

The right kind of telling: an analysis of feedback and learning in a  
journalism epistemic game

by

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*To My Family*

*With All My Love and Gratitude*

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## CHAPTER 1: INTRODUCTION

### *The challenge of 21st century skills*

The unprecedented pace of technological change and information production in this early 21<sup>st</sup> century world presents numerous challenges. Meaningful participation at work and in the community increasingly demands interdependent skills in critical thinking, information literacy and complex problem solving, extending abilities identified at least as far back as Dewey and newly recast as ‘21<sup>st</sup> century skills.’ And there is growing concern that 20<sup>th</sup> century theories of learning and cognition focused exclusively on basic facts and skills are leaving increasing numbers of young people unprepared for the future (Shaffer et al., 2005; Gee & Shaffer, 2010; Dede, 2007; Silva, 2008; Partnership, 2010).

This study examines a 21<sup>st</sup> century theory of learning and cognition that considers not only basic facts and skills, but also the connections among facts, skills, values, and the ways that people make decisions and justify actions in the context of complex, real world problem solving. Epistemic frame theory (Shaffer, 2006, 2007) argues that expertise, such as the kind involved in complex thinking and problem solving, fundamentally involves diverse and dynamic connections between different forms of knowing (Broudy, 1977) and acting, guided by the norms and principles of a

particular community. So, epistemic frame theory suggests that “thinking as an engineer” means acting like an engineer, understanding what matters to an engineer, and knowing about engineering. These skills, values, and understandings are made possible by looking at the world in a particular way —by making decisions and justifying actions as an engineer does. The same is true for lawyers, but with a different way of thinking. If a community of practice (Lave & Wenger, 1991) is a group with a local culture — what Gee describes as a Discourse or way of "seeing, valuing, being in the world" (2005, para. 5)— then the epistemic frame is the grammar of the culture (Shaffer, 2010). In other words, epistemic frames are the shared perspective that individuals internalize as they become acculturated.

More than simply a collection of different elements, though, epistemic frame theory focuses on the ways in which specific frame elements are used together during complex thinking and problem solving (Shaffer, 2010). While it can be argued that an engineer’s way of thinking always involves some combination of engineering identity, understanding, skill, values and epistemologies, when engaged with particular situations, engineers use particular knowledge and skills guided by particular engineering standards, and not others. As a result, developing the epistemic frame of a particular community of practice means learning and integrating the frame’s diverse elements.

In this dissertation, I consider the challenge of assessing the extent to which an individual has developed such a frame. Traditional assessments have been exhaustively refined to measure “only whether a student possesses a particular piece of knowledge, not whether the student can analyze the information, evaluate its utility, or create new knowledge from it – the core of 21<sup>st</sup> century skills” (Silva, 2008). As a result such assessments are not very useful for measuring performances of multidimensional thinking and learning (Gomez, et al., 1996).

I look at assessing the development of epistemic frames by using a relatively new measurement tool, epistemic network analysis (ENA), which focuses on the patterns of relations between such knowledge and the various other aspects of expertise which are mobilized together in the discourse of complex practice. ENA treats the traces of epistemic frame elements—the particular skills, understandings, identities, values and epistemologies—manifest in discourse as *nodes* in a cognitive network, and the use of different frame elements together – such as a value used to guide the use of some technique – constitute *links* between these elements.

The context for this investigation is *science.net*, a computer-supported role playing game in which young people take up the role of reporters-in-training and educational researchers take up the role of mentor editors in a simulation of a professional journalism practicum. In the game, players engage in story production

stages modeled on professional practice – from pitching ideas to interviewing experts and writing stories to be published on the game’s website. Mentor editors also engage in activity modeled on the practicum, providing reflective copyediting feedback on what works (and what does not) and why in players’ stories. Through iterative cycles of this player and mentor activity, the game is designed to help players begin to think like professional journalists.

I take this as a context for examining whether ENA can measure the development of an epistemic frame in the sense that in the study that follows I:

1. Determine whether ENA can distinguish between the feedback given to undergraduate journalists-in-training from the feedback given to a different group of professionals-in-training.
2. Determine whether, on the same metric, ENA shows that *science.net*, a game designed to simulate a professional journalism practicum, successfully reproduced this kind of feedback.
3. Determine whether, on the same metric, ENA shows that *science.net* players began to develop this way of thinking as a result of playing the game.

In other words, in this study I examine whether, as epistemic frame theory suggests, different communities of practice produce measurably different combinations of epistemic frame elements. I further examine whether a game that appears similar to a

professional practicum actually reproduces feedback of the kind found in the practicum, and, finally, I examine whether the development of this way of thinking can be assessed without resorting to traditional assessments.

Through these investigations with epistemic network analysis, this experiment suggests the connections between the particular ways of knowing, doing, being, caring, and justifying that constitute an epistemic frame can be quantified and measured. In turn, this means epistemic frame theory can be tested, providing a more rigorous basis for the design of learning environments to better prepare young people for the complex demands of the future.

### *Dissertation Overview*

While the remainder of this dissertation will provide much greater detail, a brief summary of each of the chapters may provide a helpful overview for the reader. In Chapter 2, the theoretical framework for the study is presented. This chapter suggests that epistemic network analysis can provide a way of measuring epistemic frame development through the discourse of mentor feedback and player performance. A description of the settings, data collection, and particular analysis techniques is presented in Chapter 3.

Results from these analyses are presented in Chapter 4 and demonstrate that *science.net* did reproduce the kind of mentor feedback from the professional practicum on which it was modeled. Players also were able to learn different aspects of journalistic professional expertise as a result of playing the game, and these learning gains continued to be present months after the game was over. Finally, players also demonstrated significant increases in journalism performance as measured through epistemic network analysis.

Chapter 5 presents a discussion of the study's findings, limitations and potential implications. Finally, additional supporting information is provided in the Appendices.

## CHAPTER 2: THEORETICAL FRAMEWORK

Many educational theories examine what it means to have and to develop 21<sup>st</sup> century complex thinking and problem solving skills. For example, Sternberg (2007) suggests the development of such innovative abilities depends on integrating practical, analytical, and creative skills. Ackerman and Perkins (1989) suggest interdisciplinary work – real world problems that draw on multiple forms of expertise - can help students see essential connections between bodies of knowledge and increase student motivation for developing complex skills. Preparation for Future Learning (PFL) focuses on the challenges of designing complex problem solving tasks in knowledge rich environments to scaffold the transfer of problem solving skills from familiar problems and situations to new ones (Bransford & Schwartz, 1999; Schwartz & Martin, 2004).

Epistemic frame theory (EFT) (Shaffer, 2006, 2007) similarly suggests complex thinking and problem solving require more than basic facts and skills. Like Sternberg, EFT suggests the development of innovative abilities depends not only on the possession but the integration of a range of skills. Following Ackerman and Perkins, EFT looks at complex thinking in the context of real world problems. And, as in PFL,

EFT focuses on designing complex problem solving tasks in knowledge rich environments to scaffold the transfer of problem solving skills.

EFT suggests that complex thinking can be understood in terms of the connections between *frame elements*: different skills, knowledge, values, identities, and epistemological rules from a particular domain. Epistemic frame theory was selected for this study because it has been used to examine the development of complex thinking and problem solving skills in game-based learning environments (Nulty & Shaffer, 2008; Nash & Shaffer, 2008; Hatfield & Shaffer, 2010, Svarovsky, 2010). The best games require complex thinking (Gee & Shaffer, 2010), feature challenging activities, and provide frequent and targeted feedback. As Shaffer (2005) argues, by identifying the ways in which particular epistemic frame elements are linked together in professional training activities, computer-supported role playing games can be designed to simulate these frame-developing opportunities for young people (Shaffer, 2004). Beckett and Shaffer (2005), for example, show that players developed civic knowledge and skills through working with an embedded land use zoning model that challenged them to overcome complex tradeoffs between social and environmental quality.

While it is not the only theory of 21<sup>st</sup> century thinking that could be applied to digital media, I argue that it is one worth further investigation.

### *Epistemic frame theory*

Shaffer calls the “combination—linked and interrelated—of values, knowledge, skills, epistemology, and identity” an *epistemic frame* (Shaffer, 2007). The combination is *epistemic* in Papert’s (1980) use of “epistemology,” i.e., it reflects and reinforces a *particular way of thinking and knowing*, one that is aligned with the norms and principles of a particular community (Shaffer, 2010). At the same time, epistemic frames also provide members of such communities a shared reference for interpreting and understanding activity in the world, extending Goffman’s (1974) concept of a *frame* as “the organizational rules and premises, partly existing in the minds of the participants and partly in the structure of the activity itself, that shape the perceptions of those involved” (Shaffer, 2010, p.13).

As a theory of learning and thinking that emphasizes how individuals develop and share a common perspective, epistemic frame theory is clearly related to Discourse theory. As Gee argues, a Discourse constitutes a particular way of “talking, listening, writing, reading, acting, interacting, believing, valuing, and feeling (and using various objects, symbols, images, tools, and technologies)” (Gee, 2001). Theories of Discourse analysis investigate the ways in which individuals use particular kinds of writing, speaking, and acting (i.e., discourse) to make sense of, or *frame*, activity in the world, to “recognize [themselves] and others as meaning and meaningful” (Gee, 2005, pg. 7).

Through such analyses, Discourse theories generally take identity as a primary analytic focus, seeking to better understand the development of identity and the ways in which people understand themselves and the world around them through various forms of identity and agency. Critical Discourse Analysis (Fairclough, 1995; Van Dijk, 2001), for example, focuses on power relations and ideologies, examining such issues as the discursive reproduction of racism in the media (Van Dijk, 2001). Mediated Discourse Analysis (Scollon, 2001; Norris & Jones, 2005; Wohlwend, 2008) uses the concept of a “nexus of practice” to examine language use as a component of social action during interactions with different mediating objects. And in Multimodal Discourse Analysis (Scollon & Levine, 2004; O’Halloran, 2008) digital media, such as videos and websites, are included along with more traditional conversational modes to consider how individuals create meaning across these different modes.

As with other Discourse theories, EFT shares an emphasis on the essential multidimensionality of complex thinking and other real world problem solving activities. Like Mediated Discourse Analysis, EFT focuses on how relations between different frame elements contribute to a community’s shared perspective. And as with Multimodal Discourse Analysis, EFT also looks at a range of discourse sources to provide traces of frame elements and their connections. However, EFT differs from other Discourse theories by taking epistemology, rather than identity, as the central

analytical focus (Shaffer, 2010). Even more importantly, EFT also differentiates itself from other theories of Discourse by explicitly focusing on the *linkages* between specific frame elements.

For example, when an urban planner engages with the challenge of neighborhood revitalization, she might use knowledge of transportation capacities and governmental regulations, as well as environmental impact considerations. At the same time, her ability to balance these factors and to evaluate the quality of that balance will be guided by a professional principle to serve the public interest. Journalists, who share a professional value of serving the public, would bring different knowledge and abilities to bear while engaged in such a challenge. In other words, for each profession the use of one aspect of expertise is tied to the use of other aspects, and the patterns of these relations thus constitute the distinguishing structure of each profession's epistemic frame.

Expertise can of course be described as always involving such linkages of identities and values, knowledge and skills. As Shaffer (2010) argues,

“[a]ny display of skills invokes a particular identity. Any interpretation of a situation through the lens of a particular value requires knowledge of the context and its relevant features. Any decision is conditioned on the skills, knowledge, values and identity of the community” (p. 16).

At the same time, particular instances of these elements are not always linked in the same ways nor are they necessarily all linked all the time (Shaffer, 2010). As the

example above shows, in general terms both journalists and urban planners use knowledge and skills guided by professional standards in their professional practices. But, the particular understandings and skills, the specific professional standards, differ, and they are used in different ways for different purposes.

Epistemic frame theory thus argues that expertise can be modeled as a network of connections between specific understandings, techniques, values, identities and epistemologies, all of which are articulated through discourse. Assessing the development of such expertise, however, is a significant challenge. Traditional assessments typically “fail to tap into the system of relations that hold among concepts” (Gomez, et al., 1996, p. 583), thus minimizing their usefulness in measuring the multiple interconnected and interdependent dimensions of epistemic frames. Instead, the relationships between epistemic frame elements can be quantified, and thus assessed, using network analysis (Shaffer et al., 2009; Shaffer & Graesser, 2010).

Network analyses as a general class of tools, describe systems of relations to “tease out the prominent patterns in such networks, trace the flow of information (and other resources) through them, and discover what effects these relations and networks have” on elements and groups within the network (Garton et al, 1997). Social network analysis (SNA), for example, provides a robust set of analytical tools for representing and describing networks of relationships (Wasserman & Faust, 1994; Degenne & Forse,

1999; Hanneman & Riddle, 2005; Wellman & Berkowitz, 1988). Mislove et al. (2007) examined four online social networking sites (Flickr, Orkut, YouTube, and LiveJournal) including “over 11.3 million users and 328 million links” to better understand characteristics of the networks overall, such as the average number of connections between users, how different profiles of users corresponded to patterns of higher and lower connection density, and how different groups of users clustered together. Wellman and associates (Wellman, 1988; Wellman & Wortley, 1990) used network analysis to examine how relatively static social connections, rather than geographical proximity, helped individuals maintain a sense of community. And Pathfinder Network Analysis (PNA) (Schvaneveldt, 1990) has been used to examine the underlying structure of relations in different texts (Puntambekar, 2006) and to produce maps of the relations among concepts in a domain (Schvaneveldt et. al., 1989).

In order to simplify the complexity of networks of large numbers of people or data points (e.g., pages and links on the web), traditional network analyses compute summary statistics—such as network density, structural cohesion or clustering coefficients (Wasserman & Faust, 1994)—and then compare networks by analyzing these statistics. Such techniques are not well suited, however, for the analysis of epistemic frame networks for three reasons.

First, epistemic frame networks are much smaller than traditional social networks. Where traditional social networks include thousands of individuals or nodes, typical epistemic frame networks only include 10 – 20 elements (Shaffer, 2010; Bagley, 2011; Svarovsky, 2010; Hatfield & Shaffer, 2010). As a result, techniques which aim to describe large complex networks through summary measures are less useful.

At the same time, epistemic frame networks represent the use of different discourse elements in different situations – so connections between elements change frequently over time. Thus, a central concern in the analysis of epistemic frame networks is the degree to which connections re-occur over time, ie., the weights of particular connections. By contrast, most social network analyses are focused on relatively stable connections, and identify particularly important individuals by the raw numbers of connections they have to others (who they know, and who their connections know, etc.).

Finally, epistemic frame networks, while relatively more densely connected than traditional social networks, are not fully connected. While the number of individuals represented in traditional social networks tends to be large, the number of associations between those individuals relative to all of the possible connections across the entire network tends to be far lower. In epistemic frame networks, there are a large number of connections among elements, but every possible pair of elements is not connected. As a

result, even algorithms which have been designed for weighted networks such as the Pathfinder Network Analysis algorithm (1990) are less effective for this type of network (Choi et al., 2010).

### *Epistemic network analysis*

Epistemic network analysis is being developed to address those parameters. Epistemic network analysis (ENA) extends social network analysis by focusing on the patterns of relations among discourse elements rather than individual people and developing techniques designed for the particular kinds of networks epistemic frames present.

For example, rather than exclusively assessing core disciplinary knowledge, ENA focuses on the patterns of relations between that knowledge and the various other aspects of expertise which are mobilized together in the complex work of professional practice. By treating epistemic frames as cognitive networks, different frame elements—the particular skills, understandings, identities, values and epistemologies of a profession—become *nodes* while the patterns of connections between specific aspects of expertise constitute the *links* between these nodes.

ENA techniques can then be used to measure different aspects of these networks, from the prominence of particular combinations of nodes to the similarities and

differences between different networks, and hence different epistemic frames. ENA can also be useful for understanding the kinds of linkages between and across elements taking place at different points in time and for comparing patterns of such linkages between different individuals and settings. For example, ENA methods have been used to trace epistemic frame developments in both players and mentors during educational engineering and urban planning games (Nulty & Shaffer, 2008; Nash & Shaffer, 2008).

By quantifying the patterns of connections between the different elements that combine to form epistemic frames, ENA methods provide a new alternative for measuring complex thinking and problem solving. One context for applying the principles of ENA would be in educational game environments that feature opportunities for generating and capturing complex problem solving activity and reflective feedback. Epistemic games provide such a context.

### *Epistemic games*

Using ethnographic observations of actual professional practica, epistemic games attempt to reproduce key cycles of professional activity and reflective feedback. These cycles don't reflect every kind of activity professionals engage in, nor every kind of feedback. Instead, the design of epistemic games involves identifying the novice and

mentor practices most central to the development of professional expertise, or epistemic frames. These key practices are then modulated to accommodate the developmental needs of younger learners (Shaffer, 2004) and the inexperience of adult mentors who are typically not members of the particular professional community of practice. Thus, for an epistemic game to be successful, it has to recreate the complex network of relationships between professional activities and reflective feedback *of the kind that take place in the practicum on which it is modeled.*

### ***Professions as model***

Being a professional means being part of a *community of practice*, which Lave and Wenger (1991) describe as a group of individuals who share a common repertoire of knowledge and skills, and who develop identities as members of the community through *legitimate participation*, or actions guided by the norms and values of the community. In professional work, these actions often involve working with “uncertain, unique or conflicted situations of practice” (Schön, 1987, p.39) to solve complex problems. As Schön argues, professionals use this “more or less systemically organized professional knowledge ... set of values, preferences, and norms” as a lens through

which to “make sense of practice situations, formulate goals and directions for action, and determine what constitutes acceptable professional conduct” (1987, p. 33).

The complex problem solving of professional work can thus be characterized by a particular kind of engagement with the problems that emerge during professional practice. There are, of course other views of the professions. At the level of social structures, Abbott (1988), for example, focuses on the processes by which occupations become professions and the economic and political consequences of a professional jurisdiction over particular tasks. Friedson (2001), extending Abbott, considers the professions in terms of *autonomy* and the “social processes which establish the social and economic status of professional work” while also suggesting that one distinguishing aspect of such work is that it features *discretionary specialization*, “tasks in which discretion or fresh judgment must often be exercised if they are to be performed successfully” (Friedson, 2001, p.23). Schön’s approach to the professions was chosen for this study because it specifically examines the processes by which professionals develop complex thinking while engaged in problematic situations.

