitous authorship, unearned authorship; or stories of obligations met to community members (obligations of a senior member of a junior member) in aiding them in obtaining authorship on a publication that allowed them to move on to the next stage of their career.

Community roles of senior, junior, student, post-doc, peer-reviewer, colleague, technician, are all expressed in terms of authorship. The author decision makers are usually senior people who have the power to decide authorship and order of authorship within their lab and sometimes beyond it. There are junior people, such as post-docs and students who work in a lab. Junior people are eligible to become authors, but they do not decide authorship. There are gatekeepers (usually reviewers and these people too can be senior people or decision makers; the role is not mutually exclusive) and there are colleagues with whom a scientist collaborates.

The senior/junior, author/decision maker roles in the publishing scientific community are expressed as being known and understood by all, and are defined in distinct ways with the first author contributing the most to the paper or the one who actually writes the paper; and the last author is the one who is the principal investigator or head of the lab. Ten of the twelve interviewed scientists referred to the role of decision maker or senior person or person in charge of a lab when discussing publication. All the authors in the middle have contributed to some degree but their significance is not delineated (no particular sense that second author is more significant than the third, and so on); they are just “middle.” This hierarchy of author roles is indicated as a commonly known practice: “the way it works.”

The hierarchy of roles lent itself to a specific order that determined authorship. The interviewed scientists’ community observed an order of authorship. The order of authorship is significant as it signals roles within the community. First author indicates that he or she has done the most work in association with that paper; the last author indicates that he or she is in charge of the lab or is the principal investigator of that project. Only one of the interviewed scientists clarified what “most work” meant: And I believe a person who does the work, who does the most physical work on the paper deserves to be the first author. Especially if they are involved in the writing also. Scientist #7 Here, “work” did not indicate the work of writing the paper but the “physical work” of the experiments that led to the writing of the paper. Another scientist commented that to determine authorship the scientist, … would count figures. Who made the most figures? While the data - Every figure is data. Scientist #8

The most significant author is the first author; the placement of first author indicates that this author has the most responsibility for the work conducted in the paper. First authorship signifies to the community that the first author was responsible for the work conducted in the paper. The “work” is the experimental or lab work that led up to the writing of the paper. The publication of the paper, with the scientist as first author indicates that he or she is capable of doing the work and should be credited with the discovery or knowledge generated within the paper. Unless the first author is the head of a lab, or principal investigator, his or her first authorship was determined not by his or her own choosing – as in “I think I’ll write up this experiment and I’m the first author.” First author is determined by the head of a lab and usually according to pre-set rules of the lab. These pre-set rules are in line with widely held community rules, though a head of a lab will determine the exact way in which rules are followed in his or her own lab.

Senior authorship indicates the author who takes responsibility for the first author. Senior author is the last author on the paper and placement there signifies where the work is originating from – from that author’s lab and under that author’s direction. The last author position is more senior to the junior position of first author, but by taking this position, the last author relinquishes the premier position of first author. The last author indicates that he or she has decided the order of authorship and then places him or herself last, as the senior most person. It is a position with authority but without the benefit of claiming complete ownership of the discovery or new knowledge within the paper. The discovery or new knowledge belongs to the first author.

The middle authors – be there one or many – are listed as second, third and so on in the order of authorship. Though they are responsible for some or all of the work conducted for the publication, their position indicates that they did not contribute the most (first author), nor are they responsible for the direction of the work (last author). Once the first and last authors have been established, the middle authors do not carry the same import. The order of middle authorship is not significant, except to indicate that middle authors are not significant.

There are some participants in the publication process, conducting scientific experiments that lead to publication who are not ranked as community members in terms of eligibility for authorship. The roles used by the community – junior, senior; author, author decider – become unclear when it comes to technicians, who while junior and work under supervision of a lab head or principal investigator, are not likely to be named as authors on a paper. It is possible here that the difference is that a junior person (not a technician) is being educated and trained by the community to become a senior person, to become an author decider. In that context, there is no role for someone who does not aspire or has not been put in the educational track of becoming a lab head or principal investigator.

Where a community defines its members' roles through authorship, it defines itself by subject area, field of work or methodology. Working in science is a communal process, as is reading and writing about science. Reading is communal in that a scientist reads about his or her own field, reads to see that his or her work is cited by others, and reads to understand where to take the next step in his or her research. Writing science takes a community to accomplish, because the writing of science reflects the group work that it took to conceive, implement and complete an experiment. A scientist is not only an individual, the work is conducted within a group; and to know about science is to read what has been written by the community and then to write about one's own work with the expectation that the community will read it.

Then when you publish something your manuscripts are going to be read not only by people working on Borrelia but also by the whole microbial community. Scientist #5

Within a community, there are behaviors and characteristics that define the production of scientific knowledge. Aspects of community included willingness to develop and sustain the community through work on behalf of each other in reviewing each others' work and providing training. The community also establishes a reward and recognition system, rewarding the work and accomplishments of individual scientists with authorship on a paper. The community also requires that its members know and share knowledge of each others' work. The added aspect of interpersonal skills can come into play here, with the interviewed scientists mentioning the need to get along with each other, or referencing incidents or individuals who would not get along with others.

One of the tasks of a community member is participating in the peer review process. The community develops and sustains itself through the peer review process. Peer review is a community-wide participative process. Membership in the scientific community equates to membership in a scholarly (publishing) community. Peer review is part of a process wherein one's colleagues assess one's work against community standards of quality of work, novelty of work and then makes that work available to the larger scientific community in a journal. Authors submit their work for review both in the actual sense of submission and in the sense of submitting to a process where the reviews received produce an emotional and defensive response. The option to take one's article out of play appears not to be considered. Toughening up one's response or understanding that reviewer's comments, whether one agrees with them or not, must be followed.

Another significant task for community members, and one that is a natural process for a community that defines itself hierarchically, and with senior members taking responsibility for junior ones. The telling of stories and the production of articles takes place within a community that educates its newest members on how to participate in the process. The community shares when it's appropriate to publish; what makes a story complete; when ideas and data become a contribution. Peer review also adds prestige and allows scientists to mentor junior colleagues.

Epistemic Value: Collaboration

Collaboration as an epistemic value was identified in the literature review. Collaboration connects to scholarly communication as part of the scientific infrastructure that produces publications.

Knowledge claim: Collaboration is work accomplished through relationships.

Number of scientists whose statements validate all or part of the claim: 8 (67%)

Collaborations are generally characterized by scientists with complementary sets of skills, expertise or materials working together on a scientific experiment to publish a paper.

Evidence from the interviews

The need for trustworthiness and approachability in collaborators means that sometimes friends are turned to as collaborators. If they can fulfill the requirement for expertise of some kind and bring to the collaboration needed materials or skills, then their inherent trustworthiness and approachability as friends can make them natural collaborators.

I'm going to try to get get some stuff so that I can do some collaborations with friends, but it’s always on the back burner as we do different things. Scientist #3

They like have all their friends write chapters in the book and I laugh because this one guy at a conference even said it. He goes, "it's one of those edited volumes -- so-and-so and friends." We all laughed because we know like when this guy does this edited volume he has all his friends write chapters or all his students. Scientist #3

So in our animal models we can we can generate seizures that cause death. And we can actually see the whole process. We have some cardiology friends and we do echocardiograms of these rats. Scientist #10

No, no as collaborators, you can have colleagues, you can have graduate students, you can have technicians, you can have postdoctoral trainees. You can have assistants. It's a full range of people who collaborate with you when you're doing research. Scientist #5

There's one now in which I'm a collaborator so I've had a long term, probably for the last 10 years collaboration with a guy at the … University in …. Scientist #2

I only work with high-level people. I also say -- as I often say to my, people in the laboratory to some extent I'm a noise generator. I generate lots of ideas. I throw out lots of things, and they have to use their own judgment about what is really a good thing to pursue. And that's where their individual contributions really come to the point. Scientist #4

There are work, for example, one of the most recent papers published yesterday involved several international teams. Scientist #8

and nowadays to do this kind of research you need a big lab with lots of people in the tendency nowadays is that nothing gets done by individuals it gets done by a team. You know a hundred years ago or more 125 years ago, Robert Cooke was one guy, who sat in one laboratory in his office in his home doing all this great stuff you know before there was the Cooke Institute. Nowadays that just doesn't happen. Nowadays you need big research funds, you need big labs, lots of people. You know the technology there's been an explosion in technology, not only machines, highly technical information -- if you're looking at a problem like flu you have to have a virologist and informatics person and a cell biologist and a biostatistician. Scientist #9

Knowledge sub-claim: Collaboration requires data, ideas, resources, expertise, and relationships.

Number of scientists whose statements validate all or part of the claim: 6 (50%)

Collaboration involves members of a scientific community but the catalyst that brings a collaboration into being is data, ideas, resources, expertise and relationships from community members.

Evidence from the interviews

Collaboration requires the work of others who complement an individual scientist’s expertise and skill set. A scientific collaboration might assemble a mathematician, a neuroscientist, a chemist and so forth; their expertise lends itself to a good combination for questions. Scientist #1 The specialization within science calls for multiple people and sometimes multiple labs to be involved in asking and answering scientific questions.

Collaboration is built around the work and is made manifest in publication. Science is accomplished through collaboration as it can take multiple labs and extensive resources to accomplish the work that’s needed to be done. The amount of data, resources needed, skills in conducting scientific experiments require teams rather than individuals.

Several of the scientists named specific skills or expertise required to successfully carry out an experiment:

if you're looking at a problem like flu you have to have a virologist and informatics person and a cell biologist and a biostatistician. Scientist #9

so it’s not always that hard to figure out, who might be a collaborator. … And that isn’t you know, you need as a neuroscientists, you need to persuade the mathematician that this is the problem they should work on, right and all the other problems aren’t as interesting as this thing [laughter] Scientist #1

So my interest in seizures, her interest in autonomic physiology – it took about ten years for me to appreciate the link between those two things but now it's blossomed and we're doing some interesting things. Scientist #10

Other scientists referred to the need to have materials that can be obtained only through collaboration, not through purchase. Access to samples, to patients, even to animals:

And we kind of share samples Scientist #2

And all that takes place in the rat model although I do have colleagues and my own access to data from patients in our epilepsy monitoring. Scientist #10

these fancy transgenic mice that you can't just buy you've got to like get from some Japanese collaborator Scientist #1

And I'm one of the only people in the world who have done that because my lab was a multidisciplinary lab. So we did anatomy, behavior, electrophysiology, molecular biology and biochemistry. Which is very unusual – you don't find usually a lab that where everything is done. Now today, that's less true. But at the time, it was very true. Scientist #11

That was three people. Other than me, it was a post doc who did most of the actual work, who was in my lab. And the person from [research center] who is at the Alzheimer's research center at [research center]. Scientist #12

Knowledge sub-claim: Collaboration is enabled by scientists' expertise, trustworthiness and approachability.

Number of scientists whose statements validate all or part of the claim: 6 (50%)

Collaborators must be credible to contribute to scientific work. Expertise, trustworthiness and approachability are each aspects of credibility. A scientist is dependent on his or her collaborators in working together, to achieve common goals.

Evidence from the interviews

The role of the expert in collaboration becomes apparent in the interview data. So, too, is the need for complementary skills; in some cases someone is hired within a department because of the differing skills they offer.

So we were trying to, you know get people who are expert. Scientist #3

the people that I work with are very highly accomplished people. Scientist #4

She hired me just to add a physiologist to the department. Scientist #10

We did that together with a person at the Alzheimer's disease research center at [research center]. It was a [hospital/research center] collaboration. Scientist #12

He is a molecular virologist but he doesn't know much about epidemiology and history and I'm an epidemiologist historian who doesn't know that much about molecular virology but we get together and it's just a perfect fit. Scientist #9

Trustworthiness in a collaborator allows the other scientists to know that no mistakes will be made in the work that they are doing together. Trustworthiness is an element in a scientist's credibility. Where scientists publish tells something about the scientists and their work. A more prestigious journal accords the authors recognition through the work and as capable of doing substantive work. Expertise alone is not enough in selecting a collaborator. The overall credibility also involves trust.

So that's where it really helps, if that happens, you have to have collaborators that you find approachable and that you trust. Scientist #1

You talk to people. You find out from the literature who is who. You want to go to somebody who has a track record of being a researcher. Scientist #12

If all their stuff is in the Estonian Journal of, you know, Applied Cave Implements, then probably they're not the partner you're looking for. Scientist #1

The way somebody determines that I'm capable of doing the research that I'm proposing is they look at my record of publishing other research results. And if I have a good record, then they feel that I'm qualified. If I don't have a good record, then they don't know and they're not willing to take a chance because somebody with a published record, um, they're more likely to take a chance on. Scientist #10

It's like references when you look for a job, if you don't have any, you're a questionable commodity. Scientist #10

The non-trustworthy collaborator can comprise an author's work and potentially career:

when you come around eventually to publication, you're also exposing your credibility, for example right if, if, God forbid, they're a cheat or a liar, you just got into a relationship with a cheat and a liar. Scientist #1

Knowledge claim: The purpose of collaboration is authorship and publication.

Number of scientists whose statements validate all or part of the claim: 5 (42%)

The purpose of collaboration is to conduct scientific work and obtain a publication and authorship. Collaboration is referred to in the context of what would be needed to collaborate and how the collaboration will result in a paper.

Evidence from the interviews

Collaboration is generally expected and if not required, at least “more likely” to occur than not. Collaboration has an added element of contribution, a proposed epistemic value derived from the data. “whoever’s made some kind of contribution” is eligible to be an author on a paper. Collaboration suggests that an element of work is involved and work that elevates itself to a certain level. Doing an analysis, working for someone, all appear to be criteria for collaborators to become authors.

There’s certainly things you can do that wouldn’t require collaboration but in general science is more likely to require collaboration. Scientist #1

And then like another paper, my advisor had asked me to analyze data sets for him. So I got on that paper, because I did the analysis. Scientist #3

And the people that work for him – or her - and do the work, have to have their names on the paper. Scientist #11

You may include collaborators, whoever's made some kind of contribution to what you're doing and then you send it out for publication. Scientist #2

Summary

Collaboration is an outgrowth of community. Collaboration is infrastructure through which community accomplishes its work. The knowledge claim made about collaboration within this section is that collaboration is work accomplished through relationships. These relationships are formed within the community; and a community that organizes itself around roles and responsibilities leading to publication. The knowledge sub-claims elaborate on how collaboration is defined, and what is needed to effect collaboration.

The data supported a series of knowledge claims about collaboration. That scientific work is accomplished through collaboration and that the collaboration required specific elements in order to take place. And that collaboration is supported by the capability and approachability of the scientists involved.

Collaborators work together around shared interests, even as they bring different skills and expertise. Collaborators bring different skills and experience to a collaboration. Scientist teams are multidisciplinary in approaching a scientific question. They are not all of one kind or type. The collaboration can require hard work and persuasion, as one scientist’s vision or question must engage another scientist to make the collaboration real.

Collaborators bring expertise and complementary skill sets to a collaboration but collaborators can also serve as a contact point for needed materials – data sets, animals, reagents. Scientists then depend on each other for the very stuff of which scientific experiments consist of.

A scientist’s expertise is assessed by his or her publication record. The journals in which he or she publishes in serve as markers of a scientist’s ability. A less reputable journal signals less reputable work. A published record is a sign of a scientist's ability to produce knowledge, to conduct scientific experiments.

In choosing one's collaborators, a scientist seeks out the expert in the field to work with. Being expert is necessary but not sufficient to collaboration, however. A collaborator also must be trustworthy and approachable. Especially when working with people in another field on a collaborative project, the scientist must be able to trust that the collaborator has the expertise to do the job. A scientist from one field must use markers to determine the expertise of a scientist from another field.

The selection of a collaborator becomes all the more critical given what is at stake. The possibility of scientific fraud, even if only a careless mistake, can cost not only the scientist who made the mistake but also all of the scientists associated with him or her, as co-authors on the publication.

when you come around eventually to publication, you're also exposing your credibility, for example right if, if, God forbid, they're a cheat or a liar, you just got into a relationship with a cheat and a liar. Scientist #1

The other aspect in selecting a collaborator is his or her affability or likability. The affability of another scientist can be critical when one scientist wants to ask a question or understand the other's work. Even with the expertise, the trustworthiness, if a scientist is unwilling to have his or her work questioned, then it would make it difficult to work with him or her on a collaborative project.

You also go into the area if any problems come up or if you really have dumb questions or other questions, you can approach them and you can get a lot more out on the table with them, then you can with the other one that you don't like, isn't affable, and isn't approachable. Scientist #1

The purpose of the collaboration between and among scientists is to accomplish scientific work, to advance science but most specifically, to produce publications, evidence of completed work.

Where the end goal of science is producing knowledge, the end goal of the processes of science, like collaboration, is also producing knowledge. And producing knowledge is not complete until it is shared with the larger scientific community through publication. Collaboration with another scientist is about conducting science to produce a scientific paper.

Collaboration is the work of the scientific community actualized. Science – the work of science, the scientific experiments – is conducted collaboratively. The collaboration can be within a lab, across labs and across institutions. The collaboration can be informal, through a series of connections and friendships, one scientist to another, or collaboration can be more formal, with one scientist approaching another out of need for a specific expertise or material. The collaboration is conducted with other scientists ranging from junior to senior or to colleagues.

Epistemic value: Contribution

The epistemic value of contribution was not originally identified from the literature. The concept of ‘contribution’ rather emerged from the data and appears to be tightly connected with the role of author in the community and the epistemic value of credit.

Knowledge claim: Contribution is the criteria of authorship.

Number of scientists whose statements validate all or part of the claim: 6 (50%)

There are specific criteria to being an author, with the main criterion being that of contribution. Data, ideas, scientific experiments that lead to a publishable story are all “contribution”. The largest contributor is the first author, with lessor contributors becoming second, third and so on in order of authorship; with the last author, the senior author, indicating the contribution of lab “owner” or principal investigator. The senior author contributes the facility, the resources and his or her own expertise to enable the work to be accomplished that ultimately leads to publication.

Evidence from the interviews

The deciders – senior authors – are usually the principal investigator of the lab; the “lab owner” who makes decisions about what work will be accomplished in the lab and directs the work of the students and post-docs within the lab. As such, all work coming out of the lab bears their name:

Yeah, anything that works originates here, my name is on it. I want my name on it because it really reflects me. Scientist #10

The role of junior people is expressed in terms of relationship to the more senior people. The junior people conduct experiments at the behest of the senior people, who are the “managers”, the “principal investigator of the laboratory”. But there is also recognition that the senior people have a responsibility to the students and that student success is not a solo success or solo failure.

Where problems arise with a student’s work, there may be questions whether the project was good, whether the advisor did the right thing or the committee oversight – the committee did the right thing. It’s not only you then. Scientist #12

So I'm the principal investigator of the laboratory. I don't really do experiments anymore I'm pretty much a manager, you might say. So I think of the experiments and my students and fellows actually carry them out.   Scientist #4

The senior members of the community are the ones who decide who can and cannot be an author. Whose contribution is sufficient, by amount of work, and intellectual heft, to be an author of a publication? The senior members of the community employ a logic and set of standards that the community agrees upon. Scientists who work on a paper must be acknowledged through authorship even if they are not present when the paper is finally written. The paper, as a culmination of the work that a collaboration of scientists have done together, should show all the authors' work.