In this kind of engagement professionals seek to redefine what they are seeing through the discourse of their profession (Schön, 1987). Goodwin calls this “professional vision” (1994), and provides an illustration in the professional work of archaeologists:

An archaeologist and a farmer see quite different phenomena in the same patch of dirt (e.g. soil that will support particular kinds of crops versus stains, features, and artifacts that provide evidence for earlier human activity at this spot). ... For example, even though a post that supported a roof of an ancient house has long since decayed, the earth where it stood will have subtle color differences from the dirt around it. The archaeologist attempts to locate features such as these post molds by scrutinizing the earth as she digs. Categories of relevance to the profession, such as post molds, are thus used to structure interpretation of the landscape. When a possible feature is found, the archaeological category and the traces in the dirt that possibly instantiate it are each used to elaborate the other in what has been called the documentary method of interpretation (Garfinkel 1967; Goodwin 1992; and Heritage 1984). ... [Thus] the archaeologist discursively shapes from the materials provided by the earth the phenomenal objects, e.g., archaeological features, that are the concerns of her profession. (p.610)

Professional work is a process of redefining situations in order to see particular features relevant to a particular profession and its practices. Through the process of bringing such features to light, of seeing problems through *professional vision*, professionals convert messy and ambiguous situations to more defined problems “matched to their familiar theories and techniques” (Schön, 1987) and which in turn suggest defined solutions.

Negotiating this process of “framing the problems that arise in [professional] practice situations and shaping the situations to fit the frames” (Schön, 1987), thus, clearly involves knowing the repertoire of theories and techniques associated with a particular professional community of practice. More than that, though, it involves a “complex ensemble of analytic thinking, skillful practice, and wise judgment” (Sullivan, 2005, p.195), the ability to discern when, where, and why to use those understandings

and practices. For most professions, these epistemic frames are developed in capstone courses and/or professional practicum experiences (Schön, 1983, 1987).

*The practicum as a professional practice simulation*

In the professional practicum, novice professionals begin to develop the expertise of their profession through participation in simulations of the kinds of professional work they will be expected to take on as mature professionals. However, because epistemic frames depend on dynamic interactions with diverse practice situations, developing this complex ensemble is not reducible to following simple instructions. Instead, novices face the challenge of learning to ride a bike as they are building it: they must learn to align their problem solving efforts with the community's principles and norms even as they are learning to see the very discursive features needed to properly frame such ambiguous situations. As Schön puts it: "The paradox of learning is that a student cannot first understand what he needs to learn, can learn it only by educating himself, and can educate himself only by beginning to do what he does not yet understand" (1987, p. 93).

Mentors help novices overcome this paradox through coaching and feedback. As novices engage in the simulated practices of the profession, mentors provide reflective feedback on their efforts, modeling (Collins, et al., 1991) ways of framing situations and

solving problems aligned with those frames. By focusing on what works (or doesn't) and why in novices' efforts (Wiggins, 1993), mentor reflective feedback helps to reveal or reinforce discursive features novices may (or may not) have seen, modeling the situational framing of a more experienced professional and demonstrating the use of different aspects of professional expertise in practice. Through feedback, in other words, "mentors offer learners a professional vision that they can imitate and eventually internalize" (Nash & Shaffer, 2010; Schön, 1987).

The profession of journalism provides a particularly fruitful case study because the "professional vision" of the journalist integrates skills in information literacy, critical thinking and complex problem solving with civic-oriented values.

### ***Case study: Journalism***

#### *Profession of journalism*

As professionals, journalists inherit responsibilities "to provide citizens with the information they need to be self-governing" (Kovach & Rosenstiel, 2001, p. 17), to discover important events and "help the reader make sense of them" (Murray, 2000). They must engage in a "discipline of verification" (Kovach & Rosenstiel, 2001), treating

all sources of information as “questionable” and pursuing credibility in reporting through transparency and cross-checking (Tuchman, 1978).

At the same time, reporters and news organizations must make decisions about the tiny fraction of potentially important happenings to cover and provide meaningful stories about (Gans, 1979). Further, journalism is a “practical activity geared to deadlines” (Tuchman, 1978), so the routine production of news (“feeding the beast”) has helped establish “known” forms of stories, the formulae of journalistic professional vision:

Dealing with a known form, the reporter knows which facts to seek from which centralized sources, even as the reporter searches out that story’s idiosyncratic angle. ... As known story forms (lead-documentation) demanding facts and sources, ‘the fire,’ ‘the trial,’ ‘the political convention,’ ‘the lost child,’ ‘the death of the president’ reduce the idiosyncrasy of occurrences as news.” (Tuchman, 1978, p. 103)

Professional journalists use these “known forms” -- the “familiar theories and techniques” (Schön, 1987) of journalism – guided by professional standards and values to frame significant stories in an otherwise overwhelming flood of information,

routinely employing sophisticated information literacy and critical thinking skills to engage readers and inform the public<sup>1</sup>.

### *Journalism practicum*

The journalism practicum presents simulations of professional reporting assignments as a mechanism for the development of professional vision. For novice reporters these assignments help develop a so-called “nose for news” and challenge the journalist-in-training to produce stories that demonstrate sophisticated skills in reporting and writing, on deadline and in accordance with professional norms of accuracy, transparency, and the stylistic requirements of the Associated Press.

Practicum story assignments require reporters-in-training to translate broad topics, such as ‘non-profits’ or ‘county elections,’ into the kind of specific and informative stories one might see in a regional or national newspaper. As a result, they provide novice reporters with a similar volume and variety of decisions and judgments that a professional would face.

Unlike professional news stories, though, these assignments are often not published. Instead, they serve as opportunities for feedback through copyediting by a

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<sup>1</sup> As with professions more generally, there is some debate about the value of professionalism and journalism (cf. Aldridge & Evans, 2003; Anderson, 2008; Deuze, 2005; Dunn, 2004; Singer, 2007; and Soloski, 1989). While questions about the appropriate role in society for professions and professionals are certainly important, they are beyond the scope of this study which is focused on how the training of professionals might prove useful in the development of educational games for young people.

more experienced mentor instructor. There are, of course, different forms of feedback that happen in a journalism practicum (Shaffer, 2005b; Hatfield & Shaffer, 2010) from *war stories* in which mentors reflect on their own lessons learned from past experiences to *news meetings* in which participants receive feedback on their reporting efforts. But *copyediting* feedback from mentors on participants' story drafts can be particularly important for developing and integrating journalistic expertise (Hatfield & Shaffer, 2010).

Mentor copyedits align reporters' efforts with professional expectations by bluntly highlighting what works (or doesn't) and why, relative to the values and principles of journalistic reporting and writing practice, and the standards of knowledge and skill they guide. Copyediting feedback is made up of line-by-line corrections and comments on news stories that are copious, detailed and blunt. The volume of comments is often related to their level of detail. A given story might invite attention to everything from errors in following Associated Press style and grammar rules to success in dramatically giving voice to the voiceless. Their bluntness reinforces a particularly unsentimental relationship between journalist and story, one that is driven by frequent deadlines and a potentially critical public. Through repeated iterations of such feedback, reporters begin to see their professional work through the epistemic frame of the profession. As veteran journalists Clark and Frye (2003) put it,

Through his questions and observations, the editor lets the writer know what he thinks is important. Information is important. Specific details are important. Telling a good story is important. The reader is important. ... The reporter will hear his editor's questions echoing in his head on the next story" (p. 11-12).

Developing professional expertise in journalism thus depends on opportunities to engage in simulations of the "messy," ambiguous situations of professional practice, scaffolded through the reflective feedback of more experienced mentors. And it is through such scaffolded simulations that novices are transformed into professionals. Games designed to provide a window on professional practices can extend these opportunities to a broader audience.

### *Journalism games*

A growing body of research suggests that games can provide powerful mechanisms for developing higher-order thinking skills (Shaffer et al., 2005; Gee & Shaffer, 2010; Squire, 2006; Dede, 2007; Barab et al., 2010; Barab & Dede, 2007a). For example, professional journalism role playing games such as *Be the reporter*, *Disaster at Harperville*, and *Global Conflicts: Palestine*, provide innovative opportunities to learn about the complex information practices and critical thinking skills of professional journalism.

*Be a reporter*

The Poynter Institute's NewsUniversity game, *Be a reporter*, provides a compelling but brief experience of covering breaking news. In the game, designed to be completed in 15 minutes, players work as reporters covering a story about an outbreak of food poisoning at a school in the town of Medina. After listening to a brief introduction by the local paper's virtual editor, players click on buildings in the town to interview different characters, and each interview is automatically summarized in a virtual notebook. The game ends when players submit their notebooks for story production, with different paths through the town and interactions with different characters resulting in stories of differing qualities.

In a very short amount of time, *Be a reporter* seeks to help "all of us understand how and why good journalists do what they do" (Poynter Institute, 2011). Like a reporting practicum, the game presents an open scenario in which players must decide who to interview when, and players receive feedback from the virtual editor both during assignments and in a final evaluation of the story produced. At the same time, the game is explicitly designed to present just a single scenario unlike the reporting practicum's typically more demanding assignment schedule (Hatfield & Shaffer, 2010). And more significantly, the game involves no actual writing, a key professional activity simulated in journalism practica.

### *Disaster at Harperville*

A similar reporting game, *Disaster at Harperville*, created at the University of Minnesota Institute for New Media Studies, used the commercial game platform NeverWinter Nights to provide a more “challenging and engaging” virtual setting for journalism undergraduates to explore the profession (Paul & Hansen, 2006). In this game, players learn to “conduct interviews and synthesize information gathered in low-trust environments” (Bogost et al., 2010). The game begins with the disaster: a train carrying anhydrous ammonia hits a tanker truck and derails, forcing the evacuation of the surrounding neighborhood. Players navigate a virtual 3D environment to find characters and conduct interviews, figuring out along the way what kind of angle to take on the story. Based on that decision, players then identify what kinds of interview questions and background information from which sources would be most appropriate and collect them before finishing the game by filing a story based on the collected reporting.

Like *Be a reporter*, *Disaster at Harperville* focuses on simulating the reporting aspects of an investigative news story. The game scaffolds player experiences setting up and conducting difficult interviews, helping to ensure that players (undergraduate journalism majors) get experience in a relatively low-risk environment engaging in a

challenging part of journalistic practice. However, also like *Be a reporter*, the game's focus is limited to the single disaster scenario and does not feature opportunities to compose stories or work with editors on developing journalistic writing.

### *Global conflicts: Palestine*

Another example of rich journalism game play facilitating 21<sup>st</sup> century critical thinking skills is *Global Conflicts: Palestine* (GCP), by Danish developer Serious Games Interactive (2011). An educational game developed to look more like a commercial video game, GCP gives players opportunities to simulate being a reporter working for either an Israeli or Palestinian newspaper. In the game, players interview soldiers, detainees, civilians and politicians, and learn about the complexity and challenge journalists' can face when trying to get information from difficult sources, challenges as much about professional ethics as interviewing skills (Bogost et al., 2010). At the end of the game, players file stories, selecting from information and quotes gathered during the game to assemble a newspaper article.

Like *Be a reporter* and *Disaster at Harperville*, *Global Conflicts: Palestine* (GCP) seeks to provide players with a situated understanding of the process of covering challenging stories. More expansive than the other two, GCP provides multiple stories to cover and a rich array of potential sources of varying reliability (Crafti, 2011). However, in this

game again, players do not write stories and reflective feedback on this important aspect of journalistic practice is relegated to classroom discussions outside of the game.

In summary, these games each provide innovative opportunities for players to explore aspects of the profession of journalism. They provide access to particular reporting and interviewing experiences in low-risk environments to scaffold these important journalistic practices. And although they focus on assembling stories rather than writing them, the games can emphasize the subtle point that a “journalist does not simply report reality from existing knowledge, but re-creates reality based on bits and pieces collected from different sources” (Bogost et al., 2010). However, for most journalists, writing continues to be a fundamental practice in the profession, and so these games only simulate part of the professional journalist experience. In addition, while innovative in game play, none of these simulations of professional practice seems to be explicitly based on a theory of learning. The epistemic game, *science.net*, provides a game context explicitly grounded in the epistemic frame theory of learning.

#### *Science.net – the journalism epistemic game*

The epistemic game, *science.net* was designed to reproduce the reflective feedback practice of journalism training environments. Based on an ethnography of a reporting practicum (Hatfield & Shaffer, 2010) and an earlier pilot study of how and

what young people learn when working with the tools of journalism (Hatfield & Shaffer, 2006), *science.net* was designed to help middle-school aged participants learn to think like reporters through cycles of story drafting and mentor copyediting.

In contrast to the journalism games described above, *science.net* combines reporting and interviewing efforts with the writing of stories as an important mechanism for acting professionally even before knowing how to do so and for working with mentor feedback to begin to develop the epistemic frame of a professional journalist.

In the game, players work as reporters-in-training to define story ideas, interview sources and conduct online research, and write and revise stories. The game also features mentor editors who provide guidance and support through news meetings to discuss stories in development with all of the players and editors. Guest professional journalists present war stories, reflecting on aspects of their professional experience with the group. And mentor editors provide copyediting feedback on player stories as they prepare them to be published.

In other words, players do the kinds of things journalism practicum participants do, and mentor editors do the kinds of things journalism experts do. However, the process of translating learning practices for adults into practices for young people and training practices for experienced professionals into practices for domain-inexperienced

mentors introduces a constant danger of “lethal mutations” (Brown & Campione, 1996), variations on particular activities or feedback that while superficially similar don’t function to strengthen the epistemic frame connections as intended.

For epistemic games, assessment only begins with analysis of whether and to what extent a player uses elements of the epistemic frame of a practice. In order to assess whether the player is developing a professional epistemic frame, assessment must be focused on the extent to which he or she uses elements of the frame the way a more experienced practitioner does. In other words, epistemic games must also assess the discursive performances of players and mentors. ENA provides a method of assessment that can be used flexibly with different individuals as well as for comparison among and between these different individuals, and thus provides a powerful tool for quantitatively exploring the development of complex thinking in performance.

An important question for research on epistemic frame theory and epistemic network analysis is thus how to measure the alignment between key training practices in the professional practicum and their simulations in games for young people. Performance assessments that focus solely on learner outcomes fail to address the important role mentor feedback plays in the development of novice expertise. At the same time, assessments focused solely on mastery of individual concepts fail to address

the multidimensional nature of expertise articulated in epistemic frame theory. For games that generate rich streams of performance data, “[t]he challenge lies in how to determine which data are useful and how to make use of this data in ways that will ultimately inform and improve student learning” (Behrens, et al., 2010). And as Quellmalz et al. argue, assessing the development of higher level thinking through games is in its infancy (Quellmalz, et al., 2009). For epistemic games, epistemic network analysis (ENA) offers a new analytic method for exploring ways of assessing the performances of different participants in game play that is also grounded in the multidimensional epistemic frame theory of learning.

By looking at the development of complex thinking and problem solving through epistemic network analysis, this experiment suggests the connections between the particular ways of knowing, doing, being, caring, and justifying that constitute an epistemic frame can be quantified and measured. In turn, this means epistemic frame theory can be tested, providing a more rigorous basis for the design of learning environments to better prepare young people for the complex demands of the future.

### *Research questions*

In this study I examine whether, as epistemic frame theory suggests, different communities of practice produce measurably different combinations of epistemic frame elements. I further examine whether a game that appears similar to a professional practicum actually reproduces feedback of the kind found in the practicum, and, finally, I examine whether the development of this way of thinking can be assessed without resorting to traditional assessments.

In this dissertation, I use the epistemic game *science.net* to examine the how epistemic frame theory can be measured and tested through epistemic network analysis. Specifically, I address the following research questions:

RQ1: Does epistemic network analysis show that mentor feedback from two different professions is different?

RQ2: Does epistemic network analysis show that mentor feedback from a professional practicum and a game attempting to reproduce that experience for young people is similar or different? and,

RQ3: Does epistemic network analysis show that players in this game learned to think more like professionals?

## CHAPTER 3: METHODS

### *Overview*

The research questions described in the preceding chapter are addressed in this study through an analysis of copyediting feedback discourse combined with an analysis of player learning outcomes as a result of playing the epistemic game, *science.net*. Copyediting feedback data were collected from a professional journalism practicum, a professional psychology practicum, and the *science.net* game. Learning outcome data were collected from semi-structured pre-, post- and follow-up interviews with *science.net* players. After describing each of the settings, this chapter provides definitions of key terms, “copyediting feedback” and “assignments,” and an explanation of the coding and analysis of the four data sets.

### *Settings*

#### *Journalism practicum*

Offered as part of an undergraduate major in Journalism and Mass Communications at a large Midwestern university, the journalism practicum featured

many opportunities for copyediting feedback. In this venue, 13 undergraduate journalism students produced stories for 10 assignments distributed across a 16-week semester. Assignments ranged from simulated breaking news coverage of a virtual tornado to coverage of real county elections, and included two team reporting projects in which small groups of 4-6 students produced sets of thematically related stories. The practicum was taught by one mentor instructor, an award-winning professional journalist with over 20 years experience who taught part-time while working as an investigative reporter for a regional newspaper. Final versions of stories were submitted via email to the instructor, and copyedit comments were provided in-line in response email messages to students. For team reporting projects, all members of the team received the entire set of copyediting comments for the project, while for individually reported stories, only the reporter authoring the story received the comments. Copies of all stories and mentor feedback, as well as field notes from class meetings and informal interviews with students and the instructor, were obtained as part of an earlier ethnographic study of this practicum (Hatfield & Shaffer, 2010).