I would count figures. Who made the most figures? While the data - Every figure is data. Scientist #8

The other thing that happens sometimes is we have people who can stay for a year or two they generate some data and then they move on. Then somebody else comes in another junior person, and they stay for a year or two and now we've got two people who have you know, generated equal amounts of data and we have to figure out who's going to become the first author. Scientist #2

I never place on the paper someone who hasn't done anything or I've never left out someone who's done a significant contribution. You know, I think this is a very delicate matter. It creates a lot of bad feelings in a laboratory if you don't do this with justice. Okay, and you have to be very careful about doing this with justice. Scientist #5

Contribution determines authorship, and then amount of contribution determines the order of authorship, with the status of first author going to the author who contributed the most to the work and to the paper.

The issue is how much of a contribution does it take to merit authorship? And I have to make that decision. Scientist #4

And in any case, I'm the last author, so that's two authors who are all set. Now, middle author, again, it's hard to call. It's a hard decision but not so many people care too much abut the middle author. So again, I just use the relative contribution of each person. Scientist #8

And traditionally in our field the sequence of authors is that the PI, who initiated the work and whose lab most of the work was done, is typically the last author, so that would be me. The person that did most of the work, physically, experimentally, would be the first author. And the collaborator, like the person from Mt. Sinai, who is a senior person, would be the person in front of me. Scientist #12

Knowledge claim: Contribution is either or both data and ideas that lead to publication.

Number of scientists whose statements validate all or part of the claim: 6 (50%)

Evidence from the interviews

The concept of contribution emerged from the data, firmly linked to authorship. Contribution has a tangible quality to it: "physically doing the work," (though as mentioned above, this would most likely not include technicians) "intellectually important contribution" or being the "person who did the experiment" were phrases that came out of the interviews to signify what constituted a contribution to merit authorship.

if it’s their work, … they’re physically doing the work I say if you write the paper, if you carry it on to the point where you generate the first draft of the paper and you take responsibility for writing it and pulling the data together and doing a literature review and actually writing the paper, then you can be the first author. Scientist #2

You have to at some level contributed in theory some kind of intellectually important contribution not just a pair of hands. Scientist #4

the authorship is determined by the significance of the contribution Who did the most experiments, who did the least, who didn't do anything. Scientist #5

it’s easy to have ideas. But a person who did the experiment should be, again, should be the important author. Scientist #8

Summary

The section introduces the epistemic value of contribution which did not emerge from a review of the literature, at the outset of the study. Rather, the epistemic value of contribution emerged solely from the interview data. Contribution is the necessary criteria of authorship. Contribution could be through data or ideas but is strongly associated with publication. The interviewed scientists were clear in their statements about contribution required for authorship. They were equally clear in the importance of authorship and publication to science.

Not identified in the literature, but rather emerging solely from the data, the concept of contribution figured strongly in the scientists' statements. A publication was a contribution to science; authorship is determined through contribution; contribution is tangible and practical: data or ideas that lead to completed scientific experiments and ultimately to publication.

The concept of contribution extends to the paper itself. A paper is a contribution to the field. Individual contributions lead to authorship and publication; the contribution of a paper will add to the collective knowledge of the field and the scientific community. Author order follows a set of practices that can be characterized as "rules". These rules can be violated when someone does not follow them. The rules are usually so known that the violations are specifically noted. A violation may be a senior author allowing someone who did not draft the paper to be the first author, in a lab where he or she has the "rule" that the first author is the author of the paper. Or, a more inadvertent violation of the rule, and a case where conflict can arise where a senior author must decide between two people who have done the work and both claim the role of first author.

And I never knew the rules, so I didn't do it that way. Scientist #3

Contribution is the standard for publication; a criteria for publication. Contribution is the community standard for authorship. A scientist may be expert, credible, approachable, offering good advice, but unless he or she contributes in a significant way to the work and from the work to the publication, he or she does not merit authorship. Several scientists referred to authors as "not just a pair of hands"; that the contribution must be intellectual and not only the hard work of conducting the scientific experiments. Contribution was referred to in three ways. The first two ways of contributing to the paper are significant for the actual scientific experiment: contribution of data and contribution of ideas. The third way to contribute to the paper is in writing the first draft. The scientists almost uniformly referred to the writer of the first draft of the paper as the paper's first author.

It is possible to become an author without making a contribution to the paper, whether through writing or through the work but it is noted as "gratuitous authorship" (Scientist #11). It is also possible to be made a first author out of need "if somebody needs a paper worse than somebody else Scientist #6" but this is considered not acceptable (Scientist #6). Authorship is about doing something that is essential for the paper to be published. (Scientist #11)

One scientist reported that the scientist had not ever had an issue of authorship – who should be an author, and the order, in a career in which hundreds of papers had been published. However, to illustrate the statement that,

Never once has there been an issue of authorship that I can recall. Scientist #9,

the scientist shared an example of writing a paper with two colleagues, one of who was a very senior person – both in age and in position within the scientific field. The scientist – Scientist #9 – wrote the paper, describing his/her contribution as having been 90% of the work on it. But then, when it came time to submit it I put the senior guy, the former director I put his name first. You know I figured it was a nice thing to do and he said oh you can't do that, … that would be dishonest because I did virtually nothing on this and you did everything I said well oh it's okay and he decided to leave it. [laughter]

Scientist #9

What would be described as gratuitous authorship had the tacit approval of both the author (author in terms of having written the paper), and the more senior author. In this case, the senior author – who under the "rules" would more likely have been positioned as last in author order – was given and retained the position of first author, signifying the author who did the most work, on the paper and on the work that led to the writing of the paper.

Credit

Credit was identified as an epistemic value in the literature and also emerged from the scientists' interviews. Credit is acknowledgement for work accomplished and made publicly visible to the larger scientific community. The epistemic value of credit is connected to the epistemic values of contribution and community.

Knowledge claim: Credit is being published (becoming an author) and being referenced (cited).

Number of scientists whose statements validate all or part of the claim: 10 (83%)

Credit is recognition for contribution to a paper (becoming an author) or recognition for the usefulness of the paper (being referenced) to the field.

Evidence from the interviews

First of all, if it gets published it impacts me right off the bat and so that is a good thing. Scientist #6

And

at least it's out there and it has an impact in terms of people who know the area – they will look at it. Scientist #6

Credit is earned through authorship, and then authorship generates an additional credit if the work is cited by others. Citation by others is a form of recognition; a sign that an author's work is being read; a sign that the cited authors' work is being used by others; a sign that the cited authors' work is foundational to another's work and a sign that one scientist's work is in line with other scientists' work. Citation may not mean that one scientist agrees with another's work - They never like to say, "so-and-so's work is garbage." Scientist #3 – but it does mean that the work is in the same field and deserves recognition: they cite the work to say, if they're getting the same relatedness that I saw or not. Scientist #3

The credit of citation is avidly watched: when you've seen a paper in the journal, the first thing you do is look at the title and the authors and the same thing you do is look to see if they cited your work. Scientist #2. Failure of one scientist to cite another can lead to annoyance: Like I'll read a paper -- but then I get pissed though if some people forgot to cite me. Scientist #3

Knowledge claim: Credit brings tangible rewards.

Number of scientists whose statements validate all or part of the claim: 10 (83%)

Credit, which is authorship on a peer-reviewed journal article; or a citation to a peer-reviewed journal article, can be leveraged for extrinsic compensation.

Evidence from the interviews

Credit – authorship – is used to obtain the credibility needed to graduate, to get grants, to get a job, “to do anything”. Earlier in this paper, a publication was referred to as the “currency” of science; as science’s product. The credit of being the author of the product or perhaps being seen as the owner of the currency, allows the author to obtain desired resources or placement within the scientific community.

So the logic when it was the two different labs is the students needed a first author paper to graduate. Scientist #1

Yeah, yeah. This person needs to graduate. We need to get rid of them. ‘They need to be first author here- you need to be second or joint authorship.’ Scientist #6

You have to publish to get grants. You have to publish to get a job. You have to publish to do anything. Scientist #6

Knowledge sub-claim: There are two primary and polarized types of credit, “best” and “worst”; best credit is recognition of good work; worst credit is recognition of bad or fraudulent work.

Knowledge sub-claim: The best credit is to be recognized for one’s work, either through citation or through new or additional funding.

Number of scientists whose statements validate all or part of the claim: 8 (67%)

Credit is being an author on a paper. Beyond author-credit, though, there is the impact of the author-credit.

Evidence from the interviews

The significance of credit for grant funding was alluded to earlier: credit for one's work through a publication affirms the credibility and expertise of a scientist. Publications are used to evaluate a scientist and for a scientist to be competitive.

Secondly though, and part of that too is that I needed the publication to be more competitive to get grant money. Scientist #6

So the publications are important in the sense that those publications are used to evaluate me when it comes time to getting grant money to keep your work going. Scientist #10

Oh, you can successfully do research and not publish results except if you're dependent on financing, you can't get a grant if you don't publish. Scientist #11

Even without the tangible benefit that money can bring; a paper can be cited and that has the intangible benefit of signifying usefulness to one's colleagues and to the field.

Uh, that the paper's cited widely Scientist #10

We do have what we call citation index – how many times your paper gets cited by other investigators in their papers. And in theory the higher the citation index the more impact your paper has had in terms of the field because people are citing it Scientist #6

Two of the twelve scientists specifically mentioned that the best credit is to receive a prize – the Nobel prize – for their work. The prize carries with it both significant recognition from the scientific community and a monetary reward. The Nobel prize is not unlike being cited and receiving unrestricted grant funding at one time.