*Educational psychology practicum*

Offered as part of a graduate program in Educational Psychology at a large Midwestern university, the psychology practicum was designed to prepare graduate students for professional work as educational researchers. Although students produced far fewer writing assignments than the journalism practicum, the psychology practicum provided a set of interactions between students and the professor analogous to the journalism practicum. In this practicum, 10 graduate students produced research papers for each of two writing assignments over two 16-week semesters. Assignments involved conducting empirical research on individual and social cognition and producing professional journal-ready research papers, thus simulating the kind of work expected of experienced educational researchers. The practicum was taught and written feedback was given by a tenured professor of educational research. Prior to submitting assignments for grading, participants submitted complete drafts of research papers electronically to the professor. Copyediting feedback was then provided in-line for students to use while making final revisions. Electronic copies of all papers and copyediting feedback from the professor were obtained following the conclusion of the practicum.

*Science.net game*

Building on an earlier technology pilot (Hatfield & Shaffer, 2006) and ethnographic studies (Shaffer, 2006; Hatfield & Shaffer, 2010), *science.net* was designed to simulate a professional reporting practicum experience for younger participants. In the game, 12 middle school-aged young people took on the role of reporters, working with editors and producing stories for each of 3 story assignments during 80 hours of play across 4 weeks during the summer. Assignments included contemporary science-in-society concerns such as stem cell research, invasive species, and alternative energy options, and the game's novice reporters worked for approximately 20 hours on each story. Working with Byline, the game's custom developed news writing and publishing software (Hatfield & Shaffer, 2006), players conducted in-person interviews with experts and gathered additional background research online to develop and write individual stories (i.e., no team coverage) for publication on the game's website.

The three editors in *science.net* were graduate student researchers from the School of Education who, despite having no prior experience as journalists, played the role of desk editors working with small groups of novice reporters focused on a particular area, or "desk," such as the environment. For the editors this involved leading desk meetings—meetings with a team of novice reporters designed to address the evolving stages of a newspaper story from initial idea and "pitch" to the final publishable draft.

Editors also engaged in informal check-ins to provide feedback on the novice reporters' efforts to convert broad story assignments to publishable stories.

Prior to publication, players submitted their stories for copyediting. Copyediting feedback was provided in-line on electronic versions of story drafts by the editors, and, working with that feedback, the novice reporters completed final revisions to their stories. Stories were then organized by desk and published on the game's publically accessible website.

### *Data collection and segmentation*

Four sources of data were collected from these three venues. Mentor copyediting feedback data were collected from the journalism practicum, the psychology practicum, and the journalism game, *science.net*. Learning outcome data were collected from semi-structured interviews with the *science.net* participants and included a copyediting task.

### *Mentor copyediting feedback*

For the purposes of this study, "copyediting feedback" was defined as brief, targeted comments provided in-line and anchored to particular paragraphs in a story or

assignment. An “assignment” was defined as a story or research paper submitted to a mentor that subsequently received “copyediting feedback.”

Following these definitions, writing that did not receive “copyediting feedback” was not considered an “assignment,” and written comments that were either exclusively evaluative, e.g., only indicating a grade for the assignment, or summative, e.g., comments preceding the assignment rather than being anchored in-line to particular paragraphs inside, were not considered “copyediting feedback.”

Once assignments containing copyediting feedback comments were collected, the comments were segmented. Generally, comments were brief and targeted at specific parts of a story or paper. As a result, a segment was defined as one comment. Collecting and segmenting mentor copyediting comments in this way resulted in 444 segments from four assignments in the journalism practicum, 845 segments from two assignments in the psychology practicum, and 327 segments from three assignments in the *science.net* game.

### *Player learning outcomes*

Learning gains for players resulting from playing *science.net* were determined by comparing player responses from pre-, post-, and follow-up interviews using Verbal

Analysis, a method of quantifying the qualitative coding of the contents of verbal utterances (Chi, 1997; cf. Bagley & Shaffer, 2009; Beckett & Shaffer, 2004; Hatfield & Shaffer, 2006). Designed as semi-structured interviews, the pre-, post-, and follow-up protocols asked players to explain concepts in journalism, provide opinions about far-transfer problem scenarios (Shaffer, 2004), and complete a copyediting task<sup>2</sup>. To ensure comparability, only questions appearing on all three interviews were considered during the analysis of player learning outcomes.

### *Player copyediting tasks*

Player learning of the journalism epistemic frame was assessed through a simulated copyediting task. The copyediting task was composed of two-parts. In each part, participants were asked to comment on written story information or drafts and to provide the kinds of judgments and guidance a professional journalist would.

1. In the first part of the task, participants were asked to evaluate the news value of provided information about a science-in-society topic in the news<sup>3</sup>

*(“Would this information make a good news story, and why?”)* and then to

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<sup>2</sup> Protocols for each of the pre-, post- and follow-up interviews are provided in Appendix 1.

<sup>3</sup> In each of the pre-, post-, and follow up interviews, participants were provided one of three sets of information. Each of the three sets is available in Appendix 2.

describe their actions if they were in such a situation (*“If you were a reporter handed this information, what would you do next?”*).

2. In the second part of the task, participants were given one of three story drafts written by novice journalists<sup>4</sup> and asked, *If you were an editor at a newspaper and you were given this story by a reporter, how would you change it, if at all, before publishing it in the newspaper?*

After player responses to the copyediting task questions were collected, they were segmented. Following the segmentation principle applied with the mentor copyediting feedback, the response to each question was defined as a single segment because each response was addressed to a particular piece of written text, i.e., the story information or draft being evaluated. Segments within each interview were treated as copyediting feedback on a single story or assignment. This produced 166 copyediting segments which were added to the final dataset.

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<sup>4</sup> Each of the three story drafts were authored by pilot participants in an earlier version of *science.net*, and each is available in Appendix 3.

## *Analysis*

### *Qualitative data coding*

Once the data was collected and segmented, a grounded theory approach (Strauss & Corbin, 1998) was used to develop a set of qualitative codes reflecting different aspects of journalistic expertise represented in the data. Data from the journalism practicum were used to establish the coding scheme as representative of professional journalism practice. Identification and revision of the codes continued until the coding scheme reached saturation (Strauss & Corbin, 1998), and the process resulted in a rubric of 17 codes. Table 1 describes each of the codes and provides a brief example from the data.

*Table 1. Grounded qualitative codes developed from professional journalism practicum copyediting feedback and comprising the coding rubric used in all subsequent copyediting feedback analysis.*

<b>Code</b>	<b>Description</b>	<b>Example</b>
Witnessing	Being the reader's eyes, to help make the reader feel as if s/he were witnessing the events in the story directly.	<i>Strive to invoke your senses to describe how he looks and sounds, and to put him into action scenes that reveal something about him and his activism.</i>
Pressing the source	Asking the right questions to get key details from sources, typically during interviews.	<i>Readers of this story would like one or two of those stories of history and aristocracy. Don't let sources skate by too easily.</i>
Investigating	Gathering information for a story. Involves both	<i>Ideally, of course, we'd want to interview Fuhremann before publishing this story. And we'd</i>

	interviewing live sources and researching/working with documents and data.	<i>get much of the info directly from primary sources, such as the police department, to avoid quoting other news media so extensively. Background info is effective for putting the recent event into perspective.</i>
Narrative storytelling	Using narrative devices as part of story writing.	<i>Keep striving to develop characters to make the issues real and vibrant for readers and listeners.</i>
Removing reader barriers	Telling stories clearly and with simple language.	<i>Mention of THC will confuse some readers unless you name the chemical and describe it briefly... Remember to keep removing those barriers that might keep readers from sticking with your story.</i>
Detailed description	Providing useful, specific details and facts in stories.	<i>Good use of specifics in next graph to alert readers to the size of the group.</i>
Journalistic writing	Using 'terms of art,' key words and phrases concerning journalistic writing and/or stylistic rules.	<i>Reserve direct quotes for the real gems of your story. Routine words, such as graph below, should be paraphrased.</i>
Reporting concepts	Using terms of art concerning reporting, i.e., finding, gathering, and analyzing information for stories.	<i>Above statement should be attributed to a source...</i>
Reader concerns	References to concerns for what readers need or want.	<i>An attention-grabbing lead. Readers will want to know more, though, about why the sock is "courtesy of the Madison Police Department."</i>
Journalist as reporter	References about being a reporter, including references that position the recipient as a reporter, such as 'your source' or 'your interview.'	<i>Just let your sources carry the story and you'll be fine.</i>
Journalist as writer	References about being a writer, including references that position the recipient as	<i>Avoid stating the obvious (everyone knows what aids is) especially in those precious lead sentences. Better to find drama, such as an anecdote from one</i>

	a writer, such as 'your reader(s),' 'your lead' or 'your editor.'	<i>of the event that Rubinstein organized, to pull readers into your compelling issue.</i>
Informing the public	References that reiterate the importance of informing an audience.	<i>ahh, but couldn't we get the police report and search warrant return to give readers this powerful piece of info?</i>
Engaging readers in the story	References to getting and keeping a reader's attention.	<i>Will draw readers into the story by introducing the fear and anxiety experienced by Healey.</i>
Transparency	Providing readers with enough information to make their own judgments about the issues involved, including feedback on source attribution and clearly indicating where information in a story was coming from.	<i>At some point in story, would need to tell readers how we got the details about this scene -- Healey, police, documents or a mixture, for example.</i>
Accuracy	Presenting unbiased, objective and reliable information as an appropriate kind of activity.	<i>The speculation in the above sentence seems out of place.</i>
Personal narrative	Telling powerful stories through characters that readers can relate to as a particularly informative storytelling strategy.	<i>Great sources such as Douglas and Sogol, if you can get them working for you, can provide the anecdotes, passionate quotes and powerful stats to bring readers aboard, and to keep them with you to the end.</i>
Rich details	Showing rather than telling to bring stories 'alive,' and using powerful details to connect with issues of broader significance as a storytelling strategy.	<i>Fine sourcing and effective use of a document. Story would be greatly strengthened, though, through use of stats as well as more development of characters and details regarding specific incidents, such as the grain bin accident, to bring the story alive for readers.</i>

After the initial coding scheme was developed, the reliability of the coding process was checked through an inter-rater reliability analysis. An educational psychology researcher working on a non-journalism domain was trained on the coding scheme and independently coded one tenth of randomly selected data for the presence or absence of each of the 17 codes. Reliability of the codes assigned by both the primary and secondary coders was measured through Cronbach's alpha. Across all codes Cronbach's alpha was 0.85; Cronbach's alphas for individual codes are provided in Table 2. Since the correlation was  $\geq 0.70$  (Nunnally & Bernstein, 1994), the primary coder coded the remaining data for the presence or absence of the 17 codes in all four datasets.

*Table 2: Cronbach's alpha values for reliability of qualitative codes comprising the coding rubric, showing correlation greater than 0.70 for each code between primary and secondary coder.*

<b>Code</b>	<b>Cronbach's Alpha</b>
<b>Witnessing</b>	0.932
<b>Pressing the source</b>	0.798
<b>Investigating</b>	0.725
<b>Narrative storytelling</b>	0.818
<b>Removing reader barriers</b>	0.845
<b>Detailed description</b>	0.737

<b>Journalistic writing</b>	0.905
<b>Reporting concepts</b>	0.889
<b>Reader concerns</b>	0.993
<b>Journalist as reporter</b>	0.932
<b>Journalist as writer</b>	0.943
<b>Informing the public</b>	0.909
<b>Engaging the reader in the story</b>	0.79
<b>Transparency</b>	0.844
<b>Accuracy</b>	0.837
<b>Personal narrative</b>	0.876
<b>Rich details</b>	0.795

### *Player learning outcomes*

Player responses to matched questions from the pre-, post- and follow-up interviews were analyzed for learning outcome differences. In each interview and for each player, coded data were first summed for each of the qualitative codes, and then aggregated into one of the five epistemic frame categories in order to determine if players showed learning gains on broad categories of journalism expertise. Mapping the grounded codes to particular epistemic frame categories was based on qualitative

interpretation of the codes and the coding rubric, similar to aggregations in prior studies (Bagley & Shaffer, 2009; Beckett & Shaffer, 2004; Hatfield & Shaffer, 2006).

Many of the qualitative codes were defined through the use in the copyediting discourse of keywords or particular parts of speech which aligned directly with particular epistemic frame categories. The codes for *Journalistic Writing*, *Reporting concepts*, and *Reader concerns* were each defined through the use of specific keywords or *terms of art* and so were mapped to the understanding or Knowledge epistemic frame category. The codes for *Journalist as reporter* and *Journalist as writer* were similarly defined through the use of particular keywords including ‘reporter’ and ‘journalist’ and so were interpreted as markers of identity. The codes for *Witnessing*, *Pressing the source*, *Investigating*, *Narrative storytelling*, *Removing reader barriers*, and *Detailed description* all involved particular actions and so were mapped to the epistemic category of Skills. The codes *Informing the public*, *Engaging the reader in the story*, and *Transparency* were mapped to the epistemic category of Values because each of these were defined in terms of priorities or normative guides for professional practice, i.e., standards which journalists *should* pursue or employ in practice. Finally, codes that aligned with fundamental principles or justifications to the profession—*Accuracy*, *Personal Narrative*, and *Rich details*—were mapped to the category of Epistemology.

Once the coded matched interview questions were aggregated by epistemic frame category, the mean number of references for each category was calculated for each player in each interview and then compared using paired sample t-tests. Learning gains were indicated by a statistically significant positive difference between pre- and post-interview means for a given epistemic frame category. After this initial comparison, the same technique was used to compare player responses from pre- to follow-up interview, conducted three months after the conclusion of the epistemic game, to look for any sustained learning outcomes. Quantitative results were further substantiated through qualitative analysis of exemplary interview response cases.

#### *Copyediting discourse similarity*

To analyze the similarity of copyediting discourse in each of the venues as well as by novice reporters during interviews, an epistemic network analysis was conducted on coded copyediting data from all four copyediting datasets (mentor copyedits in the journalism practicum, in the educational psychology course, and in *science.net*, and player copyedits in pre, post and follow-up interviews).

As described earlier in the Theory chapter, epistemic network analysis (ENA) measures the relationships between a set of discursive elements within a particular unit

of analysis or network, such as the relationships between the 17 different aspects of journalistic expertise used to code the copyediting feedback. Each epistemic network was defined as the set of copyediting feedback segments for an individual participant on an individual assignment in an individual setting, i.e., as one unit of analysis, and thus represented an epistemic frame as inferred through the coding process.

Formally, the journalism epistemic frame can be characterized by individual frame elements,  $f_i$ , where  $i$  = a particular coded element of a professional epistemic frame. For any participant,  $p$ , in any given story assignment,  $s$ , each segment of copyediting discourse,  $D^{p,s}$ , provides evidence of whether participant  $p$  was using one or more of the epistemic frame elements.

As described in the *Qualitative data coding* section, each segment of coded data was represented as a vector of ones or zeroes representing the presence or absence, respectively, of each of the 17 codes. *Links*, or relations, between epistemic frame elements were defined as co-occurrences of qualitative codes within the same segment. To calculate these links, each coded vector was then converted into an adjacency matrix,  $A^{p,s}$ , for participant  $p$  in a given story assignment,  $s$  (1).

$$A^{p,s}_{ij} = 1 \text{ if } f_i \text{ and } f_j \text{ are both in } D^{p,s} \quad (1)$$

Each coded segment's adjacency matrix,  $A^{p,s}_{ij}$ , was then converted into an adjacency vector and summed into a single cumulative adjacency vector for each participant  $p$  for each story assignment,  $U^{p,s}$ , i.e., for each unit of analysis (2).

$$U^{p,s} = \sum A^{p,s} \quad (2)$$

For each participant,  $p$ , and each story assignment,  $s$ , the cumulative adjacency vector,  $U^{p,s}$ , was used to define the location of the copyediting segments in a high dimensional vector space defined by the intersections of each the 17 codes, i.e., a 289 dimensional space.

Cumulative adjacency vectors were then normalized to a unit hypersphere to control for the variation in vector length, representing frequencies of co-occurring code pairs, by dividing each value by the square root of the sum of squares of the vector (3).

$$nU^{p,s} = U^{p,s} / \sqrt{\sum (U^{p,s})^2} \quad (3)$$

This was necessary to emphasize similarities in the types of co-occurring code pairs rather than similarities based primarily on the frequencies of co-occurring code pairs.

Cumulative adjacency vectors containing all zeroes, i.e., segments containing no co-occurrence data, were then removed from the dataset because the normalization process positions all such vectors at the origin rather than projecting them into the high dimensional vector space. Following normalization, the journalism practicum included

327 copyedit segments, the science.net game included 257 copyedit segments, the psychology practicum included 130 segments, and the player interviews included 92 segments.

A singular value decomposition (SVD) was then performed to explore the structure of the qualitative code co-occurrences in all of the copyediting datasets. SVD was used to first project the normalized cumulative adjacency vectors into a high dimensional space such that similar patterns of co-occurrences between epistemic frame element codes would be positioned proximately. The SVD analysis then decomposed the structure of the data in this high dimensional space into a set of uncorrelated components, fewer in number than the number of dimensions that still account for as much of the variance in the data as possible. The first two principal components were chosen from the 289 generated as both capturing the most variance in the data and “providing useful interpretations” (Bartholomew et al., 2008, p.124).

Positions for each unit of analysis on each of the first and second principal components were determined by multiplying the unit’s normalized cumulative adjacency vector by the component loadings. This produced two values used to plot the positions for each unit of analysis in two dimensional graphs.

Similarity between settings was analyzed by calculating the mean position on the component for all units from the same setting and then comparing values using

unpaired two-sample t-tests. Similarity was indicated by the absence of a statistically significant difference between values on each component.

In order to interpret each component, the pattern of component loadings (i.e., pairs of co-occurring epistemic frame element codes contributing to the component) was examined (Bartholomew et al., 2008, p.124). Specifically, the three most positive and most negative component loadings were used to define the significance of the component itself and also to guide subsequent qualitative analysis of feedback comments.

### *Robustness*

One additional analysis was also conducted as a preliminary examination of the robustness of the mentor copyediting ENA results. For this analysis, a reduced data set was produced using the same process as described above except seven of the original 17 codes were removed. These codes—*Pressing the source*, *Investigating*, *Narrative Storytelling*, *Journalist as reporter*, *Journalist as writer*, *Personal narrative*, and *Rich details*—were never observed in the copyediting feedback in the psychology practicum, and were removed to explore whether patterns of co-occurring code pairs were sensitive to the lack of data in these codes in the psychology dataset.

## CHAPTER 4: RESULTS

The results of this work are presented in three parts. In Part One, epistemic network analysis is used to provide evidence that differences in professional mentoring feedback from a journalism practicum and an educational psychology practicum can be measured. In Part Two, epistemic network analysis is used to provide evidence that the epistemic game, Science.net, reproduced the professional mentoring feedback of a journalism practicum upon which it was modeled. Finally, in Part Three, Science.net player learning outcomes are analyzed, initially highlighting the journalism skills, knowledge, identity, values, and epistemology developed during game-play. Then, epistemic network analysis is used once again, this time to show players learned to use these different epistemic frame elements together in ways similar to a professional journalism mentor.

### *Part One: Distinguishing professional practicum feedback*

Using epistemic network analysis, as described in Chapter 3, mentor copyediting feedback data from a professional journalism practicum and a professional educational research practicum were analyzed for similarity using ENA. On the first principal

component (PC1), the journalism feedback overall (mean = 0.2943, SD = 0.1094) is different from the psychology course feedback overall (mean = -0.5679, SD = 0.1245,  $p < 0.01$ ). On the second principal component (PC2), the journalism feedback overall (mean = 0.2455, SD = 0.1505) is also different from the psychology course feedback overall (mean = 0.0698, SD = 0.0637,  $p < 0.01$ ).

In addition, none of the 95% confidence intervals for mentor feedback on individual journalism stories overlaps with mentor feedback in the assignments in the psychology course for the first component. While not as pronounced, this difference is also observed for the second component, with only one set of journalism mentor feedback (story 2) showing an overlapping 95% confidence interval with either of the psychology mentor feedback sets (see Figure 1; see Table 3 for means, standard deviations, and 95% confidence intervals for individual assignments).

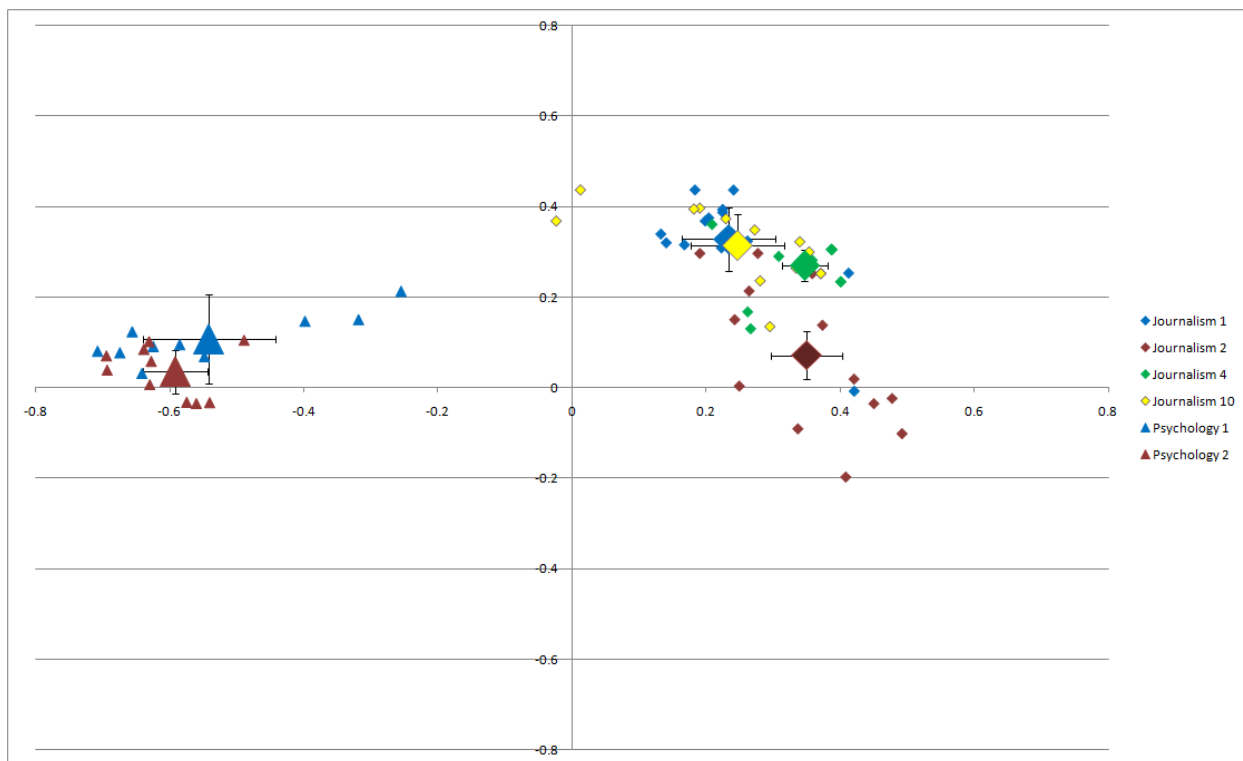


Figure 15 Showing significant differences between journalism practicum copyedit feedback (diamond icons) and psychology practicum feedback (triangle icons) on the principal component (x-dimension). Enlarged icons represent assignment means.

<sup>5</sup> In graphs of ENA results presented in this study, smaller points represent copyedit feedback for individual participants in a given venue for an individual assignment. Each venue is represented by a distinct icon shape, and each assignment within each venue is indicated by a color series, with the first assignment set in blue, the second in red, an optional third in green, and an optional fourth in yellow. Finally, the means for each combination of venue, assignment, and participants, are represented by oversized icons with 95% confidence intervals reflected in the associated whisker plots.

Table 3: Descriptive statistics for feedback aggregated by assignment in Journalism practicum (J1 through J10) and Psychology practicum (P1 and P2), showing significant difference between the two practica on the first principal component.

		J 1	J 2	J 4	J 10	P 1	P 2
PC 1	Mean	0.2340	0.3496	0.3471	0.2466	-0.5414	-0.5920
	St. Dev.	0.0893	0.0978	0.0635	0.1288	0.1596	0.0820
	Conf. Int. (95%)	0.1855, 0.2825	0.2964, 0.4028	0.3126, 0.3816	0.1766, 0.3166	-0.4425, -0.6403	-0.5436, -0.6404
PC 2	Mean	0.3277	0.0716	0.2690	0.3136	0.1076	0.0354
	St. Dev.	0.1136	0.1634	0.0626	0.0842	0.0519	0.0541
	Conf. Int. (95%)	0.2792, 0.3762	0.0184, 0.1248	0.2345, 0.3035	0.2436, 0.3836	0.0087, 0.2065	-0.0130, 0.0838

Analysis of mentor feedback within each setting shows mixed similarity results.

For the psychology course, on component 1 (PC1) the mentor feedback on the first assignment (mean = -0.5414, SD = 0.1596) is not statistically different from mentor feedback on the second assignment (mean = -0.5920, SD = 0.0820,  $p > 0.05$ ), while on the second component (PC2) the same first assignment feedback (mean = 0.1076, SD = 0.0519) is statistically different from feedback on the second assignment (mean = 0.0354, SD = 0.0541,  $p < 0.01$ ).

The journalism practicum also shows mixed similarity results when comparing mentor feedback on stories within this setting. For example, the first component of

mentor feedback on the first story in this setting (mean = 0.2340, SD = 0.0893) is not statistically different from feedback on the final story (mean = 0.2466, SD = 0.1288,  $p > 0.05$ ), but is different from feedback on the second story (mean = 0.3496, SD = 0.0978,  $p < 0.01$ ) and fourth story (mean = 0.3471, SD = 0.0635,  $p < 0.01$ ). The second component of mentor feedback on the first story (mean = 0.3277, SD = 0.1136) is also not statistically different from feedback on the final story (mean = 0.3136, SD = 0.0842,  $p > 0.05$ ), but is different from feedback on the second story (mean = 0.0716, SD = 0.1634,  $p < 0.01$ ).

Results from these two venues suggest that in both cases feedback varied somewhat between assignments. Since each assignment posed a different practice situation for students to engage with, it is not surprising that differences in mentor feedback emerge. At the same time, as the comparison between the settings shows, there are much larger differences in the journalism mentor feedback and the psychology mentor feedback. In other words, using this approach it is possible to measure both similarities and differences between journalistic and non-journalistic mentor feedback.

To better understand what each of these principal components represents and thus what similarity and/or difference between instances of mentor feedback on these components means, we can look at the details of the components. The first and second principal components account for approximately 29% of the variance within the copyediting data. For each component, correlation coefficient loadings with an absolute

value greater than 0.1 were singled out for use in defining the significance of each dimension. While not a very large correlation, for this data set this threshold identifies the 3-5 most positively and negatively correlated code pairs for each dimension, and is shown in Table 4.

*Table 4: Component loadings for the first and second principal components, copyediting feedback data, showing a contrast between positive coefficients for linkages between reporting and writing elements and negative coefficients for linkages between writing clarity and audience concerns.*

	Code pairs	$\alpha_{i1}$		Code pairs	$\alpha_{i2}$
	Proportion of total variance	17.9%		Proportion of total variance	11.2%
Most Positive	Investigating x Reporting concerns	0.1858	Most Positive	Journalistic writing x Reader concerns	0.2303
	Journalistic writing x Reporting concerns	0.1718		Reader concerns x Informing the public	0.1992
	Investigating x Journalistic writing	0.1378		Detailed description x Reader concerns	0.1643
	...	...		...	...
Most Negative	Detailed description x Reader concerns	-0.1242	Most Negative	Investigating x Journalist as reporter	-0.1126
	Reader concerns x Engaging the reader	-0.3062		Reporting concerns x Accuracy	-0.1148
	Detailed description x Engaging the reader	-0.3960		Investigating x Reporting concerns	-0.1749

The first component,  $\alpha_{i1}$ , can be interpreted as a contrast in mentor feedback between writing seen primarily through the lens of sourcing and writing seen primarily through the lens of readers. Using the three most positive loadings on this component reveals a nexus of elements, indicating a relationship between investigating practices

and reporting concepts, writing concepts and reporting concepts, and investigating practices and writing concepts—all part of information gathering to produce good stories. In contrast, the three most negative loadings suggest a different complex of elements. This complex shows a relationship between detailed writing practices and reader understanding, reader understanding and the importance of engaging readers, and detailed writing practices and engaging readers—elements that situate writing in terms of readers.

The second component,  $\alpha_{i2}$ , can be interpreted as contrast in mentor feedback between a focus on informing the public and a focus on finding the right information through investigation. Again, using the three most positive loadings on this component reveals a clustering of elements. In this case, the cluster indicates a relationship between understanding of story and reader, understanding of reader and the importance of informing the public, and detailed writing practices and reader understanding—all elements about providing readers particular kinds of information. The three most negative loadings on the second component reveal a contrasting cluster indicating a relationship between investigating practices and the professional identity of being a reporter, reporting concepts and fundamental concerns with accuracy, and investigating practices and reporting concepts—i.e., a complex of elements about the process of reporting.

This interpretation of the components can be substantiated by examining the feedback comments on the stories themselves. For instance, one of the stories from the journalism practicum that was positioned most positively on both component one and two received feedback including these comments<sup>6</sup>:

... In above graph, don't settle for letting a source promise "good music." Provide specific examples and provide a hint why music matters in Madison. Strive, too, to pursue more energetically the question of who got left out of the party...

... some good specifics in the Sensenbrenner section. Just add a little more color about who he is, a tale about why he's concerned, and it'd really sing.

... Wagner content above is fairly strong. Keep striving, though, to elicit dramatic tales - what pushed him to become involved, what conflicts have erupted, what surprising pieces of history has he unearthed? And remember to describe his appearance and voice to help draw readers into the report.

... Ahh, but the readers of this story would like one or two of those stories of history and aristocracy. Don't let sources skate by too easily. And some neighborhoods were segregated. Tell those tales, too, or at least allude to them.

In comments like these, we can see numerous examples of the patterns of frame element linking suggested by the quantitative analysis. In the first two comments above, the mentor focuses attention on the skills of *investigating* ("don't settle for letting a source promise 'good music'", "pursue more energetically the question of who got left out"), linked with both *reporting* terms of art ("a source") and journalistic *story* terms ("above graph", "a little more color"), a combination of elements reflected in the positive end of the first principal component. In the third comment above, the mentor also links story

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<sup>6</sup> See Appendix 4 for the complete set of feedback comments on this example.

terms (“Wagner content,” “dramatic tales”) with skills of providing *detailed description* (“remember to describe his appearance and voice”) for *reader engagement* (“... to help draw readers into the report”), reflecting the positive end of the second principal component. And in the final comment excerpted above, both of these complexes are reflected, as the mentor justifies *detailed description* through an understanding of *readers* (“readers of this story would like .. those stories”), and links these concerns for *story* and *informing the public* with *investigation* skills (“Don’t let sources skate by too easily”, “Tell those tales too”).

In contrast, feedback on assignments from the non-journalism comparison practicum show a different complex of elements being emphasized. For example, one of the assignments from the educational psychology practicum that was positioned most negatively on component one and slightly positively on component two received feedback including these comments<sup>7</sup>:

... This is a great study. I really like the idea that you were able to develop a coding scheme that operationalizes elements of [Dreyfus & Dreyfus]’s framework in the context of video evaluation of teaching, and that the scheme can differentiate between expert and novice teachers. Cool....

... Why does this matter? ...

... I don’t see why that interpretation follows. It feels like you are just assuming that as a reader I will see the difference between what the expert is doing and what the novices did. Your job is to explain it to me—and, actually, to show me that the categories [Dreyfus & Dreyfus] provide are the right tools to make that clear. I think that the fact

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<sup>7</sup> See Appendix 5 for the complete set of feedback comments on this example.

that your data is heavily weighted to the novices makes this more problematic, of course. ...

In this case, the mentor also emphasized the importance of *detailed description*, from developing elements of a theoretical framework (“you were able to develop a coding scheme that operationalizes elements of .. framework”) to ‘explaining’ and ‘showing’ particular details of an argument (“your job is to explain it to me – and, actually show me”). These are also linked to concerns about *reader engagement* (“I don’t see why that interpretation follows”) and assumptions that seem to jeopardize that engagement (“you are just assuming that as a reader I will see the difference”). In emphasizing and linking these elements, this feedback reflects elements defining the positive end of the second principal component, like the journalism practicum feedback.

But as might be expected, there are also clearly differences from the journalism practicum feedback excerpts. Feedback to provide more detail and engage readers in this setting is not bound to concerns for reporting or investigating. Instead, this feedback emphasizes writing concerns within a research oriented framework (“a great study”) where methodology (“scheme can differentiate between expert and novice teachers”), argument (“explain it to me ... show me that the categories [Dreyfus & Dreyfus] provide are the right tools”), and evidence (“the fact that your data is heavily weighted to the novices makes this more problematic”), rather than more journalistic

concerns of story writing and reporting, predominate. This combination of reader-focused elements and the absence of reporting and investigation elements thus reflects the significance of the negative end of the first principal component.

This result is also fairly robust. One concern might be that the similarities and differences seen in Figure 1 were artifacts of the way the principal components were generated given that the coded mentor feedback from the non-journalism practicum, not surprisingly, included far more zeros (reflecting the absence of journalism epistemic frame elements) than the other settings. To address this potential problem and as described in the Methods chapter, a second epistemic network analysis was performed with a new dataset include only those epistemic frame code dimensions which were represented in the non-journalism practicum.

Using the same analytic process as followed above, the reduced mentor copyediting feedback datasets from the professional journalism practicum and the professional educational research practicum were analyzed for similarity using ENA. Because this was a new dataset, a new high dimensional space was generated from the data, which produced a new set of principal components. However, while a full elaboration of the new dimensions is beyond the scope of this study, the relationships between the different datasets, while inverted, appear to persist<sup>8</sup>.

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<sup>8</sup> See Appendix 8 for the relevant component loadings for the first and second components in this new space.

On the first principal component (PC1), the journalism feedback overall (mean = -0.2390, SD = 0.1651) is different from the psychology course feedback overall (mean = 0.5434, SD = 0.1327,  $p < 0.01$ , see Figure 2). On the second principal component (PC2), the journalism feedback overall (mean = 0.3270, SD = 0.2121) is also different from the psychology course feedback overall (mean = 0.0418, SD = 0.1066,  $p < 0.01$ ). In other words, despite reducing the dataset to only those elements observed in both the journalism practicum and the psychology practicum, ENA is able to differentiate mentor copyediting feedback from different practicum environments.

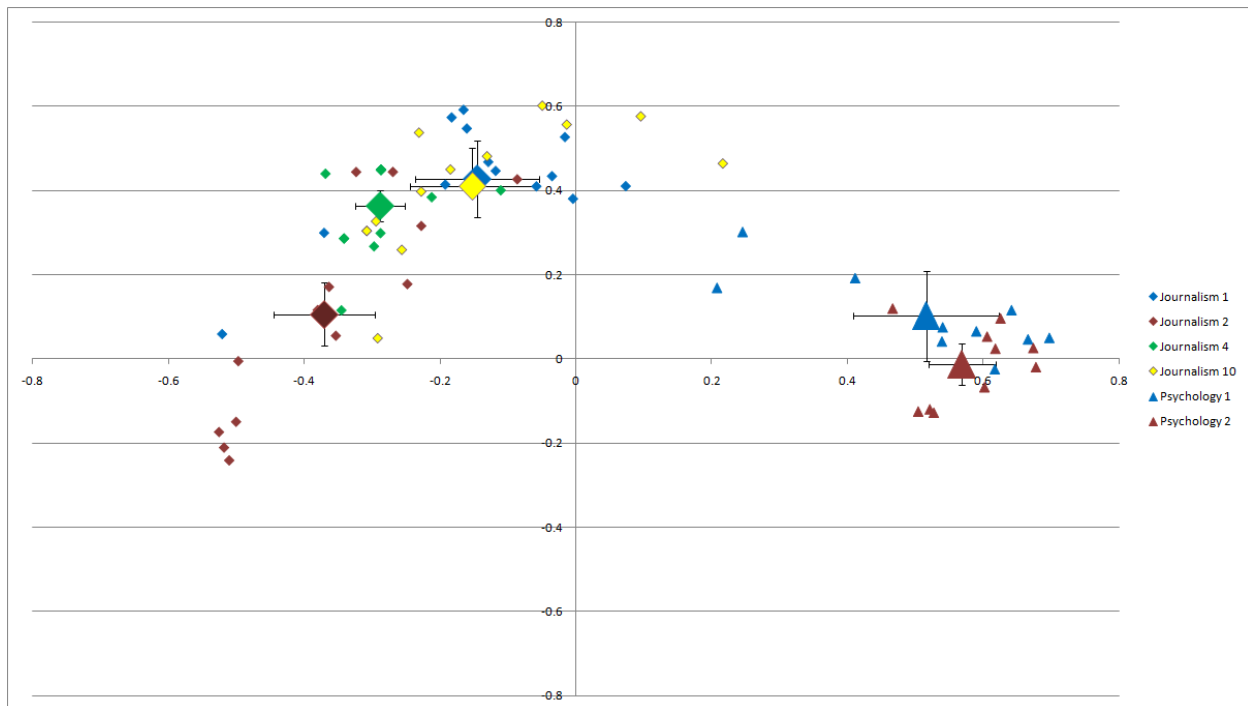


Figure 2: Copyediting feedback plotted on first and second principal components using a reduced data set to test robustness, and showing a vertically mirrored but similar pattern of relative positions for mentor and player feedback as was obtained in the main analysis.