But lets say there is a Nobel prize in France, we – it will be in the *New York Times* – you will know about it. So that is the absolute. Because you asked me what would be the absolute, best. Scientist #12

There are papers that give people the Nobel prize so that's you know, I guess can't be better than that. Scientist #8

One scientist mentioned that being recognized outside the scientific community would be the best credit; but the recognition from the community was by far the greater and more frequently stated form of credit.

The best impact I think would be if it's known outside of the scientific community. Scientist #12

I think for me the best possible impact is that people react one way or another to what I've written. Scientist #9

Knowledge sub-claim: The worst or bad credit is for a paper to be published with a fatal flaw or mistake in it.

Number of scientists whose statements validate all or part of the claim: 3 (25%)

Evidence from the interviews

A bad consequence of authorship (bad credit) is “fatal flaw” Scientist #6 in the data presented. Being wrong, or being found to be wrong, where “somebody would say that you made a horrible mistake” Scientist #9 or repeated your work and found that you were incorrect would be the worst thing for a scientist-author. Being known as wrong throughout the community is significant and not for the interpretation of the data but for the data itself:

– it’s one thing to be wrong in your discussion, that’s okay, Scientist #6

Not that we misinterpreted the data because that’s – an interpretation is just that, it’s an interpretation. Scientist #10

Care is taken to present accurate data to the community.

That's why you proofread everything a million times -- it's so easy to make a mistake when you write a complicated paper. Scientist #9

One scientist offered another viewpoint on what the worst credit would be: not receiving any recognition is a kind of "no credit". Either credited with a mistake or flaw in the data; or not credited with having contributed at all, the value is in the relationship to the community.

The worst is that no one cites it, no one calls you and no one knows that you did that work. Scientist #5

Summary

The epistemic value of credit was identified in the literature but evidence from the data defines and clarifies the role of credit. Credit can be good or bad; good credit brings positive recognition for one's work and offers tangible rewards such as a job or grant funding. In essence, the reward for work is to be able to continue working, whether through moving on to a new job or obtaining funding to take the next steps in the research. Bad credit stops the work: either it reveals the original research as flawed and thus potentially not worth pursuing or upon publication the work is little noticed or recognized. With no one else noticing or building on the original research, the work may or may not proceed. It does not, though, benefit from community interest.

Credit is a tangible reward and acknowledgement for contributions made and scientific work accomplished. Credit is expressed through authorship and being referenced.

For a scientist to be an author is to be credited with the work conducted within the paper. Authorship is credit. The impact of that credit within the scientific community is multiple. A scientist receives attention, recognition and greater visibility for his or her work upon publication. Other scientists will look at his or her work.

at least it's out there and it has an impact in terms of people who know the area – they will look at it. Scientist #6

Credit is positive attention from the community. Requests for reprints, contacting the author through phone calls or emails; a reaction of one kind or another signifies that a scientist's work is worth paying attention to and the scientist is recognized for the work that he or she accomplished.

I think for me the best possible impact is that people react one way or another to what I've written. Scientist #9

The attention does not always have to be positive. It's possible to have negative attention but still have that be a form of credit. It at least lets the scientist know that his or her work is acknowledged, and visible within and to the community: And if you get any nasty emails from people who think you shouldn't have published them or you should have cited them. Scientist #6

Visibility can be so critical that even negative data can be acknowledged. One scientist reported that data produced by one collaborator in a project ultimately proved not to be useful to the publication:

We ended up putting the person on the paper because she did work on the paper; and she ended up reviewing it and making comments, and the fact that her data were negative and wasn't important enough to actually put in the paper. But we did learn something from it. Scientist #2

An additional benefit to the credit obtained by publication and being cited, is that publications attest to its author's capability and subsequent credibility as a scientist. Being an author indicates that one has contributed to the paper through the scientific work, that authorship signals that the scientist is capable of doing that work. If the scientific experiment written about in a paper called for work with a particular kind of animal or using a specific set of materials or conducting a test, by becoming an author on the paper, a scientist indicates that he or she is capable of all the work that led to the publication.

It is not enough though to be able to conduct the experiments. A scientist also must demonstrate knowledge of other's work. Not being aware of the work of other community members demonstrates a lack of knowledge of the scientific field.

Demonstrating knowledge of the scientific literature is expressed in the negative, that is, when a person displays a lack of knowledge of the literature. Lack of knowledge of the literature, as demonstrated by the inability to reference others' work, casts doubts on one’s scientific expertise and capability. Lack of knowledge of the literature can also annoy one’s colleagues, by failing to acknowledge their work. In a community that depends on peer review in part to certify one’s work is worthy, failing to cite someone else’ work, can mean that you have not sufficiently demonstrated your knowledge of the scientific field in which you are working.

But what it also actually says which is a bit more significant is that beyond the fact that you’ve pissed people off, which is not a good thing to do in a peer-review system, the other part that it would speak to is, perhaps, is your lack of expertise or familiarity with the literature. That would be a big problem, right, if it becomes clear that you don’t really know the literature in this field. Um, then there’s all sorts of questions one would legitimately have about everything else that follows after that, right? Like the science. You know, are there problems with the science, because you didn’t know the literature. Or you didn’t cite the right article you should have cited so that shows you didn’t know the literature which means you probably don’t know the assays and that says you probably didn’t do the experiment right. So you start going down a train of, at the very best, inciting suspicion for the reviewers. They’re going to really wonder about your expertise.Scientist #1

Um, I find it lacking in true scholarship. And you see that all the time. You see that people ignore things that don’t come up in the computer. If it doesn’t come up in the computer, they ignore the papers. And and the computer systems only go back a certain number of years. So when I did my review I not only read – well, the first review because the second review was only from 87, I was reviewing from 1987 on – I would read all, I would look at the bibliographies of every paper I had and check that I knew about all the previous work that wasn't showing up in the computer. Scientist #11

A scientist's lack of knowledge of the literature could be a degree of laziness, citing only papers they find through a computer literature search. Or, it could signify something greater, a lack of ability to conduct scientific experiments.

Or you didn't cite the right article you should have cited so that shows you didn't know the literature which means you probably don't know the assays [procedure where a property or concentration of an analyte is measured] and that says you probably didn't do the experiment right. Scientist #1

Authorship and the credit achieved through authorship bring tangible rewards. In addition to visibility within the scientific community, credit (authorship) offers tangible benefits. A scientist needs a "first author" paper to graduate. And the obligation of the community is to ensure that he or she gets that first author paper. A more senior scientist may even be willing to give up credit (authorship) in order to ensure that a student gets the first authorship, and the credit that goes with it, to graduate.

Given both the tangible and intangible rewards of credit, it is perhaps inevitable that three of the twelve scientists referred to instances of conflict in authorship. One scientist referred to stolen data and ideas published without crediting the scientist. The scientist acknowledged that there were rules of conduct that are followed in authoring a publication and not everyone follows those rules.

you know in any field -- it's not just science -- in any field there are always people who don't play fair by your ideas of what playing fair is. Scientist #9

One of the ones we just had with another lab, I gave up the last authorship and the communicating author, I gave that to the other guy because I wanted my student to be first author. So I horse–traded to put the student as co-first with his student.

Scientist #1

The introduction of new technologies can have an impact on authorship as well, as what constitutes data, ideas and contributions must be remediated.

he said well, you know, this is my database, I'm going to be the first author, no matter what. And this other person said, but it's my idea. You shouldn't be the first author I'm going to do all the work and they sort of got into a tiff over this. Because both of them had these kind of rigid ideas of what they should do.Scientist #2

Epistemic Value: Competition

Knowledge claim: Competition is a key element in scholarly communication.

Number of scientists whose statements validate all or part of the claim: 6 (50%)

Competition is an aspect of scientists' work from competing in the actual research to competing to be the first published and thus obtaining community recognition for the work. Competition is both a positive and negative value within scholarly communication. On the positive side, competition moves science forward, propelling scientists to publish their data and ideas, to meet community expectations and standards and to share their work so it can be used by others. On the negative side, competition could encourage premature publication of not yet sound findings, and encourage peer reviewers to delay the publication of colleagues' work in the challenge to be first in publication.

Evidence from the data

The interviewed scientists brought up the issue of competition themselves in citing competition within a lab for the work, or competition for authorship or competition to be heavily cited (noticed by others in the community). The scientists are cognizant about competition and for the senior scientists – they see that it is something to manage or to anticipate; for other scientists competition is something to be watched for as it affects one's career.

It also happens because some people think my neighbor's project is more exciting than mine; I want to do that too. Scientist #10

The fact of the matter is, when I screen a cv, I don't see any stars [indicating co-first authorship] and you're first or you're last or you're in the middle. … That can come up for promotions consideration. Scientist #10

It's very competitive so if I have a choice between somebody with fifty references and somebody with none, I take the one that's a better known commodity. Scientist #10

So then you put somebody else on the project and John is not happy, but maybe John would never get the project done. So as a PI you have to think about these things. Scientist #12

Knowledge claim: Competition arises when there is disagreement or controversy over becoming an author or the order of authorship.

Number of scientists whose statements validate all or part of the claim: 9 (75%)

As scientists compete for the opportunity to do work, the competition manifests itself in achieving authorship.

Evidence from the interviews

Disagreement and competition go hand in hand as the senior scientists set criteria and adjudicate whose work merits authorship and by what standards. Once authorship is established, the scientists then decide the order of authorship. Even with known standards for authorship within a lab, there can be disagreement and competition for first author.