In sum, epistemic network analysis (ENA) can provide a relatively robust way of measuring and contrasting mentor feedback, differentiating copyedit feedback in a journalism practicum from that of a non-journalism professional learning environment. While both practica revealed concerns about writing and readers which was reflected in the second principal component, particular patterns of associations with reporting and investigative skills and values were discernable between the two settings in the more significant first principal component. In the next part, we use this technique to measure and contrast the mentor feedback from the journalism practicum with that from the epistemic journalism game, *science.net*.

### ***Part Two: Measuring the fidelity of game feedback***

*Science.net*, an epistemic game for middle school-aged young people, was designed to simulate a professional journalism practicum, and featured adult desk editors providing copyediting feedback for the game's players. Since none of the game's desk editors were themselves journalists by training, the second research question seeks to measure how similar the mentoring feedback in the game was to the professional journalism practicum model.

Following the same process of epistemic network analysis described above, mentor copyediting feedback data from *science.net* was analyzed for similarity with feedback from the two professional practica. On the first principal component (PC1), the game feedback overall (mean = 0.2680, SD = 0.1497) is not different from the journalism practicum feedback overall (mean = 0.2943, SD = 0.1094,  $p > 0.05$ ). On the second principal component (PC2), the game feedback overall (mean = 0.1940, SD = 0.1048) is also not different from the journalism feedback overall (mean = 0.2455, SD = 0.1505,  $p > 0.05$ ). Moreover, all of the 95% confidence intervals for mentor feedback on individual game stories overlap with mentor feedback in the journalism practicum for the first and second components (see Figure 3).

In contrast, on the first principal component, the game feedback overall (mean = 0.2680, SD = 0.1497) is statistically different from the psychology course feedback overall (mean = -0.5679, SD = 0.1245,  $p < 0.01$ ), and, on the second principal component, the game feedback overall (mean = 0.1940, SD = 0.1048) is also statistically different from the psychology course feedback overall (mean = 0.0698, SD = 0.0637,  $p < 0.01$ ). Additionally, none of the 95% confidence intervals for mentor feedback on individual game stories overlap with mentor feedback in the journalism practicum for the first component, although for the second component there are several overlapping 95% confidence intervals for feedback on the game stories and feedback on the psychology assignments

(see Figure 3; see Table 5 for means, standard deviations, and 95% confidence intervals for individual assignments).

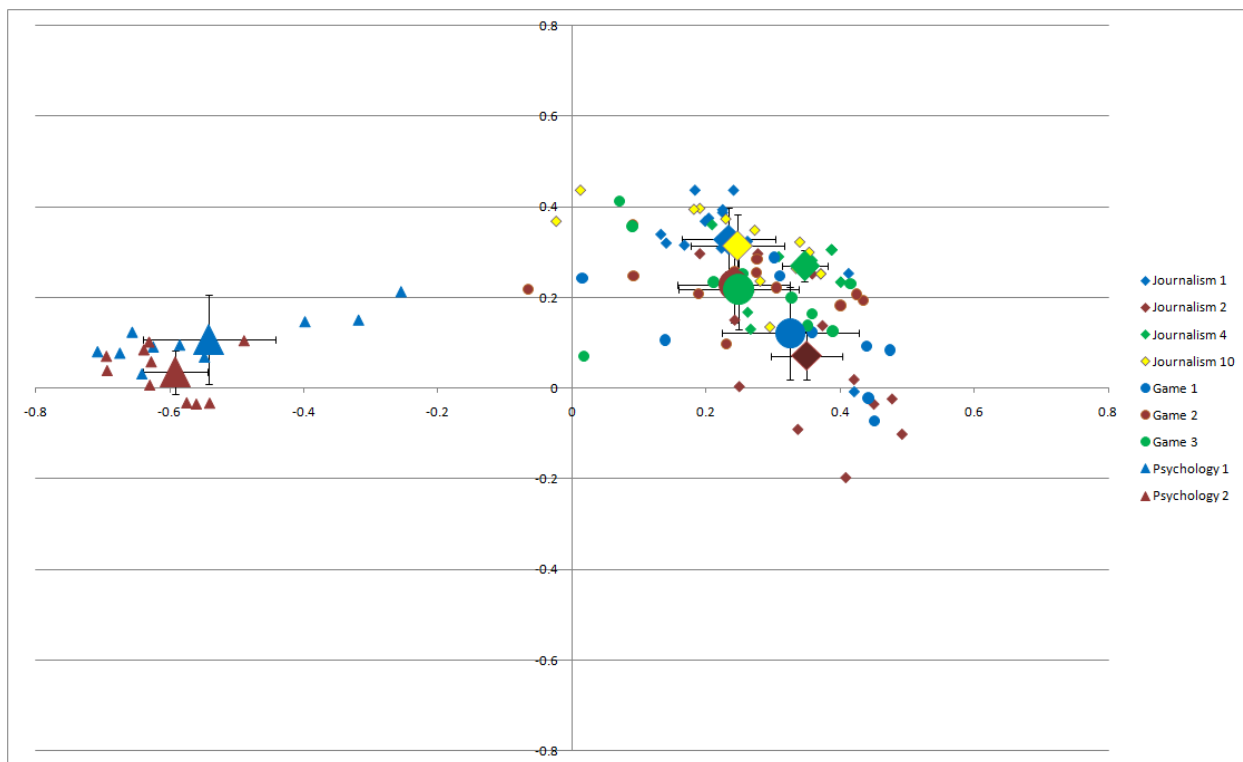


Figure 3 Showing mentor copyediting feedback from journalism practicum, non-journalism comparison practicum and Science.net game, suggesting game mentor copyedit feedback measurably reproduced this important professional practice from the journalism practicum.

Table 5: Descriptive statistics for feedback aggregated by assignment in journalism practicum (J1 through J10), psychology practicum (P1 and P2), and science.net game (G1, G2, and G3), showing similarity between the journalism practicum and science.net on the first and second components.

		J 1	J 2	J 4	J10	P 1	P 2	G 1	G 2	G 3
PC 1	Mean	0.2340	0.3496	0.3471	0.2466	-0.5414	-0.5920	0.3255	0.2411	0.2485
	St. Dev.	0.0893	0.0978	0.0635	0.1288	0.1596	0.0820	0.1570	0.1492	0.1444
	Conf. Int. (95%)	0.1855, 0.2825	0.2964, 0.4028	0.3126, 0.3816	0.1766, 0.3166	-0.4425, -0.6403	-0.5436, -0.6404	0.2229, 0.4281	0.1567, 0.3255	0.1590, 0.3380
PC 2	Mean	0.3277	0.0716	0.2690	0.3136	0.1076	0.0354	0.1213	0.2281	0.2186
	St. Dev.	0.1136	0.1634	0.0626	0.0842	0.0519	0.0541	0.1219	0.0634	0.1048
	Conf. Int. (95%)	0.2792, 0.3762	0.0184, 0.1248	0.2345, 0.3035	0.2436, 0.3836	0.0087, 0.2065	-0.0130, 0.0838	0.0187, 0.2239	0.1437, 0.3125	0.1291, 0.3081

In other words, using ENA's quantitative technique, mentor feedback in the game successfully reproduced mentor feedback from a professional journalism practicum. A qualitative look at the mentor feedback from the two settings confirms this result. Excerpts from one of the game's assignments included these comments<sup>9</sup>:

... As a reader, I really appreciate how you explain the process of converting manure into biogas. I'd love to see a picture of a biogas converter! You use Professor Reinemann's quotes really well, but I'd like to see more sources. Maybe you can find more sources when you fill in information about the benefits, risks, and price. Start by asking Ted tomorrow. Well done!

... YES! Your lead grabbed me! You piqued my senses. Well done!!! Your initial quote is great, but it kind of comes out of nowhere. I'd think about setting up your quote with an

<sup>9</sup> See Appendix 6 for the complete set of feedback comments on this example.

introductory sentence that says something like 'In a recent interview with Doug Reinemann, he described the process of converting cow manure into energy.'

... Great sourcing and structure. As a reader, I followed your story well and learned lots of valuable information that is important to me. Thanks!

... Well balanced reporting! Did Ted say can't or can in the following quote?

... Your readers will appreciate your analogy!

In these comments and much like the journalism practicum, we can see the game mentor encouraging attention to particular aspects of journalistic expertise while linking these aspects together. She commends the player's understanding of *reporting* and *story* ("I really appreciate how you explain...", "you use Professor Reinemann's quotes really well", "Your lead grabbed me"), while also encouraging the reporter to do more *investigation* ("I'd like to see more sources", "Maybe you can find more sources..."). As she encourages the reporter to think about writing through the lens of sourcing, we can see the game mentor's feedback reflecting the complex of elements defining the positive end of the first component.

The game mentor's feedback also reflects the complex of elements defining the positive end of the second component. Through comments that link *readers* with *story details* and *information* ("As a reader, I really appreciate how you explain," "As a reader, I followed your story," "Your readers will appreciate your analogy"), we can see the positive end of the second component as well, with the mentor's feedback focusing on the complex of elements around providing readers with the right kind of information.

Thus, looking across the three settings, epistemic network analysis is able to differentiate journalistic mentor feedback from non-journalistic feedback in two professional learning environments. Further, this technique also shows that the Science.net game was able to reproduce an important aspect of journalistic training and learning practice. In the next section, we move on to the next research question: were players in the game able to develop the particular aspects of journalistic expertise?

### *Part Three: Learning Outcomes of Game-play*

#### *Learning the elements of journalism*

Overall, the results from the pre- and post-interviews suggest that players were able to develop aspects of the repertoire of journalism skills, knowledge, identity, values, and epistemologies as a result of playing Science.net. Matched pair questions on each of the interviews probed players' understanding of the different epistemic frame elements, asking them to define key concepts, articulate their views, and engage in journalism tasks. In the pre-interviews, many of the players' responses to the matched pair questions provided brief and generic descriptions of journalism, suggesting a

limited understanding of the profession. However, in the post-interviews, players' responses were more accurate, specific, and sophisticated, demonstrated by the significant increase in the number of references to each frame element across the set of matched pair questions from pre- to post-interview. Moreover, the results from the follow-up interviews indicate that learning gains observed immediately after the game ended (in the post-interview) were still present three months later. The learning outcomes associated with each of the frame elements are presented below, including the results of paired-sample t-tests and excerpts from player interviews.

### *Skills*

References to journalism skills increased significantly from pre- to post-interview (mean pre = 4.2, mean post = 7.6,  $p < 0.01$ , Figure 4.) This learning gain was maintained through the follow-up interview as well (mean pre = 4.2, mean follow-up = 7.4,  $p < 0.01$ , Figure 4). For example, when asked how journalists get information for their stories, one player responded, "they just look around for stories themselves." After the game, the same player provided a more detailed answer, stating:

Well I guess researching on the internet and interviewing different people on the topic. ... Because well on the internet if you look up like reliable sites then if by writing that in your story then people will trust your story more and believe what you're saying and plus the internet there's so many different sites and you can learn a lot from it if you get on the right sites and interviewing people, you're interviewing experts on the topic so

they'll know a lot and it will also add more to your story because it will give someone's opinion about it and also people will I guess respect and will want to read more about your story if there are quotes cause it's someone reliable saying something that they think about.

In this response, the player describes several aspects of journalistic practice. In particular, s/he distinguishes between different ways that reporters get information – through research and interviews – while also providing a much richer sense of how these skills are bound to journalistic values of reliability and reader engagement.

### *Knowledge*

References to journalism knowledge increased significantly from pre- to post-interview (mean pre = 5.3, mean post = 15.1,  $p < 0.01$ , Figure 4.) This learning gain was maintained through the follow-up interview as well (mean pre = 5.3, mean follow-up = 14.7,  $p < 0.01$ , Figure 4). For example, when asked why journalists edit their stories, one player responded, "[s]o they don't say something inappropriate or if they make like grammar mistakes or like a spelling mistake or something."

In the post interview, the same player responded:

Because it's important. I mean you don't want to have spelling mistakes or grammar mistakes cause it's easy to fix. You know just spell check and if people see it then they'll just read that and move on because they know it's an easy thing to fix and they really won't want to read your story. And plus like editing, if you read over it, maybe the transitions aren't good, and just making your story flow better and going over it is important. I mean you just don't want to write something and leave it like that and

making sure your beginning like grabs the reader and there's a lot of things to think about and your organization, which things are going first.

In this response, the player moves beyond his/her initial understanding of journalistic writing practice as relatively generic writing concerns related to grammar and spelling. Expanding on that, the player draws attention to the importance of getting the organization or structure of the story right and situates editing relative to an understanding of how readers will react – if it doesn't grab the reader, if the reader sees easily correctible mistakes, they'll simply stop reading – something of paramount importance to avoid for journalists.

### *Identity*

References to journalistic identity increased significantly from pre- to post-interview (mean pre = 1.2, mean post = 5.2,  $p < 0.01$ , Figure 4.) This learning gain increased slightly through the follow-up interview (mean pre= 1.2, mean follow-up = 5.9,  $p < 0.01$ , Figure 4). For example, when asked if he had ever thought of himself as a journalist in the pre interview, one player said, "No." In response to the same question after the game, the same player said:

[W]hen we did the Science.net thing. ... because I had to search for the right facts and I had a due date and I was supplying the public who go to that website with facts.

In this response, the player describes the dual nature of journalistic identity – the *journalist as reporter*, gathering accurate information ‘the right facts’ to ‘supply the public’, and the *journalist as writer*, working on deadline to get stories out, in this case published to the game’s public website. Further, while 4 of 12 participants indicated they had thought of themselves as journalists before the game and self-reports of identity should always be taken as relatively thin evidence, all 12 indicated after the game they felt they had been journalists while playing.

### *Values*

References to journalistic values increased significantly from pre- to post-interview (mean pre = 4.3, mean post = 10.2,  $p < 0.01$ , Figure 4), and this increase was maintained through the follow-up interview (mean pre = 4.3, mean follow-up = 9.5,  $p < 0.01$ , Figure 4). For example, when asked, what does it mean to be a journalist, before the game one player responded: “Well, you can either be a journalist like literally your job is journalism, or you can just, you can keep your own daily journal if you want.”

After the game, the same player responded:

I think to be a good journalist you have to be unbiased, or... you can have an opinion, but you shouldn’t let it show in your story because you want the reader to be able to make up their own mind. ... You have to have enough information that the reader is informed but... it doesn’t put them to sleep reading the article.

This player's response is particularly interesting as it articulates an important set of journalistic values that guide professional practice, details absent from the player's pre-interview response. Journalists report and write so that 'the reader is informed,' in an engaging way that seeks to manage personal bias, for the ultimate purpose of helping readers 'make up their own mind.'

### *Epistemology*

References to journalism epistemology increased significantly from pre- to post-interview (mean pre = 2.1, mean post = 6.0,  $p < 0.01$ , Figure 4.) This learning gain was maintained in the follow-up interview (mean pre = 2.1, mean follow-up = 5.8,  $p < 0.01$ , Figure 4). For example, when asked how s/he would decide if s/he should use information that s/he found on the Internet? in the pre-interview, one player responded:

Well if I find information on the internet that maybe that I think supports the points that I'm trying to get across in my writing and I think that not just repeating something else I've gotten there, that it makes sense and that it would help to sort of make my writing more interesting, then I'd use that in a science essay or something.

In the post-interview, the same player responded:

I would see if it has credible sources, for instance on the address and stuff you can find a lot of stuff like if it's a .edu and something then you know it's definitely credible or .gov and depending on who has created the site, which you can also find out from the site, you can also find out if it's credible.

In this response the player demonstrates an important shift in thinking about information and research. Rather than looking solely for agreement, the credibility of the source, its quality, has become a primary concern.

The statistically significant increases from pre- to post-interview, and the extent to which those increases were sustained in the follow-up interview, can be seen in Figure 4. As such, it summarizes the results presented above, which suggest that players were able to begin to develop the journalism epistemic frame as a result of playing *science.net*.

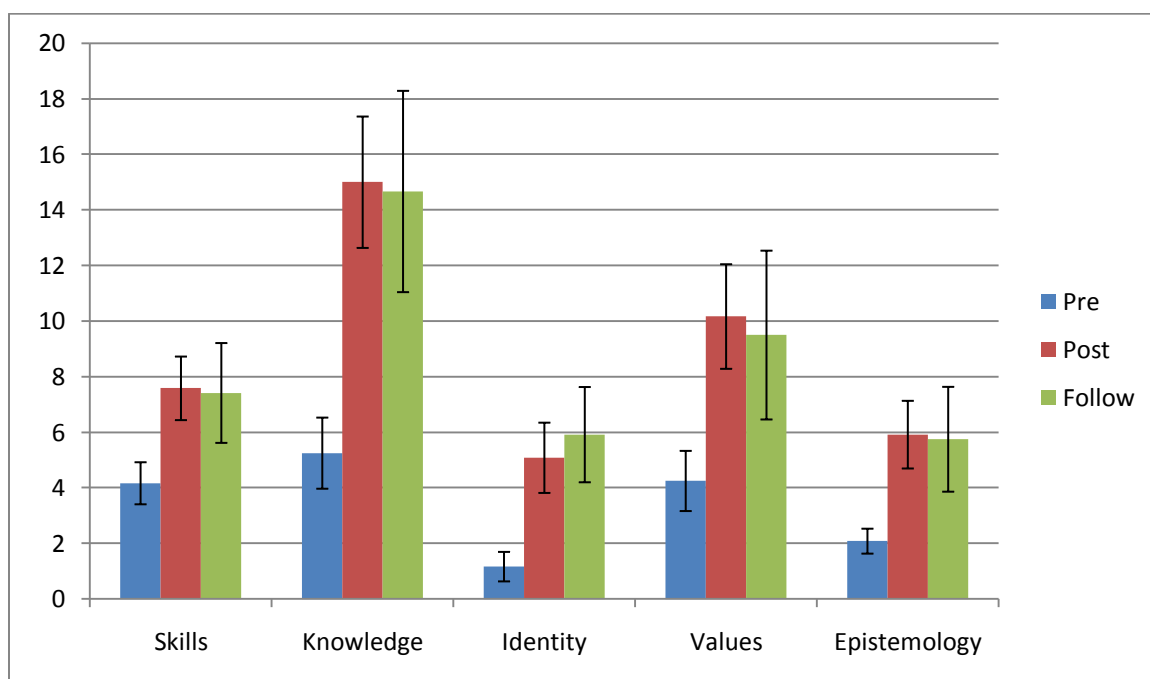


Figure 4 Epistemic frame elements demonstrated in outcome measures showing significant learning gains from pre- to post-interviews sustained through follow-up interviews.

Clearly, players learned individual aspects of journalistic expertise as demonstrated in the significant increases from pre-interview to post-interview and sustained through the several months later follow-up interview. However, according to epistemic frame theory, the more important question is the extent to which players learned to use these different dimensions together while engaged in professional problem solving. This question is addressed in the next section.

### *Complex Learning Outcomes: putting the elements together*

As shown in the epistemic network analysis in Part Two, *science.net* successfully reproduced a key mentor feedback practice from the professional journalism practicum. As shown in the learning outcomes analysis above, *science.net* players demonstrated learning gains on particular categories of epistemic frame elements as a result of playing the game. Bringing the two together, this section addresses research question three: whether players learned to use these different elements of journalistic expertise together in ways that reflect the professional journalism epistemic frame.

As described in the Methods chapter, during each of the pre-, post- and follow-up interviews, *science.net* players were asked to complete a journalism copyediting task in which they were asked to read draft information for a possible story and then

evaluate and provide feedback on that information as if they were journalists at a newspaper. Responses were analyzed for similarity using the same process of epistemic network analysis described in Part One above.

On the first principal component (PC1), player responses in the post-interview (mean = 0.4282, SD = 0.0807,  $p < 0.01$ ) are different from player responses in the post-interview (mean = 0.0885, SD = 0.1524), and this difference was maintained through the follow-up interview responses (mean = 0.4334, SD = 0.1245,  $p < 0.01$ ). No statistical difference was found for the second principal component (PC2) between the pre-interview responses (mean = 0.0022, SD = 0.1201) and the post-interview responses (mean = -0.0849, SD = 0.0999,  $p > 0.05$ ). At the same time, 95% confidence intervals for player pre-interview responses do not overlap those of player post-interview responses for PC1 (see Figure 5, see Table 5 for means, standard deviations, and 95% confidence intervals for each interview). In other words, we see a significant increase in players' use of the complex of elements related to thinking about writing through the lens of sourcing.

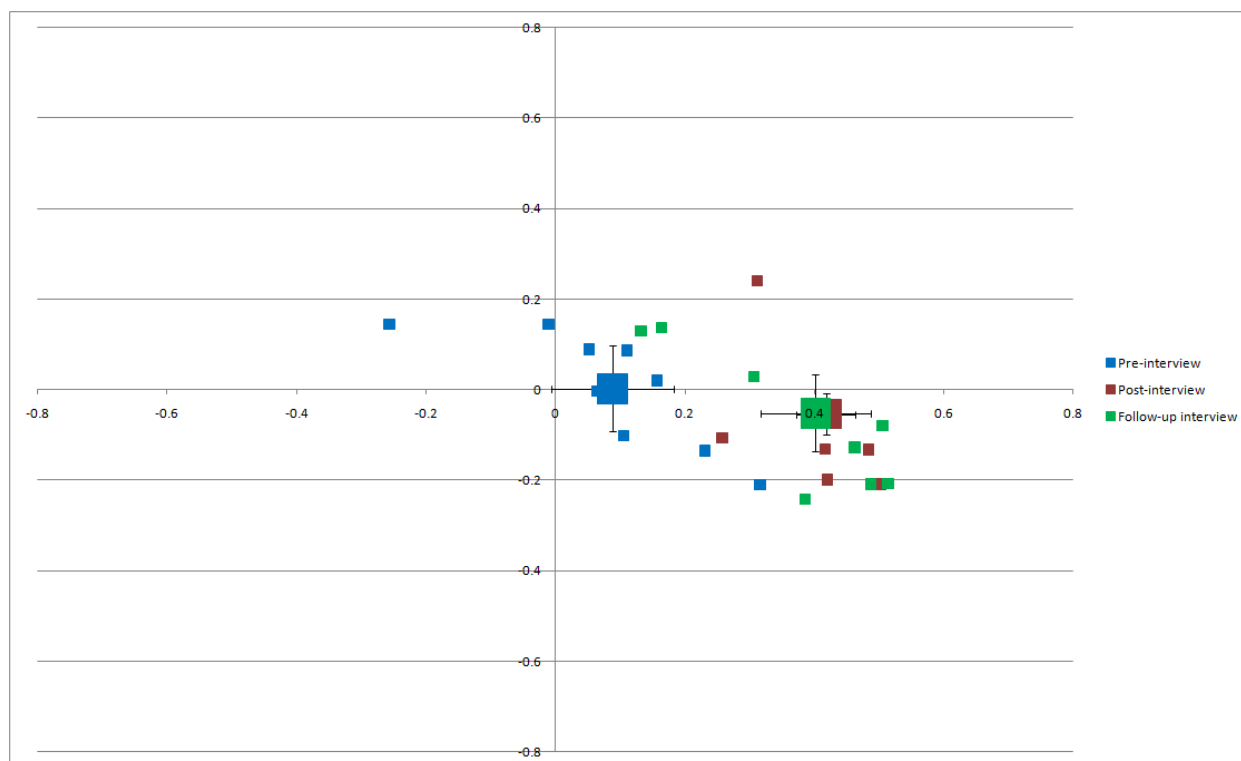


Figure 5 Science.net player interview copyediting task data, showing a significant difference between pre-interviews and post-/follow-up interviews for both the first and second principal components

Table 6: Descriptive statistics for player copyediting feedback from pre-interview, post interview, and follow-up interviews, showing a significant difference between the pre- and post interviews on the first principal component.

		Pre Interview	Post Interview	Follow-up Interview
PC 1	Mean	0.0885	0.4282	0.4334
	St. Dev.	0.1524	0.0807	0.1245
	Conf. Int. (95%)	-0.0059, 0.1829	0.3781, 0.4782	0.3521, 0.5148
PC 2	Mean	0.0022	-0.0849	-0.0514
	St. Dev.	0.1201	0.0999	0.1317
	Conf. Int. (95%)	-0.0722, 0.0767	-0.1468, -0.0230	-0.1374, 0.0347

Player interview response data was also compared with mentor copyediting data using ENA. On the first principal component (PC1), player responses in the pre-interview (mean = 0.0885, SD = 0.1524) are different from mentor feedback in the game overall (mean = 0.2680, SD = 0.1497,  $p < 0.01$ ). On PC1 player responses in the post-interview (mean = 0.4282, SD = 0.0807) are also different from mentor feedback in the game overall (mean = 0.2680, SD = 0.1497,  $p < 0.01$ ). Likewise, on the second principal component (PC2), player responses in the pre-interview (mean = 0.0022, SD = 0.1201) are different from mentor feedback in the game overall (mean = 0.1940, SD = 0.1048,  $p < 0.01$ ), and on PC2 player responses in the post-interview (mean = -0.0849, SD = 0.0999) are also different from mentor feedback in the game overall (mean = 0.1940, SD = 0.1048,  $p < 0.01$ ).

In other words, while players' post-game performance was not statistically similar to the performance of the mentors in-game performance, players did demonstrate significant learning gains in thinking about and discussing writing in terms of sources rather than solely in terms of readers. And these learning gains were maintained several months after playing the game. Situating player interview response data in the context of the mentor copyediting data (see Figure 6) helps further illustrate this result.

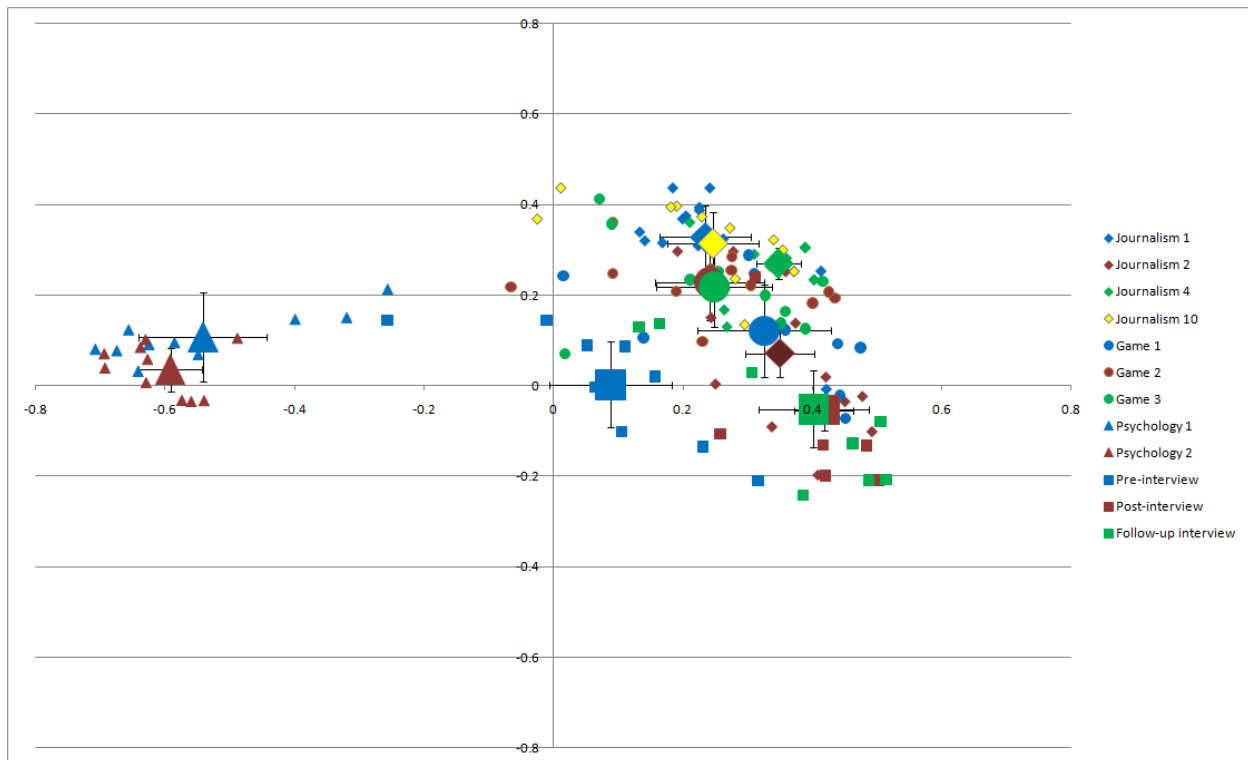


Figure 6: Showing mentor copyediting feedback from journalism practicum, psychology practicum, science.net game, and player interview copyediting task responses from pre-, post- and follow-up interviews. Indicates a significant change towards thinking about writing in terms of sources for the player responses from pre- to post-interviews.

Quantitatively then, we see players not only learned individual aspects of journalism, they demonstrated an increase in the patterns of linking characterizing professional journalistic expertise as theorized by epistemic frame theory. Comparing one player's pre-interview responses with her post-interview responses helps further substantiate this picture.

In one player's pre-interview, we see some prior understanding of journalism in the first part of her response:

*Interviewer: So do you think this information would make a good news story?*

Player: Well I think yes. Because it's important. It would affect a lot of people. It would affect everyone who eats beef and drinks milk because it could involve their health.

*Interviewer: If you were a reporter given this information, what would you do?*

Player: I would incorporate the information in an article and talk about both sides of the both opinions of the scientists that yes the genes should be change and one of other people saying no, they shouldn't be changed.

We can see in these comments that the player began the game with an understanding journalism as the gathering of information and balancing of different opinions to create an article. The second part of this player's response provides some clarification though:

*Interviewer: If you were an editor and a reporter gave you this [different story draft], how would you change it, if at all, before publishing it in the newspaper?*

Player: I would change the 2nd sentence to say something more like, is this situation as important as the 9:00 news as it or is it simply an over exaggeration of a minor problem and I think I would also modify the style to be a little more formal and also not capitalize toxic. Also I would split up the last sentence and I would make a new sentence. That is probably true but it happened in 2002 in a golf course pond. .. Instead of making it 1 sentence.

*Interviewer: Would you ask the reporter for anything else?*

Player: Well I'd ask for have there been other incidences of blue green algae problems other than the dog incident.

As we see in these comments, the player's pre-game understanding of how journalists actually create and revise those articles seems fairly limited and academic, focusing primarily on "modifying the style" and changing sentences.

In the post-interview, the same player provided a more sophisticated response.

In the first part of the journalism task, she said:

*Interviewer: So do you think this information would make a good news story?*

Player: Yeah I think it would. ... Because it's an important issue. They could create a new kind of fish. Who wouldn't be interested in that? .. And then it has potential to be all kinds of other things like what else could they genetically modify?

*Interviewer: If you were a reporter given this information, what would you do?*

Player: That's not... I don't think that's enough information. I'd find a lot more background information and then I'd go out and find out which scientists are involved with that and I'd interview them, ask some questions about that... Then I would start organizing the information that I gathered and find out... and I'd start writing my story.

Like the pre-interview, we see an understanding of journalism as an activity concerned with "important issues" and one that involves gathering information and writing stories. But in this response, we see this process articulated much more clearly and in much more detail. The player differentiates between "background information" and source information from interviews, and she recognizes the importance of "organizing the information" in order to produce a journalism story.

In the second part of the journalism task, the same player continues:

*Interviewer: If you were an editor and a reporter gave you this [new story draft], how would you change it, if at all, before publishing it in the newspaper?*

Player: People all around the world are destroying our earth without even knowing it. All around the world people are littering. Littering is a very destructive thing to do. When you are littering you are destroying the earth. One man says many people know that pollution from cars and factories is making the hole in the ozone layer even bigger. The hole allows too many dangerous rays through. As you can see, polluting can destroy parts of the ozone layer. The balance of our environment is off and humans must find a new environmentally healthy balance.

*Interviewer: Would you ask the reporter for anything else?*

Player: Well, um... I changed the wording in this first paragraph because it's really bad... They drop litter on the ground destroying natural spaces and I said next littering can destroy the earth. Instead of one man says, I said who? Give me the name and title and then like... the whole paragraph I said is this like about littering or what? And then I go pollution and then it talks about pollution from cars and factories... and then I wrote pollution from cars and factories, what is this story about?

*Interviewer:* Okay so you're saying he's kind of wandering around off topic.

Player: Yeah, I'm like, I thought this was about litter but it's about pollution from cars and factories? Litter does not destroy the ozone layer. I don't... this is not... actually. This person would do well to just write the whole story over again. And then I wrote a note to the person. Check your sources, source the quote, decide what your story is about and delete irrelevant material, please! And I uncapitalized ozone layer. That's not supposed to be capitalized.

After playing the game, the player demonstrates a much richer understanding of reporting. Here we see the player enacting journalistic feedback much like that seen in the professional practicum. While the player initially reads out the changes she thinks ought to be made in the story, in the second part of the response she unpacks these changes, practically channeling the voice of a gruff, if not snarky, editor. She focuses on the journalistic value of *transparency*, seeking “the name and title” for sources, and links this to more stylistic writing concerns about *relevance*. She efficiently tacks back and forth between reporting concerns like *accuracy*, “Check your sources” and *investigative* skills, “source the quote,” and journalistic writing concerns like “deleting irrelevant material” to make it clearer “what is this story about.”

These results suggest that after playing *science.net*, players were able to begin thinking like journalists about writing in terms of sourcing – demonstrating the use of multiple elements of journalistic expertise, more appropriately linked, in their

simulated copyedit feedback as compared with their performance before playing the game. These results also suggest that epistemic network analysis can provide a powerful assessment tool for measuring these multidimensional learning outcomes. The larger significance of these results is explored in Chapter 5.

## CHAPTER 5: DISCUSSION

Educational activities, like computer-supported role playing games, that mimic or model the training of professionals have the potential to develop the kinds of higher-level thinking that young people need in the knowledge economy and global society of the 21<sup>st</sup> century. A key challenge in this emerging field, however, is to improve the opportunities for developing and assessing such higher-level thinking.

*Science.net* was designed to reproduce the key training practices of a professional journalism practicum. In the game, these practices involve both novices trying to use their developing professional vision to see stories in broad topic assignments and the reflective copyediting feedback of mentors working to align those efforts with the standards of the profession. The players in the game were middle-school aged young people, and the mentors were not journalists. But as these results show, the mentors in

the game were able to provide the same kind of multidimensional feedback as that found in the journalism practicum.