Sometimes there are disagreements. But most of the time people know what they have done. It's relatively easy to decide that. Scientist #4

If you've got two people that feel like they have done the work that can be a problem. If you have two major labs doing the work- So one of the labs, the PI – the principal investigator is first author – the other lab is the principal investigator is, you know, the last author. And then the poor person who did all the work is somewhere in the middle now because of the two main labs having to get their claim in there. (Laughing). So that can be a problem particularly. Scientist #6

So with that in mind you actually plan the first authorship very early on when the study's being conceptualized. At least I do. Because I really do not want to get into a squabble between people in my group about who's first author. Scientist #1

It can be an issue of contention who is on the paper and in what position on the paper.
Scientist #12

Knowledge claim: Community members can make a choice not to compete or choose a non-competitive area in which to work.

Number of scientists whose statements validate all or part of the claim: 2 (17%)

Competition in science creates a crowd in a field, competing for resources and credit in a particular field. Options for someone who does not want to compete are to choose a different field entirely, or to move in a direction where no one else is currently working.

Evidence from the interviews

Knowing that competition exists within the scientific community can lead a scientist to choose another pathway in conducting his or her research or serves as a benefit in allowing one to "get in on the ground floor". Competition can spur research or potentially deter it.

And I decided that I would change my direction, and I go in this area where luckily there was no competition. Now there's a ton of competition and to pick area now, but luckily I was able to get in on the ground floor at one point. So that's how I got to where I am. Scientist #2

because of a personality quirk of mine, I wanted to work on an animal that did not have a lot of other people working on it. 'Cause I don't like competition and I didn't want to have to work really um, well, I didn't want to have to publish prematurely just to be out the opposition – the uh, competition. Not the opposition, the competition. Scientist #11

Summary

One of the intriguing results of the concept mapping process was that the central, organizing theme was not a literature-identified theme but rather one that emerged from the transcripts themselves. Competition was not originally identified within the literature review as an epistemic value. Competition is integrally linked to the other epistemic values, where a community exists, competition exists; collaboration and competition are twinned together, with potentially one group of collaborators pitted against another in the competition to publish a finding. Initial publication of a finding provides credit to the collaborators. The competition is inherent in the scholarly communication process and the desire and need to publish and continue the scientific work. Competition emerged from the interviewed scientists' data as an epistemic value that affected authorship and research direction.

The scientific community also engages in competition to be first in publishing. Novelty in publication matters; the complete story out first is essential. The review that community members submit to, can also work against the submitters when the reviewers prevent another scientist's work from being published first.

And uh, we're all competing. The ten of us are going to be the people who review one another's papers. We're all in the same area. So that uh, if I can delay your publication, it it marks mine as having been earlier, so I'm first. If I can delay your publication I can show more on a cv perhaps than you can show on a cv so that we come to submit a grant application. Scientist #10

Competition operates side by side with contribution. Contribution is about ensuring that those who did the work – and work is carefully calibrated and counted – receive acknowledgement, competition is about ensuring that working for the opportunity to make the contribution. It's competitive to be a first author, competitive to author enough papers to establish a greater level of expertise over another author, and competitive to do the kind of work that is more likely to lead to a first author publication.

Competition also introduces the concept of conflict. Six of the twelve scientists had a story of competition in deciding authorship that was presented as an aberration in the usual activity of assigning authorship. Conflict could be seen as a separate element; in the data generated through the study, it was competition that was most clearly identified as an epistemic value through the coding process. It's possible that conflict is itself a characteristic of competition though further research would be needed to clarify this. The role of author and criteria of authorship is not always universally observed, however. Disputes may arise about ownership and use of data, or amount of contribution made to a paper. Junior people (students, post-docs, junior faculty), will have their authorship status adjudicated by more senior people.

Competition sets up a pressure to publish, sometimes to the detriment of the scientific work. For a careful scientist – one who does not want to have the "bad credit" of flawed data presented to the community – choosing a non-competitive area can give him or her breathing room necessary to conduct the work and subsequently publish when he or she is ready.

Chapter 5: Discussion

The major findings of the research study confirmed the presence of the majority of the epistemic values within biological scientists' scholarly communication system as first identified in the literature: community, collaboration and credit. The data did not confirm the presence of one literature-identified epistemic value – connectivity; and the literature did not reveal the presence of two interview-identified epistemic values of contribution and competition. Using the literature to identify epistemic values as a starting point for the research study and a framework for the interview questions proved to be a useful approach. Keeping an open-ended interview process and using the constant comparative method when analyzing the data as appropriate for a qualitative study allowed the data to determine the findings. One advantage of using the literature in shaping the research questions to be asked of the scientists was that the literature provided background and a framework. That approach worked well in identifying the questions to ask and obtaining rich and detailed data from the scientists.

This study used this unique approach of combining the etic and emic – both a top-down and bottom-up approach – to framing the research question, the interview questions and generating and confirming the data to produce knowledge claims. The knowledge claims in this study are supported by both the literature and by scientists' own statements from interviews. This method may be one that could be used to generate a robust theoretical model that is equally rooted in literature and study-generated data; one that is firmly supported by previous research but builds upon and expands it using the words and experiences of scientists currently engaged in scholarly publishing.

Though the research questions were aimed at drawing out the epistemic values of biological scientists as rooted in scholarly communication, there were knowledge claims that also emerged from the data about scholarly communication itself. The data point to the essential nature of scholarly communication to science and to scientists. Price (1969), in fact, defines a scientist as “any person who has ever published a scientific paper.” The definition is striking in that it does not define a scientist by his or her degrees, place of work, type of work, skills, experiments conducted or theories hypothesized but instead he or she is defined by publication. This definition confirms the choice of scholarly communication as a prism through which to examine the epistemic values of biological scientists.

Identification of epistemic values

Looking closer at the components of the scholarly communication system, where there are authors, it follows there will be readers and an audience for the published paper. There is, in fact, a community of scientists. The interview data particularly pointed out the prevalence of community within science and within scientific publication. The scientific community is hierarchical and within the hierarchy, community members have roles reflecting their knowledge and power (senior, junior). The scientific roles are mirrored by the roles of scientific publication: deciding who are authors and the order of authors on a journal article is generally implemented by senior scientists, through an acknowledged system of authorship that is agreed to by all participating members of the scientific community. The scientists perpetuate the scientific author hierarchy and the publishing progress through informal socialization, formal explanations from seniors to juniors and even through published guidelines. To become an author – and using Price's definition, to become a scientist – requires an adherence to the community's rules. Where Price's definition of a scientist was inclusive – as long as you published, you could be a scientist – the scientific community puts specific criteria on authorship. The community deems authorship a reward for hard work and contribution.

Beyond the hierarchy, the scientific community evidenced regular collaboration to accomplish the science necessary for publication. The scientists identified the need for additional materials beyond what he or she had at hand, or access to someone who has complementary skills needed for the work. One collaborator may have an idea that another does not. The concept of a collaborator's trustworthiness emerged from the interviews when discussing the scientific work. Trustworthiness is important for the work, especially when asking a scientist who has expertise that a scientist with a different expertise cannot assess. Ensuring that the scientific experiment being conducted is conducted accurately, analyzed and interpreted in a way that meets the standards of science requires that all involved are trustworthy in their abilities in representation of the work. The high stakes of trustworthiness though becomes even more important when the work is published. The collaborators become co-authors on a publication, forever linked in print (or online) to the work and to each other.

Identification of additional dimensions of epistemic values from the data

The epistemic value of "credit" emerged strongly from the data. Credit is acknowledgement for work accomplished by means of authorship. To put it another way, to be an author is to receive credit for what is written in an article and the work contained within it. It was in learning about authorship from the scientists that two additional epistemic values emerged from the data: that of contribution and competition. Both relate to credit. The scientists spoke of "contribution" as criteria for authorship. The contribution could be an idea, the actual work that went into conducting the scientific experiment, or the resources necessary to conduct the work. The statements from the scientists had consensus on the importance of contribution to becoming an author and receiving credit.

There appeared to be some nuances amongst the scientists about the different ways of contributing. For one scientist, just having the idea was not as significant as conducting the experiment – "idea is [sic] cheap." Scientist #8. For another scientist, just doing the work was not enough; the contribution needed to be intellectual: "So a person whose only contribution is their hands and they don't contribute in any substantive way, I acknowledge their work." Scientist #11

There may be a number of reasons why contribution emerged from the data and not from the literature. Contribution may be assumed or understood amongst the scientific community and therefore not as apparent. Contribution serves as an invisible element of the visible manifestation of credit: authorship. Contribution is adjudicated within a lab or there may be differing hierarchies amongst labs as to what "counts more" as contribution: ideas or experimental work or work-work to accomplish the experiment. While authorship (and therefore credit) is a judgment call of a senior scientist, there appear to be more known rules of what is required to be an author and the subsequent order of authorship than rules of contribution. Where contribution is variable, authorship, particularly its order is less so. First author is acknowledged to have written the paper (at least the first draft) and contributed the most scientific work to the paper; the last author is usually the principal investigator of the lab and the senior scientist. The contribution that leads to authorship, though, is more subjective, weighed by the judgment of the senior scientist.

Competition, similarly to contribution, emerged from the data and was not originally identified as an epistemic value from the literature review. Competition confirms the existence of the community author-roles because the disagreement highlights the competing ideas of authorship. Choosing not to compete not only removes a scientist from “the game” but also can render his or her work less visible. One scientist commented that by choosing to work with an animal that not a lot of others were working on s/he was choosing not to compete: I wanted to work on an animal that did not have a lot of other people working on it. ‘Cause I don’t like competition and I didn’t want to have to work really um, well, I didn’t want to have to publish prematurely just to be out the opposition – the uh, competition. Not the opposition, the competition. Scientist #11 However, in eschewing the competition, s/he found that his/her work was ignored by scientists working with the same system, but different animal:

A: And some very famous people who will remain nameless, actually published papers where we had already demonstrated something that um, they, uh, they said it was the first time it had ever been demonstrated.

Q: And it wasn’t.

A: No, we’d shown it in snakes already. But because it was in snakes, it wasn’t interesting.

Returning to the literature, it is clear that both contribution and competition are present (Floyd et al, 1994), with both emerging in published articles to highlight differences of opinion, presumed changes in the scientific publishing paradigm, and reflecting changes in how science itself is conducted. In reviewing the literature for this study, the author focused on the routine or working aspect of scholarly communication. The literature review did not focus on where there are fissures in the process. These "fissures" of competition were often presented by the scientists as a 'story' – a one-time example of something that happened that violated the norm of author assignation and author order determination.

There was an element of conflict present in the competitive nature of authorship: one scientist's view of who contributed the most, who "needed" the first authorship more than someone else; and who controlled what resources that could be utilized in the production of future papers. It's possible that conflict could stand out as a separate epistemic value, as yet not clearly identified in this study. The description of competition presents a perhaps telling point in publication that needs to be investigated not as a "sensational," one-time event in a scientists life but a regular occurrence in the production of science and scientific publications. That in a community that tightly observes hierarchy, role identification, control of resources and rewarding of credit that allows junior members to achieve independence that a darker side of publication emerges. With senior members controlling author order, a less generous and even-handed senior scientist could imperil the progress of a junior member of the scientific community, denying him or her the author credit that s/he needs to progress.

Non-identification of epistemic value of connectivity

One of the values identified in the literature, however, but not validated by the interviewed scientists' statements is that of connectivity. Connectivity was identified in the literature because of both multiple authorships and the scientist-author's practice of citing one another in publication. The author interpreted the multiple authorships on a single paper and referencing one another's work as a type of connectedness between the scientists. The connections of authors on papers and author's work in references were identified as a potential empiric value of connectivity. A limitation in identifying connectivity as an epistemic value is the chosen method of individual interviews. The single method of individual interviews did not allow for observations of the scientific community together, as a community, such as may be found at a conference. Interpretation of findings of epistemic values is dependent on the data; when the data is solely derived from a single methodology, the interpretation is similarly limited.

In interviewing the scientists, the epistemic values of community, collaboration and credit emerged, but not connectivity. The scientists frequently referred to collaborations for the purposes of conducting scientific experiments and for publication, but did not speak of a lasting connection between one scientist or another. It is possible to construe the collaboration for the purpose of writing a paper as a type of connectedness, and indeed, as long as the published paper exists, the scientists were connected to one another on that paper. At least one scientist acknowledged the need to trust a potential collaborator because their names would always be linked on a paper and should the collaborator prove to be untrustworthy in his or her science, that link - that connection –

would possibly taint the other authors on that paper. While the concept of connectivity appears clear in the literature and has some reference to it in the scientists' statements, as an epistemic value it did not emerge from the literature. The collaboration, the relationships in community that produced publications did emerge in the literature and were borne out by the scientists' statements.

Inter-relationships amongst epistemic values

One of the research questions to be answered with this study was on the inter-relationships amongst epistemic values. The statements made to scientists indicate that there were strong relationships amongst the epistemic values. Statements about community related to authorship; authorship to credit; statements about collaboration connected to contribution. The scientists frequently and spontaneously – as no questions directly asked about competition or conflict – brought up these concepts as identified epistemic values. Competition and conflict were strongly rooted and came from community, expressed through the need and right for credit.

One particular example of the relationship amongst epistemic values is the epistemic value of community which was pervasive throughout the interviews. One hundred percent of the scientists interviewed made statements that validated knowledge claims about community, its own set of relationships and rules; and the significance of authorship within the community. The strong knowledge claims about the community of scientist-authors connect with the similarly strong knowledge claims about credit. Eighty-three percent of scientists made statements validating knowledge claims as to credit being recognition for one's work and the best and worst types of credit. Becoming an author – in this community of authors – brings credit; credit brings rewards.

Toward a theoretical model

This study contributes to an understanding of the epistemic values of scientists as expressed in scholarly publication process. It first produced literature-identified epistemic values of community, collaboration, connectivity and credit; and then validated those epistemic values with an empirical, qualitative study of scientists currently engaged in research and publication. Though not all of the literature-identified epistemic values were borne out by the data, three of the four were validated by scientists' statements. The epistemic value of connectivity remained only identified in the literature and may require additional research to confirm or disconfirm its presence within the scholarly publication process. The data in turn uncovered epistemic values not identified in the literature including that of contribution and competition. All of these values are intertwined within the scholarly publication process. The identification and validation of epistemic values within scholarly publication form a foundation upon which a theoretical model could be built, explaining not simply the mechanics of publication but the deeply-held values that motivate not just publication but also the "doing of science" itself.

Limitations

While the senior scientists were clearly knowledgeable about the publication process and were authors and co-authors of numerous publications, they understandably presented a senior and experienced viewpoint during the interviews. Successful under the current publication system, the senior scientists perhaps had a stake in presenting and preserving the status quo. Less experienced scientists or graduate students might not have been as clear about the scholarly publication system and the process. The one junior scientist interviewed in fact spoke or his/her interaction with more senior scientists in his/her department over the issue of publication and when it should occur:

Well, I'm in the middle of writing a paper so -- they said, "You'd better publish or perish". And I'm like "okay". So they're like "you know that data you have." -- I would have sat on and collected other kinds of data and made like a mega-paper and they're like "no, don't make a mega-paper, just make a paper." And I'm "okay". Because you know its tenure time so it's like okay, all right. So I'll just -- because it's a finding. You know, it's not as much or as thorough as I'd like it to cover all bases, but people can use it. Scientist #3

Additional interviews with scientists on the hierarchical continuum may have yielded a bigger and more robust picture than the data gathered for this study. Similarly, because the interviewed scientists were obtained through a professional network of librarian colleagues it may be that those interviewed were more predisposed to thoughtful reflection of the publication process or shared a similar viewpoint on the publication process. This potential limitation was not apparent in the interviews but should be acknowledged here as a possibility.

The number of interviewed scientists (15) was slightly below what Creswell (1998) recommends for a grounded theory study and for a study that will reach data saturation. Given that the study used a qualitative and not purely grounded theory approach and that a literature review was used to identify the interview questions, thus focusing the study and that the interviews were continued until data saturation was reached, this concern appears to have been obviated. It is possible, though, that more interviews may have revealed new and unexpected data. Additional studies may be needed to achieve this.

The limitation of the study in using the literature review to focus the interview questions and provide a framework for the study perhaps shaped and possibly introduced unknown biases into the approach of identifying epistemic values and deepening an understanding of them from the data. A grounded theory approach where the researcher approaches the study without pre-formed hypotheses or questions might have yielded a more complete and deeper picture of the scholarly communication process and the epistemic values of biological scientists. Using a single method also has its limitations. A multiple-methods approach is frequently recommended in social science research currently, as a means of triangulating the data and providing greater methodological strength from which to analyze the data, and draw inferences and conclusions. Using multiple methods could have provided more data and more means of validating the data and conclusions drawn.

Future research

Future research is needed to develop a theory of the epistemic values of community, collaboration, contribution, competition and credit. This study touched on, but did not fully address the potential interrelationships of a hierarchy of epistemic values. This study implied a tight connectedness amongst the epistemic values, so much so that separating them from each other leaves the scholarly publication process not fully explained or understood.

Additional studies that use multiple methods and broaden the pool of interviewed scientists beyond biological scientists may find different epistemic values or a different set of values depending on their field or discipline. Scientists in other fields may not be as concerned about credit or may have credit awarded in different ways; similarly what defines contribution within the sciences may not be clear within other fields. The interplay and relationship of the hierarchical community in the sciences may not be as strictly observed in other fields; in other fields too the issue of funding or perhaps the lack of it may create a more diffuse community and one in which the publication process is similarly diffuse.

Purpose and implications for practice

The purpose of the study is to identify epistemic values of biological scientists as rooted in scholarly communication and to provide a deeper understanding of these values. The implications for practice of a deeper understanding of biological scientists' epistemic values extend to system creation, fostering of relationships within scholarly communities and to those who provide service to them; and may well form the underpinnings of successful implementation of new media within scholarly communities. Behavior that stems from epistemic values is likely to be deeply held and motivated, rather than behaviors that are simply born of habit or practice.

New scholarly communication systems and systems that capture the scientific output, such as institutional repositories, could significantly benefit from an understanding of scientists epistemic values. It seems likely that institutional repository models that do not encapsulate epistemic values will be less successful than those that do. A university-based repository offers perpetual access to scholarly publications on behalf of its own university community, not the scientific community within which scientists work and publish. While university-based repositories offer a way of making a contribution, perhaps to the field, though most notably to the university, there is no credit gained within the scientific community through submission to institutional repositories. The opportunity for collaboration does not emerge through an institutional repository, except perhaps through repositories that offer features connecting potential collaborators based on the subject of their work. The most such a feature could do, however, is provide a list of potential collaborators at a given institution; it could not offer that essential element of trust and trustworthiness needed to be a collaborator. In planning for a repository, universities may need to acknowledge that an institutional repository may have epistemic values that are embedded in other fields, such as university administrators or librarians who may identify more closely with the university community than a separate scientific community. Repositories that are built across institutional lines and inclusive of a scientific field may better match the epistemic values of scientists. The online repository, ArXIV, is well-known and utilized within the physics' community. However, the biomedical online repository, PubMed Central, was not as successful in obtaining author-deposited copies of articles until regulations required that articles be deposited. Though not a topic of exploration of this dissertation, and not initially proposed as an epistemic value, meeting external obligations such as compliance to regulations or meeting grant reviewer's expectations, that offered access to funding was at least a sub-theme in the scientists interviews. Publication of articles was important for credit and to "get funding;" with these new regulations it is even more clear that a scientist must receive credit both through publication and now through depositing one's articles to be able to receive funding. Where publication demonstrates one's contribution to the field and capability of doing future scientific work, depositing one's penultimately published article in PubMed Central also contributes to the field and indicates capability of complying with a funder's request.