*Science.net* improved players' mastery of elements in the repertoire of journalistic expertise. As their responses to matched interview questions showed, players demonstrated significant learning gains on journalism knowledge, skills, values, identity, and epistemology. In other words, *science.net* gave players a better understanding of the elements of the journalism epistemic frame.

Perhaps most importantly, *science.net* not only fostered the development of the epistemic frame elements, but also helped players integrate those elements to begin acting more like professional journalists. Players showed significant increases in thinking about writing through the lens of sourcing rather than solely in terms of readers when engaged in an interview task simulating copyediting.

These results are most important for how they were measured. As a tool for multidimensional assessment, epistemic network analysis (ENA) is flexible enough to use for the analysis of performances that support learning as well as the analysis of performances of learning. Using ENA, this study differentiated between mentor copyediting feedback from different professional practica, helping to establish ENA's similarity analysis as a ruler for comparing the use of interlinked epistemic frame elements in copyediting feedback of the journalism practicum and game mentors.

Moreover, ENA illustrated that the game, *science.net*, did reproduce important linkages in mentor feedback modeled from a professional journalism practicum. ENA further provided important details about the patterns of linkages reflected in player copyediting performance, helping to reveal players' increasing development of the journalistic epistemic frame.

Overall, this study extends the research on game-based learning environments by showing that through the reproduction of professional practicum activities by players and reflective feedback by mentors, professional role playing games can help young people begin to develop the epistemic frame of a profession even when the mentors involved are not professionals themselves.

This study also shows that more than simply measuring individual student achievement, new methods like epistemic network analysis can measure the discursive activity of multiple game players in different roles, an important flexibility given the importance of mentors in professional role playing games and the large number of games involving many roles.

Learning to think like a journalist, or any professional, is about making use of different aspects of expertise in a coherent and patterned way, and these aspects, such as sourcing, accuracy, and transparency for journalism, are clearly aligned with 21<sup>st</sup> century skills, such as information literacy and critical thinking. Learning to think like a

professional can thus help young people develop these important abilities, and epistemic network analysis can help us know when they do.

### *Limitations*

The study presented has several limitations. First, the small sample size means that any conclusions are limited to the particular contexts involved. This applies to both the number of individuals in each of the particular settings and also to the settings themselves (i.e., the study involved only one journalism practicum model). Therefore, as Shaffer and Serlin (2004) argue, the purpose of significance tests under such circumstances is to show that additional observations made under the same conditions would show similar results. Future work might address this limitation through an expansion of settings to include a range of journalism practica and comparison settings, as well as through an increase in the number of participants in *science.net* games.

A second limitation concerns the player copyediting task from the pre-, post- and follow-up interviews. Although players were asked to engage in the same kind of evaluation that editors perform, this study is limited in that there was only one task with only a few questions to provide evidence of player performance. This suggests an important area for future work would involve identifying additional ways of capturing

player discourse, through different kinds of activities and also throughout the course of the game to be able to assess development in a richer and more longitudinal way.

A third limitation concerns the epistemic frame codes and categories themselves. While the coding rubric for this study was developed through a grounded theory method and codes were developed to refer to distinct aspects of journalistic expertise, the boundaries between these aspects (e.g., distinguishing between particular skills and understandings) are not always clear. Further, since the coding process was explicitly designed to segment discourse at a grain size sufficient to highlight the co-occurrences of multiple codes within individual segments, segments were regularly coded for multiple epistemic frame element codes.

This raises a concern that the boundaries between the codes, and more generally between different epistemic frame categories, can become blurred and complicate the validity of the construct. Particularly as the examination of discourse moves from qualitative to quantitative analysis, this raises questions like - do the quantitative patterns of correlation, similarity, etc. reflect patterns in the professional discourse? Or do they reflect blurry boundaries between the constructs themselves.

This is a limitation of this exploratory qualitative study, particularly as it uses quantitative methods in the service of establishing a better, richer understanding of the patterns at work in these specific settings. To mitigate this limitation somewhat,

quantitative results were routinely substantiated through qualitative analysis of the discourse itself. While this does not resolve the underlying challenge, it does provide triangulation support for quantitative patterns in case blurry boundaries overly influenced the ENA calculations. In addition, this study conducted a second, robustness analysis of the mentor copyediting feedback results to address possible problems related to the codes. Again, this does not eliminate the underlying problem, but it does provide additional data for consideration.

Finally, ENA is an emerging method with techniques still being established. For example, during this study, there were specific opportunities to gather data which made it more or less likely to capture certain kinds of discourse elements. Though this limitation is mitigated to a certain extent through the normalizing process, which privileges the existence of linkages between elements over their frequency, additional studies are needed to establish broader benchmarks of reliability.

### *Implications*

Despite these limitations, the flexibility and power of epistemic network analysis to assess the development of multidimensional constructs like epistemic frames for

different participants in different roles in epistemic games suggests a number of exciting possibilities.

First, by analyzing player discourse at different stages of a single game, this technique could reveal important effects for epistemic frame development as a result of particular activities as well as for particular individuals and/or groups of individuals. Player discourse from a series of games could be analyzed for longer term or cumulative effects. Discourse from different players in multiple parallel offerings of the same game could also be analyzed to investigate variance and reliability of frame development across games. In short, this technique offers new possibilities for measuring how well players are thinking like professionals, and enables corresponding dynamic feedback about what worked, what did not work, and why. And used with epistemic games, ENA provides a way to test whether students can solve complex professional problems using 21<sup>st</sup> century skills.

Second, using ENA to measure and test the fidelity of simulations also has important implications for design research (Cobb, et al., 2003; Barab & Squire, 2004). Epistemic games like *science.net* are examples of design-based research in which particular forms of learning are 'engineered' while also being systematically and iteratively studied within a realistic context (Cobb, et al., 2003). This kind of iterative design depends on systematic attention to evidence about learning and on measures

which can warrant that the productive elements in one design iteration are accurately reproduced in the next (Cobb, et al., 2003). Thus, an important aspect of this study is that it tests this basic principle: that the fidelity of reimplementation of key professional training practices can in fact be measured and warranted. In other words, epistemic network analysis and epistemic frame theory are productive because together they provide a metric not just for measuring learning outcomes, whether a particular epistemic game helped young people learn to think in particular ways through simulation, but whether in fact the game actually simulated the professional learning environment, and therefore ultimately the extent to which the fidelity of the game simulation is tied to the quality of those outcomes.

## References

- Abbott, A. (1988). *The system of professions: an essay on the division of expert labor*. Chicago: University Of Chicago Press.
- Ackerman, D. & Perkins, D. (1989). Integrating Thinking and Learning Skills Across the Curriculum. IN H.H. Jacobs (Ed), *Interdisciplinary Curriculum: Design and Implementation*. Alexandria, VA: Association for Supervision and Curriculum Development.
- Aldridge, M., & Evetts, J. (2003). Rethinking the Concept of Professionalism: The case of journalism. *British Journal of Sociology*, 54(4), 547-564.
- Anderson, C. (2008). Journalism: Expertise, authority, and power in public life. In D. Hesmondhalgh & J. Toynbee (Eds.), *The Media and Social Theory* (pp. 248-264). New York, NY: Routledge.
- Bagley, Elizabeth A. S. (2011) Stop Talking and Type: Mentoring in a Virtual and Face-to-Face Environmental Education Environment. University of Wisconsin-Madison. Unpublished dissertation.
- Bagley, E., & Shaffer, D. W. (2009). When people get in the way: Promoting civic thinking through epistemic game play. *International Journal of Gaming and Computer-Mediated Simulations*, 1(1), 36-52.
- Barab, S., & Dede, C. (2007). Games and immersive participatory simulations for science education: An emerging type of curricula. *Journal of Science Education and Technology*, 16(1), 1-3.
- Barab, S., & Squire, K. (2004). Design-based research: putting a stake in the ground. *Journal of the Learning Sciences*, 13(1), 1-14.
- Barab, S.A., Gresalfi, M.S., Dodge, T., & Ingram-Goble, A. (2010). Narratizing Disciplines and Disciplinizing Narratives: Games as 21st Century Curriculum. *International Journal for Gaming and Computer-Mediated Simulations*, 2(1). 17-30.
- Bartholomew, D. J., Steele, F., Moustaki, I., & Galbraith, J. (2008). *Analysis of Multivariate Social Science Data* (2 ed.). Boca Raton, FL: Chapman and Hall/CRC.
- Beckett, K., & Shaffer, D. W. (2004). *We built this city: Developing students' understanding of ecology through the professional practice of urban planning*. Paper presented at the ICLS, Santa Monica, CA.

- Behrens, J., Mislevy, R., DiCerbo, K., & Levy, R. (2010). *An Evidence Centered Design for Learning and Assessment in the Digital World*. Los Angeles, CA: UCLA Graduate School of Education & Information Sciences.
- Bogost, I., Ferrari, S., & B., S. (2010). *Newsgames: Journalism at play*. Cambridge, MA: The MIT Press.
- Bransford, J. D., & Schwartz, D. L. (1999). Rethinking transfer: A simple proposal with multiple implications. In A. Iran-Nejad & P. D. Pearson (Eds.), *Review of Research in Education* (Vol. 24, pp. 61-101). Washington D.C.: American Educational Research Association.
- Broudy, H. (1977). Types of knowledge and purposes of education. In R. C. Anderson, R. J. Spiro & W. E. Montague (Eds.), *Schooling and the acquisition of knowledge* (pp. 1-17). Hillsdale, NJ: Lawrence Erlbaum.
- Brown, J. S. (2006). New Learning Environments for the 21st Century: Exploring the Edge. *Change Magazine*, July.
- Chi, M. (1997). *Quantifying qualitative analyses of verbal data: A practical guide*. London: Routledge.
- Choi, Y., Rupp, A., Gushta, M., & S. Sweet. (2010). Modeling learning trajectories with epistemic network analysis: An investigation of a novel analytic method for learning progressions in epistemic games. Submitted to National Council on Measurement in Education, Denver, CO.
- Clark, R. P., & Fry, D. (2003). *Coaching Writers: Editors and reporters working together across media platforms* (2 ed.). New York, NY: Bedford/St. Martin's.
- Cobb, P., Confrey, J., diSessa, A., Lehrer, R., and Schauble, L. (2003). Design experiments in educational research. *Educational Researcher*, 32(1), 9-13.
- Collins, A., Brown, J. S., & Holum, A. (1991). Cognitive apprenticeship: Making thinking visible. *American Educator*, 15(3), 6-11.
- Crafti, J. (2011). Playing at War: The 'Global Conflicts' Game Series. *Screen Education*, 61, 90-94.
- Dede, C. (2007). *Transforming Education for the 21st Century: New pedagogies that help all students attain sophisticated learning outcomes*. Cambridge, MA: Harvard University.
- Degenne, A., & Forse, M. (1999). *Introducing Social Networks*. London: Sage.
- Deuze, M. (2005). What is journalism: Professional identity and ideology of journalists reconsidered. *Journalism*, 6(4), 442-464.

- Dewey, J. (Ed.). (1974). *John Dewey on Education: Selected Writings*. Chicago, IL: University of Chicago Press.
- Dunn, A. (2004). From Quasi to Fully: On journalism as a profession. *Australian Journalism Review*, 26(2), 21-30.
- Friedson, E. (2001). *Professionalism, the Third Logic: On the Practice of Knowledge*. Chicago: University Of Chicago Press.
- Gans, H. J. (1979). *Deciding What's News: A study of CBS evening news, NBC nightly news, Newsweek, and Time*. New York, NY: Random House, Inc.
- Garfinkel, H. (1967). *Studies in ethnomethodology*. Cambridge: Prentice-Hall.
- Garton, L., Haythornthwaite, C. & Wellman, B. (1997). Studying Online Social Networks. *Journal of Computer-Mediated Communication* 3(1).
- Gawel, D. J., Phillips, R., Svihla, V., Vye, N. J., & Bransford, J. D. (2008). Considerations for the development of a Preparation for Future Learning Assessment. In P. A. Kirschner, F. Prins, V. Jonker & G. Kanselaar (Eds.), *International Perspectives in the Learning Sciences: Creating a learning world: Proceedings of the 8th international conference on International conference for the learning sciences (ICLS2008)* (Vol. 1, pp. 273-280). Utrecht, Netherlands: International Society of the Learning Sciences.
- Gee, J. P. (2003). *What Video Games Have to Teach Us About Learning and Literacy*. New York: Palgrave/Macmillan.
- Gee, J. P., & Shaffer, D. W. (2010). Looking Where the Light is Bad: Video Games and the Future of Assessment. *Phi Delta Kappa International EDge*, 6(1).
- Goffman, E. (1974). *Frame analysis : an essay on the organization of experience*. New York: Harper & Row.
- Gomez, R. L., Hadfield, O. D., & Housner, L. D. (1996). Conceptual maps and simulated teaching episodes as indicators of competence in teaching elementary mathematics. *Journal of Educational Psychology*, 88(3), 572-585.
- Goodwin, C. (1994). Professional Vision. *American Anthropologist*, 96(3), 606-633.
- Hanneman, R. A., & Riddle, M. (2005). *Introduction to social network methods*. Riverside, CA: University of California at Riverside.
- Hatfield, D., & Shaffer, D. W. (2006). *Press play: Designing an epistemic game engine for journalism*. Paper presented at the ICLS, Bloomington, IN.

- Hatfield, D., & Shaffer, D. W. (2008). *Reflection in professional play*. Paper presented at the ICLS, Utrecht, Netherlands.
- Hatfield, D. & Shaffer, D. W. (2010). The Epistemography of a Journalism Practicum: The Complex Mechanisms of Developing Journalistic Expertise. (WCER Working Paper 2010-10). Madison: University of Wisconsin-Madison, Wisconsin Center for Education Research.
- Heritage, J. (1984). *Garfinkel and Ethnomethodology*. Cambridge: Blackwell Publishers Ltd.
- Jacobs, H.H. (Ed.) (1989). *Interdisciplinary Curriculum: Design and Implementation*. Alexandria, VA: Association for Supervision and Curriculum Development.
- Kovach, B., & Rosenstiel, T. (2001). *The Elements of Journalism: What newspeople should know and the public should expect*. New York, NY: Three Rivers Press.
- Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge, MA: Cambridge University Press.
- Mislove, A., Marcon, M., Gummadi, K., Druschel, P., and Bhattacharjee, B. (2007) Measurement and analysis of online social networks. In *Proceedings of the 7th ACM SIGCOMM conference on Internet measurement (IMC '07)*. ACM, New York, NY, USA, 29-42.
- Murnane, R., & Levy, F. (2004). *The New Division of Labor: How computers are creating the next job market*. Princeton, NJ: Princeton University Press.
- Murray, D. M. (2000). *Writing to deadline: The journalist at work*. Portsmouth, NH: Heinemann.
- Nash, P., & Shaffer, D. W. (2008). *Player-mentor interactions in an epistemic game: A preliminary analysis*. Paper presented at the ICLS, Utrecht, Netherlands.
- Nash, P., & Shaffer, D. W. (2010). *Mentor modeling: The internalization of modeled professional thinking in an epistemic game*. Paper presented at the ICLS, Chicago, IL.
- Nulty, A., & Shaffer, D. W. (2008). *Digital zoo: The effects on mentoring on young engineers*. Paper presented at the ICLS, Utrecht, Netherlands.
- Nunnally, J. C., & Bernstein, I. H. (1994). *Psychometric theory* (3rd ed.). New York, New York: McGraw-Hill.
- Partnership for 21st Century Skills. (2004). *21st Century Readiness for Every Child*. Tucson, AZ.

- Paul, N., & Hansen, K. (2006). *Disaster at Harpersville: The modding of Neverwinter Nights to teach journalism students the strategic steps in information gathering*. Paper presented at the World Conference on Educational Multimedia, Chesapeake, VA.
- Poynter Institute. (2011). Poynter News University. Retrieved July 13, 2011, from <http://www.newsu.org/>
- Puntambekar, S. (2006). Learning from digital text in inquiry-based science classes: lessons learned in one program. IN *ICLS 2006 Proceedings of the 7th international conference on Learning sciences*. Bloomington, IN.
- Quellmalz, E., Timms, M. J., & Buckley, B. C. (2009). *Using Science Simulations to Support Powerful Formative Assessments of Complex Science Learning*. San Francisco, CA: SimScientists: WestED.
- Schon, D. (1987). *Educating the reflective practitioner: Toward a new design for teaching and learning in the professions*. San Francisco: Jossey-Bass.
- Schon, D. A. (1983). *The reflexive practitioner: How professionals think in action*. New York: Basic Books.
- Schvaneveldt, R. (1990). *Pathfinder Associative Networks: Studies in Knowledge Organization*. Norwood, NJ: Ablex.
- Schvaneveldt, R. W., Durso, F. T., and Dearholt, D. W. (1989). Network structures in proximity data. In G. Bower (Ed.), *The Psychology of Learning and Motivation: Advances in Research and Theory*, 24 (pp. 249-284). New York: Academic Press.
- Schwartz, D. & Martin, T. (2004). Inventing to Prepare for Future Learning: The Hidden Efficiency of Encouraging Original Student Production in Statistics Instruction. *Cognition and instruction*, 22(2), 129-184.
- Scollon, R. (2001). *Mediated Discourse: The Nexus of Practice*. New York: Routledge.
- Serious Games Initiative. (2011). Global Conflicts. Retrieved July 13, 2011, 2011, from <http://www.globalconflicts.eu/>
- Shaffer, D. W. (2004). Pedagogical praxis: The professions as models for post-industrial education. *Teachers College Record*, 106(7), 1401-1421.
- Shaffer, D. W. (2005a). Epistemic Games. *Innovate*, 1(6).