The importance of community, found in this study, signals how important the creation and fostering of communities is to science and to scholarly communication. Social media has already accomplished much in the arena of community creation and support, bringing together people based on shared interests, diseases, habits, goals and business. The information science industry has created a "community of science" for scientists but it is not entirely clear how successful that science is; if it's the only one or if there are others. Perhaps there are created communities of some duration or perhaps they are temporary in nature. Where information science has focused on community creation using new tools as they emerge and using the tools to market and get its own "information/library science" message out, it may be that an understanding of the epistemic values could add to an evaluation and assessment of these new online communities. The epistemic value of community indicates that the scientific community is hierarchical; a necessary question to ask is whether or not that hierarchy remains in the online world or if it has undergone a change in this democratized world of non-linear, non-mediated communication. Though the technology is moving quickly, information scientists need to be actively engaged not just in using and trying out new media but applying a values-embedded framework to understand the potential for success or failure with the use of these new tools.

The social networking tools that librarians and information professionals may prize could match their epistemic and professional values, for example – sharing, cooperation and democracy. The scientists' epistemic values of community and collaboration may also coincide with social networking but the epistemic values of credit and contribution are not as clearly evident. Though scientists value novelty in publication, which would seem to dovetail with the immediacy provided through web publication, the importance of credit is still deeply embedded within traditional journal publication channels. Publication outside of peer-reviewed literature does not "count," and will not provide the scientific credit needed for authorship and subsequently for jobs, grants and promotions. Any use of the new media to post material in advance jeopardizes the credit obtained through journal publication.

The provision of library and information services is uniquely tied to the communities they serve. Library services are a manifestation of community values, hopes and aspirations. In examining and understanding the epistemic values of scientists engaged in the production and communication of science, librarians can envision and implement services and build information infrastructure that reflect deeply held behaviors. As library collections migrate from print to electronic only, librarians can uncover the values of library as provider of information in any location and can re-examine and re-align the library-as-place in conjunction with other values. Where libraries can provide place for community and collaboration they may be more accurately creating a space that is value-embedded and ultimately successful and enduring.

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Appendix A Informed Consent Form

School of Communication, Information and Library Studies

Rutgers, The State University of New Jersey

4 Huntington St.

New Brunswick NJ 08901

August 1, 2006

Dear Participant:

You are invited to take part in a research study that is being conducted by Kathel Dunn, PhD candidate at the School of Communication, Information and Library Studies at Rutgers University. The purpose of this research is to develop an understanding of what is important and valued by scientists in the scholarly communication process.

You have been chosen to participate in this study because you are a biological scientist currently engaged in research, have published peer review papers in the past and have had at least one paper published in the past year. You will be interviewed by myself and the interview will be taped. The interview will last approximately one hour and you will have the opportunity to review the transcript of the interview after it is completed. I may ask you to clarify statements post the interview. The questions I will ask are on the topic of the scholarly publication:

writing a peer-reviewed paper

the process of writing a peer-reviewed paper

what was important to the process

There are no risks for participating in this study, and you will not benefit directly from participation. However, the knowledge that we obtain from your participation may lead to further richer understanding of what is important in the scholarly publication system, and thus indirectly be beneficial for you in your future work.

If you have any questions, please feel free to contact Ms. Dunn.

Please mark with your initials that you have read and understood the information above

____

Participation in the interview is voluntary. You may choose not to answer any questions with which you are not comfortable. There are no costs involved in participating in the interview, apart from giving up some time. You will receive no compensation for participation. If you withdraw from the interview prior to its completion, you will receive no penalty. If you withdraw from the interview before data collection is completed your data will be removed from the data set and destroyed.

This research is confidential. Your name will not be identified. This information will be kept confidential. The research team and the Institutional Review Board at Rutgers University are the only parties that will be allowed to see the data, except as may be required by law. In published reports and conference presentations group results will be presented and illustrative quotations used will not enable the identification of the participant. Data will be stored at a secure private home computer.

If you have any questions about the study procedures, you may contact Kathel Dunn at 718-623-6590. If you have any questions about your rights as a research subject, you may contact the Sponsored Programs Administrator at Rutgers University at:

Rutgers University Institutional Review Board for the Protection of Human Subjects

Office of Research and Sponsored Programs

3 Rutgers Plaza

New Brunswick, NJ 08901-8559

Tel: 732-932-0150 ext. 2104

Email: humansubjects@orsp.rutgers.edu

You will be given a copy of this consent form for your records.

Sign below if you agree to participate in this research study:

Subject ____ Date_________

Principal Investigator _______________________________ Date _________

Appendix B Pilot Study Findings

The Pilot Study Scientists

The scientists who participated in the pilot study were all senior within their fields, as assessed by the dates they received their PhDs, with the most junior having received his degree 27 years previously; and the most senior earning his PhD 42 years previously. Their senior status was reflected in the interviews: they each answered questions within the context of their role as mentor, teacher, supervisor of, more junior faculty and students. The discussion of these scientists' publications inevitably brought up their responsibilities to ensure that their students and fellows also became published, peer-reviewed authors. The scientists were each in different fields - obstetrics and gynecology, pathology and neuroscience – but their status as a senior scientist with responsibilities for students and departments was a major, common theme among them. The scientists were all actively engaged in research, each sharing a story or pointing to work (a poster, papers), in their office that they were currently involved in.

Scientific Publication Values

The data resulted in four knowledge claim statements. These knowledge claims are on the epistemic values of community, collaboration, connectivity and credit. The knowledge claims and the data that support them are explicated below.

Knowledge claim #1

Community is an epistemic value of scientists in their reading, writing and publishing of scientific results.

Scientists read, write and publish their research results within and for a community of peer-scientists. It is scientists' peers who can understand the published research and assess it to be worthy and of value. The worth and value of scientists' work is dependent on others' assessment of the research and further use it in other research. Additional research may be in validating the first scientists' work or in using the research results to extend the existing field. The scientists' writing and reading community of peers is one with a strong set of norms and rules that all are aware of and follow, whether or not there is agreement as to the "rightness" or "wrongness" of the rules. In publication, it is not the largest audience that matters, but the audience of peers.

It is also scientists' peers that serve as gatekeepers to the scientific audience, as peer reviewers controlling access to journal readers. Scientist-reviewers who agree that a fellow scientist's work is of value (meaning "of use") will allow it to reach the intended audience. Work not judged of value ("or use" or meeting community standards in methodology or approach) is rejected, returned to the scientist-author. The need for agreement of value/utility of the scientific research within the scientific community is such that the lack of it can prevent the field from moving forward. Scientist #2 relayed a story of a disagreement that became public within the scientific community and stopped a particular field from continuing with its research:

Uh, I had a very unfortunate experience. I published a paper in Science and uh, a year later in the Technical Notes section they published a refutation of our work. And, uh, I asked the author of the Technical Note, “Why didn’t you come to me and tell me you couldn’t reproduce my work?” He said that he did the work because uh, he wanted to get an NIH grant and we were the only people publishing in the field and he was interested in another aspect of it. But in order to do that he had to try to reproduce our work. And he couldn’t.

So that the next time that I put in for a grant, the authors, the reviewers said, “This is a controversial subject.” That was it. I didn’t get the grant.

Knowledge claim #2

Collaboration is an epistemic value of scientists who work and publish with each other.

Scientists conduct publishable research in collaboration with other scientists. While a scientist may work alone, a scientist’s publishable work takes place in collaboration with other scientists. The collaboration may be internal, within a scientist’s lab; it may be institutionally internal, with collaboration among scientists of different disciplines but also at the same institution; or collaboration may be external to the institution, but amongst scientists in the same field. Collaboration takes place within a scientific hierarchy of students, junior scientists, senior scientists and department chairs. The scientific hierarchy is supplemented by layers of roles: “the person with the idea,” the “persons who do the work,” “experts,” “editors,” “hot people,” “reviewers.” A junior scientist may be the person with the idea but in order to realize the idea, the junior person must engage senior people and potentially involve other scientists who are not in his department to see the idea come to fruition through publication. Scientists depend on other scientists to accomplish scientific work.

> The problem in of course science these days is you can’t command all of the fields that you need to all the technology you need to either because of money or because of training or association or whatever so you get some friend to do this other part and then together you come up with a collaborative paper.

Collaboration is an invitation; an “ask,” where one scientists asks the other to act on his/her role: the “person who does work” asking the “expert” to lend their expertise to a project. Or, “the expert” could ask “person who does work” to do the work: to put in the hours of time required to conduct the experiment, review the data, to analyze the results. A request to collaborate, while it may call on different roles, is ultimately a request for all involved to contribute to the scientific endeavor at hand.

Collaboration, in the context of publication, results in authorship; and authorship serves as a record of contribution to the published scientific idea. Publications – journal articles – serve as a public record of the scientific collaboration and the list of names on the publication, and the order they appear in, mark the significance of the collaboration. Successful collaborations result in publication. And collaborations begin with the invitation to conduct scientific work.

They asked me to collaborate. They wanted to know what was happening with their patients.

I was invited as a member of the editorial board to contribute to the journal or get off the board.

Knowledge claim #3

Connectivity is an epistemic value of the scholarly publication system as scientists' publications – authorship, use of literature - are highly connected to the authorship and use of literature of other scientists.

Scientists' publications – authorship, use of literature – are highly connected to the authorship and use of literature of other scientists. Scientists are expected to know and be able to use other scientists' work as described in the published literature. One of the participants was most clear in describing the need to know literature.

you see, in order to think about how research is done and in order to understand it, it's - you're looking for an unknown. And all the ideas of research have to be built around having read the literature, understanding what a field is and looking to extend the field beyond that.

The other scientists interviewed did not express as explicit a reference to using the literature in publication. They did indicate the importance of being cited, and citation as the highest possible impact of publication.

Scientists' connectivity is also expressed through citations. The impact of a paper is assessed, in part, through its being cited by other scientists. While the literature on citing provides a multitude of reasons for citing [Smith, 1981], one aspect would certainly be referencing the utility of the paper or the idea expressed in the paper. Scientists' connectivity is manifestly, concretely made clear through citation. Inasmuch as authorship is a manifestation of collaboration, citations manifest the larger scientific community, or indeed silent collaborators, collaborating without consent but by use of their ideas in shaping the argument or laying the foundation of the paper that cites them. The connectivity ensures that ideas stay discovered and credited to the discoverer. Not being cited disconnects the scientist and his or her work from the scientific community.

> If you never get cited, then it [the article] got lost.

Connectivity was weakly expressed in the interviews but highly linked to community, collaboration and credit. The subsequent interviews for the dissertation will focus further on this knowledge claim to determine whether it is strongly or weakly supported by the data.

Knowledge claim #4

Credit is an epistemic value of scientists' scholarly communication system as scientists receive credit for their work and their research through the authorship of peer-reviewed publication.

Scientists receive credit for their work, their research, though the authorship of peer-reviewed publication. Receiving credit is paramount in science. Credit for the idea, credit for the work, credit for contributing, credit for the role played (as expert, as department chair). Credit and authorship go hand in hand. Not being an author denies a scientist credit for work done, idea thought of, or role in the scientific community.

Authorship may also be given out of courtesy, a courtesy role, for example in relationship to the work conducted for the paper. In this case, credit is seen perhaps as undeserved. In the scientific community, where work is highly prized, courtesy roles go against a community standard of contribution equals authorship equals credit.

[Scientist A] thought it was politic to make Dr. [X] who's the chairman of the department a co-author. I don't think he contributed a thing to this paper. This happens sometimes.

Credit can be as literal as counting up the numbers of papers in which as scientist is an author. The number of scientific papers accumulates into a career, success that cannot be removed or taken away from the scientist and accords a scientist a degree of security.

And I’ve got a hundred some odd, 120-130 papers published. I’m not worried about where my name is on things I’ve collaborated on as opposed to things I’ve started myself.

Credit is assigned by senior scientists who make decisions as to author order, though usually within the context of formal and informal scientific standards. “The one who writes the paper” is most often the first author. One of the scientists interviewed talked about “dividing up the treasure” before the work even began on the project or paper. “Dividing up the treasure” was deciding on authorship in advance of the experiment, let alone the writing of the paper. The paper, then, serves as a record of the work accomplished, as reviewed and approved by one’s peers. Authorship is a record of a scientists’ work and ultimately career. To be an author is to receive credit for work, and for a lifetime of work.

Appendix C Selections from Transcripts and Initial, Open Coding

Scientist #6 Transcript Statement	Detailed Concepts	Broader Concepts
A: No, if you don't publish you are not going to have a job. The expectation is at least a paper a year and yeah, if you don't publish…Two things: one, if you don't publish than you really have never given anything back to the scientific community because nobody can see your work if you don't publish it. So in a sense your research is a dead end if it doesn't get published. And two, you know, just self preservation. You have to publish to get grants. You have to publish to get a job. You have to publish to do anything.	Having a job requires publication Expectation = paper a year Publication is a way of giving back Publication = 1.grants 2.job 3.anything	Credit – through publication = 1.job 2.grants 3.anything 4.money Community – standards in quantities of publications

Scientist #11 Transcript Statement	Detailed Concepts	Broader Concepts
A: Well, today almost nobody single authors a paper. At least in the neurosciences, in the biological sciences, because it's almost impossible to do any of the studies that could be published with just using one technique and doing it by yourself. So – uh, anybody who has a grant is going to want his or her name on the paper. And the people that work for him – or her - and do the work, have to have their names on the paper. At least you have to have two people. The person who is running the lab and the person who does the actual work.	Science is done collaboratively If you have a grant (financing) you can be an author (you are an author?) Do the work, and you can be an author (you are an author?)	Collaboration (science is accomplished through) Credit (obtaining funding is a claim toward authorship) Credit (authorship achieved through work)

Appendix D Coding: Broad Concepts Compiled and Categorized by Scientist

Scientist #6

Credit – what it is

Credit – attention (phone calls, email)

Credit – authorship – amount of work

Credit – authorship – idea

Credit – authorship – intellectual contribution

Credit – authorship – intellectual contribution

Credit – authorship – money

Credit – types/kinds

Credit - Best credit – funding (5)

Credit - Best credit – new novelty (5)

Credit – worst – fatal flaw in experimental part of data

Credit – how obtained

Credit – for being "out there" in community

Credit – for being used (cited)

Credit – for contribution

Credit – for publication

Credit – given where not necessarily deserved (out of need) (2)

Credit – given where not necessarily deserved (out of need)

Credit – not given – for technical work only “Only … a pair of hands”

Credit – what it does

Credit – through publication – adds to competitiveness

Credit – through publication – bestows credibility

Credit – through publication = anything

Credit – through publication = grants

Credit – through publication = job

Credit – through publication = money

Scientist #11

Collaboration – what it is

Collaboration (expertise associating with expertise)

Collaboration (expertise of one’s colleagues)

Collaboration (junior person associating with senior/expert person)

Collaboration (within lab of people with different expertise)

Collaboration – what it does

Collaboration (science is accomplished through)

Appendix E Analysis of Broader Concepts

Credit - what it does	Scientist #1	Scientist #6	Scientist #7	Scientist #8	Scientist #10	Scientist #11
Credit is leverage, allowing a scientist to graduate, obtain a job and obtain funding.	Credit (funding)	Credit – through publication = grants	Credit – publication rewards with – money	Credit (publication = funding/money)	Credit (publications necessary to obtain grants) (4)	Credit (authorship can lead to grants)
	Credit (publication necessary for degree)	Credit – through publication = job	Credit – publication rewards with – more work	Credit (publication aids in promotion)		Credit (authorship essential to career) (2)

Credit - what it does	Scientist #1	Scientist #6	Scientist #7	Scientist #8	Scientist #10	Scientist #11
	Credit (publication needed for promotion, tenure; sign of productivity; sign of contribution?)	Credit – through publication = money	Credit – publication rewards with – supplies	Credit (publication aids in receiving grants)		Credit (publication provides credit that can produce grants)
	Credit (publication needed to graduate, leave institution and	Credit – through publication = anything	Credit – publications matter for getting a job	Credit (publication can bring attention, credit)		Credit (obtaining funding is a claim toward authorship)

Credit - what it does	Scientist #1	Scientist #6	Scientist #7	Scientist #8	Scientist #10	Scientist #11
	go to another – community handoff) (3)					
			Credit – publications necessary to obtain funding			
			Credit – publications needed to obtain a grant			
			Credit – support is rewarded			

Credit - what it does	Scientist #1	Scientist #6	Scientist #7	Scientist #8	Scientist #10	Scientist #11
			(resources) (2)			

Appendix F Broader Concept Knowledge Claims Confirmed with Statements from Transcripts (2007)

Scientist	Credit - Broader Concept Knowledge Claims	Number/Percent
#1, #2, #3, #4, #5, #7, #8, #10, #11, #12	Credit is being published and being referenced (cited).	10 (83%)
#1, #2, #4, #6, #8, #9, #10, #12	Credit is attention, recognition and interest from others within the community (and more rarely, outside the community).	8 (67%)
#1, #6, #7, #8, #10, #11	Credit is leverage, allowing a scientist to graduate, obtain a job and obtain funding.	6 (50%)
#6, #7, #9, #10, #12	A scientist receives credit for a contribution to work.	5 (42%)
#6, #7, #9, #10, #12	A scientist obtains credit by being published (through publication).	5 (42%)
#1, #4, #8, #11, #3	There are standards to receiving credit, and those standards are not always followed.	5 (42%)
#6, #8, #10, #11	Credit bestows credibility.	4 (33%)
#2, #4, #10, #12	Credit is given for visible work.	4 (33%)
#6, #7, #9, #12	There can be controvery and conflict in publication, often over authorship, and the rewarding and receiving of credit.	4 (33%)
#6, #7, #9	A scientist obtains credit by being visible.	3 (25%)
#1, #11, #3	Credit affects others.	3 (25%)
#1, #8, #9	Credit can be shared, traded and stolen.	3 (25%)
#7, #9	There can be enough credit.	2 (17%)
#6, 10	Credit is denied for a contribution that is not intellectually substantive.	2 (17%)
#10	The last author position signals that the publication is about that scientist's research area.	1 (8%)
#6	A scientist obtains credit by being cited.	1 (8%)
#6	Credit adds to one's competitiveness.	1 (8%)
#1	Credit equates to credibility.	1 (8%)
#10	To receive credit, a scientist must be the first author.	1 (8%)
#10	The middle author position is of last value in author order.	1 (8%)

Curriculum Vita
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University of North Carolina at Chapel Hill
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National Library of Medicine
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National Network of Libraries of Medicine, (NN/LM) Middle Atlantic Region (MAR)
Associate Director, 2006 – 2008

Ehrman Medical Library, New York University Medical Center
Associate Director of Public Services 2002 – 2006

Mt. Sinai School of Medicine, Department of Geriatrics and Adult Development
Program Manager, Education 2000 – 2002

New York Academy of Medicine
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Director, Library Services 1999 – 2000
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Information Specialist 1995 – 1997

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