- Shaffer, D. W. (2005b). *Epistemography and the Participant Structures of a Professional Practicum: A story behind the story of Journalism 828* (Working Paper): University of Wisconsin-Madison, Wisconsin Center for Education Research.
- Shaffer, D. W. (2006). Epistemic frames for epistemic games. *Computers and Education*, 46(3), 223-234.
- Shaffer, D. W. (2007). *How Computer Games Help Children Learn*. New York: Palgrave.
- Shaffer, D. W. (2010). *The Bicycle Helmets of "Amsterdam": Computer games and the problem of transfer*: Epistemic Games Group, University of Wisconsin-Madison.
- Shaffer, D.W. & Graesser, A. (2010). *Using a Quantitative Model of Participation in a Community of Practice to Direct Automated Mentoring in an Ill-Formed Domain*. Paper presented at Intelligent Tutoring Systems (ITS), Pittsburgh, PA.
- Shaffer, D. W., Hatfield, D., Svarovsky, G., Nash, P., Nulty, A., Bagley, E., et al. (2009). Epistemic Network Analysis: A prototype for 21st century assessment of learning. *The International Journal of Learning and Media*, 1(1), 1-21.
- Shaffer, D. W., & Serlin, R. (2004). What good are statistics that don't generalize? *Educational Researcher*, 33(9), 14-25.
- Shaffer, D. W., Squire, K., Halverson, R., & Gee, J. P. (2005). Video Games and the Future of Learning. *Phi Delta Kappan*, 87(2), 104-111.
- Shute, V. J., Ventura, M., Bauer, M. I., & Zapata-Rivera, D. (2009). Melding the power of serious games and embedded assessment to monitor and foster learning: Flow and grow. In U. Ritterfeld, M. Cody & P. Vorderer (Eds.), *Serious games: Mechanisms and effects* (pp. 295-321). Mahwah, NJ: Routledge, Taylor and Francis.
- Silva, E. (2008). Measuring Skills for the 21st Century. Retrieved 10/29/2010, 2010, from <http://www.educationsector.org/publications/measuring-skills-21st-century>
- Singer, J. (2007). Contested Autonomy: Professional and popular claims on journalistic norms. *Journalism Studies*, 8(1), 79-95.
- Soloski, J. (1989). News Reporting and Professionalism: Some constraints on reporting the news. *Media, Culture and Society*, 11, 207-228.
- Squire, K. (2003). Video games in education. *International Journal of Intelligent Simulations and Gaming*, 2(1).

- Squire, K. (2006). From content to context: Video games as designed experiences. *Educational Researcher*, 35(8), 19-29.
- Stein, S. (2000). *Equipped for the Future Content Standards: What adults need to know and be able to do in the 21st Century*. Washington, DC: National Institute for Literacy.
- Sternberg, R. (2007). "Finding Students Who Are Wise, Practical, and Creative" *The Chronicle of Higher Education*, July 6, 2007.
- Strauss, A., & Corbin, J. (1998). *Basics of qualitative research* (3 ed.). Thousand Oaks: Sage Publications, Inc.
- Sullivan, W. (2005). *Work and Integrity: The crisis and promise of professionalism in America*. San Francisco, CA: Jossey-Bass.
- Svarovsky, Gina. (2010). Unpacking an engineering practicum: Building engineers, one participant structure at a time. (WCER Working Paper). Madison: University of Wisconsin-Madison, Wisconsin Center for Education Research.
- Tuchman, G. (1978). *Making News: A study in the construction of reality*. London: Free Press.
- Van Dijk, T. (1991). *Racism and the Press*. London: Routledge.
- Wasserman, S., & Faust, K. (1994). *Social Networks Analysis: Methods and Applications*. Cambridge: Cambridge University Press.
- Wellman, B. (1988). The community question re-evaluated. In M. P. Smith (Ed.), *Power, community and the city* (pp. 81-107). New Brunswick, NJ: Transaction Books.
- Wellman, B., & Berkowitz, S. D. (Eds.). (1988). *Social structures: A network approach*. Cambridge, UK: Cambridge University Press.
- Wellman, B., & Wortley, S. (1990). Different strokes from different folks: Community ties and social support. *American Journal of Sociology*, 96, 558-88.
- Wiggins, G. (1993). *Assessing Student Performance: Exploring the purpose and limits of testing* San Francisco, CA: Jossey-Bass.
- Wohlwend, K. (2008). Kindergarten as Nexus of Practice: A Mediated Discourse Analysis of Reading, Writing, Play, and Design in an Early Literacy Apprenticeship. *Reading Research Quarterly* 43(4) (Oct. - Dec., 2008), pp. 332-334.

## Appendix 1. *Science.net* Interview Protocols

### PRE-INTERVIEW

#### INTERVIEW QUESTIONS:

\* questions appear in all three interviews (pre, post, and followup)

**[Note: Please see Appendix 2 and 3 for Journalism task information and questions]**

#### General—

How did you hear about science.net?

What made you decide to come to science.net?

#### Science—

Do you study science at school?

What kind of science?

\* Is science interesting to you?

Do you think of yourself as good at science?

Do you study it on your own?

Can you tell me about that?

\* What do you think science is?

\* Is science important?

Why is that?

\* What do you think it means to be a scientist?

Have you ever thought of yourself that way?

#### Writing—

\* Do you like to write?

What kinds of things do you like to write?

Why?

\* Do you think of yourself as good at writing?

When do you feel that way?

When you write, does anyone else read your work?

Who reads it?

Does having someone else read your writing make you treat it differently?

**Info Literacy—**

- \* Do you use the Internet?  
     What do you use it for?  
     Has this changed from how you felt before science.net?  
         (If so) what about it changed your feeling?
- \* How would you use the Internet to learn about something new?
- \* How would you decide if you should use information on the Internet?

**Journalism—**

- \* What do you think journalism is?
- \* Is journalism important?  
     Why?
- \* Is journalism interesting to you?  
     How so?  
     Have you ever written for a newspaper or newsletter?
- \* What do you think it means to be a journalist?
- \* Have you ever thought of yourself that way?
- \* How or when do you think an issue becomes news?
- \* How do journalists get information for their stories?  
     Why do they do that?
- \* Why do journalists copyedit their stories?  
     Do you think that's important?
- \* What do you think makes a good opening paragraph for a newspaper story?  
     Why is that?
- \* Do you think that newspapers are accurate?  
     Why?  
     Do you think it's important for newspapers to be accurate?
- \* Do you read any newspapers?  
     (if yes) What parts do you read? Why?

**\* Science Transfer Task**

**S1a.** Deciding if something is living is not always as easy as testing a blob of grape jelly. Imagine a crystal that just sits in a test tube for years. A crystal is nonliving. It does not show any of the processes of life. However, viruses can form crystals, but can also reproduce. A virus is a complex particle that has features of living and nonliving things. Viruses can reproduce, but only inside living cells. When a virus becomes active, it changes the life processes of cells in the organism it has entered. This change in an organism often results in a disease.

Do you think that this is an important scientific issue?

Why?

Would this affect your community?

If so, how?

**S1b.** Precipitation that soaks into the ground through small pores or openings becomes groundwater. The amount of precipitation that soaks in depends on the porosity and permeability of the ground. The upper surface of the zone saturated with groundwater is the water table. The water table may be right at Earth's surface or hundreds of meters deep. Occasionally, the water table meets the land surface on the side of a hill. The groundwater flows out onto the surface. This is called a spring. Water also flows through rock. Permeable rocks filled up with water are called aquifers. Wells are often drilled through layers of soil and impermeable rocks to reach aquifers. Such wells are important sources of fresh water.

Do you think that this is an important scientific issue?

Why?

Would this affect your community?

If so, how?

**S1c.** All machines contain moving parts. These moving parts produce some friction. Some of the work you put into a machine acts to overcome friction and is changed to thermal energy. Therefore, the useful work the machine does is lessened by the work used to overcome friction. The efficiency of the machine increases as friction is reduced or eliminated. Machine efficiency is a measurement of the work put into a machine compared with the work that the machine does. A machine in which much of the work put into it is changed into unwanted thermal energy has low efficiency. High efficiency means that much of the work put in is changed to useful output work.

Do you think that this is an important scientific issue?

Why?

Would this affect your community?

If so, how?

**\* Cost-Benefit Cases**

**CB1a.** Midwest Marine, a fish farming company, has created a new breed of salmon that get bigger and grow more quickly than normal fish. Since the fish grow quickly, farmers could raise them at a much lower cost and then sell them to buyers at a lower cost. However, environmental groups are concerned that there is a risk: if these salmon get out of breeding ponds and into the wild, they will take over water habitats, leading to the extinction of other species.

Should there be any limits on how people use this new breed of fish?

If so, why?

What should those limits be?

**CB1b.** Agribiz, a large food company, has recently developed a new kind of wheat that needs less water to grow. If farmers used less water for their fields, it would reduce the need to dam rivers and drain reservoirs to support farmlands. However, if the wheat were planted in farmers' fields, environmentalists are concerned that the genetic changes in the wheat might be spread to nearby weeds. These genetic changes would allow the weeds to grow with small amounts of rain, and possibly to take over crops, causing farmers to use many more weed-killing chemicals on their fields.

Should there be any limits on how people use this new kind of wheat?

If so, why?

What should those limits be?

**CB1c.** Newleaf, a large vegetable company, has created a new kind of hybrid potato that produces its own pesticide. Because it kills the insects that harm it, this new type of potato grows more quickly than other potatoes, requires less care, and can be sold to buyers at a lower cost. However, if the potatoes were planted in fields, environmentalists are concerned that the genetic changes in the potatoes might be spread to nearby plants. These genetic changes could allow weeds to become stronger and possibly to take over a farmer's other crops.

Should there be any limits on how people use this new kind of potato?

If so, why?

What should those limits be?

**CB2a.** A surgeon has just developed a new technique for treating cancer by transplanting bone marrow. The treatment involves first removing bone marrow from a patient and then carefully separating the healthy cells from the cancerous cells. The healthy cells are returned to the patient to replace his or her diseased bone marrow. The procedure has a 5% success rate with patients for whom all other techniques have failed. However, it is extremely expensive, and patient's rights groups are concerned that it will take money away from less expensive and more effective treatments for cancer.

Should there be any limits on how people use this new treatment?

If so, why?

What should those limits be?

**CB2b.** A surgeon at the Bellaire Hospital in Salt Lake City, Utah has just developed a technique to treat advanced forms of memory loss diseases like Alzheimer's. The treatment involves removing nerve cells

from a patient and changing their DNA. The cells are then reintroduced into the patient. The procedure has a 5% success rate with patients for whom all other techniques have failed. However, several physicians' groups are worried that the technique is extremely expensive, and that it will take money away from less expensive and more effective treatments for these diseases.

Should there be any limits on how people use this new treatment?

If so, why?

What should those limits be?

**CB2c.** Engineers at a company called Ecodrive developed a new kind of car that can run on a hydrogen fuel cell. Because the car does not burn gasoline, it runs for a longer time on less fuel and creates much less air pollution than regular cars. However, manufacturing hydrogen for use in a car is dangerous. As a result, the hydrogen cars are very expensive to build and it is likely that only 10% of families would be able to afford them. Several environmental groups are excited about the fuel cell technology, but concerned that it is extremely expensive and that it will take resources away from potentially less expensive and safer fuel technologies.

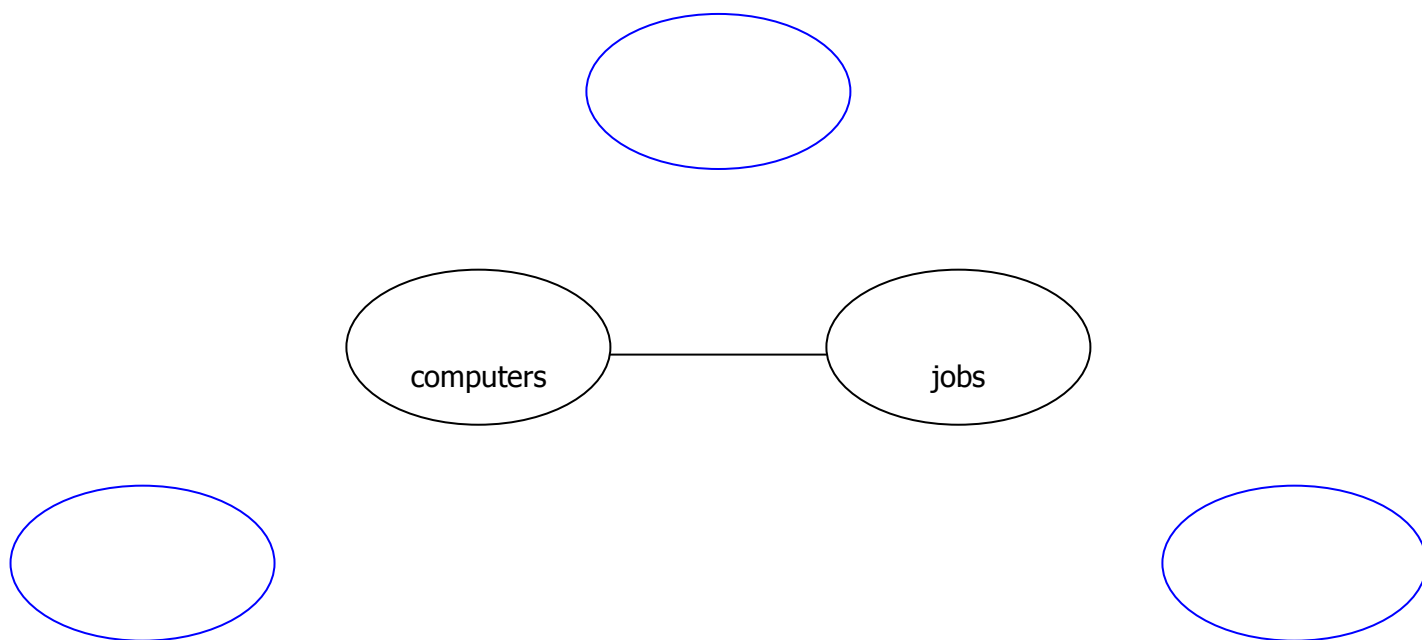
Should there be any limits on how people use this new kind of car?

If so, why?

What should those limits be?

**\* Concept Map:**

What is the role of science and technology in your community?



## POST-INTERVIEW

### INTERVIEW QUESTIONS:

\* questions appear in all three interviews (pre, post, and followup)

#### **General—**

Was playing the game what you expected?

Why?

How would you describe science.net to someone who wasn't a part of it?

#### **Science—**

\* Is science interesting to you?

How so?

Since the beginning of science.net, have you found yourself studying science on your own, beyond the research you did for your article?

(If so) what kinds?

Why?

\* What do you think science is?

\* Is science important?

Why is that?

\* What do you think it means to be a scientist?

Have you ever thought of yourself that way?

Has your thinking about science changed from how you felt before science.net?

(If so) what about it changed your feeling?

#### **Writing—**

\* Do you like to write?

What kinds of things do you like to write?

\* Do you think of yourself as good at writing?

When do you feel that way?

During science.net, what did you write about?

(if necessary) What did you learn from these stories?

How did you feel when these stories were done?

Did anyone else read your stories?

Who?

How did you feel about that?

Do you think differently about writing now than you did before science.net?

(If so) what about it changed your feeling?

#### **Info Literacy—**

\* Do you use the Internet?

What do you use it for?

Has this changed from how you felt before science.net?

(If so) what about it changed your feeling?

- \* How would you use the Internet to learn about something new?
- \* How would you decide if you should use information on the Internet?

### **Journalism—**

- \* What do you think journalism is?
  - \* Is journalism important?  
Why?
  - \* Is journalism interesting to you?  
Why?
  - \* What do you think it means to be a journalist?  
Say more?
  - \* Have you ever thought of yourself as a journalist?  
Particular example from the game?
  - \* How or when does an issue become news?
  - \* How do journalists get information for their stories?  
Why do they do that?
  - \* Why do journalists copyedit their stories?  
Do you think that's important?
  - \* What do you think makes a good opening paragraph for a newspaper story?  
Why is that?
  - \* Do you think that newspapers are accurate?  
Why?  
Do you think that's important?
  - \* Do you read any newspapers?  
Why / Why not?
- Do you think differently about Journalism now compared with before the game?  
If so, what about the game changed your feeling?

### **Game—**

- W1. During science.net, were there any activities that you especially liked?  
Why?
- W2. Did you accomplish anything that you are proud of?  
If so, why are you proud of it – can you say more about that?
- W3. Do you feel that you learned anything new from the game?  
If so, can you talk a little bit about those things?  
What part of the game helped you learn those things?
- W4. Was this game similar to or different from school?  
How so?
- W5. Was it worth it to have the experts come to the game?  
Why?
- W6. What did you think about your story pitches?  
Did you get better at them?  
Was pitching helpful to you?  
How so?

W7. Was it worth it to interview the scientists?

Why?

W8. Which was your favorite interview?

Can you tell me a little bit about it? What did you learn from it?

W9. When you researched a story, what did you do?

Why did you do that?

W10. After the peer copyediting sessions, what did you think about your stories?

Can you tell me more about that?

How about when your desk editor copyedited them?

**Byline—**

When you worked on your stories, what did think about Byline, the computer software we used? Was it good, bad, easy, frustrating?

What did you like most about it?

Why?

Was there anything in particular you would recommend that we change?

Why is that?

Did the tags and panels affect how you thought about your stories?

How so?/Why not?

Do you think the tags affect how others see your stories?

How so?/Why not?

Were you ever surprised by what the preview panels showed?

If so, can you tell me about what happened?

Why did the preview show that?

Do you think Byline would be a good tool for a newspaper reporter?

Why/Why not?

Would you rather use Byline or Word for writing stories?

Why?

How did it feel to get your stories published on the Internet?

Was it important?

Did Byline help you learn about Journalism?

How so?

Was there anything else about Byline that you feel we should know?

\* **Science Transfer Tasks** [Repeated from Pre-interview]

\* **Cost-Benefit Cases** [Repeated from Pre-interview]

\* **Journalism Task** [Repeated from Pre-interview]

\* **Concept Map:** [Repeated from Pre-interview]

## FOLLOW-UP INTERVIEW

### INTERVIEW QUESTIONS:

\* questions appear in all three interviews (pre, post, and followup)

#### General—

Have you thought much about science.net since the summer?

About the things we worked on there?

Have you changed the way you think about science.net since the summer?

Have you used any of the ideas from the game in school?

Science?

Journalism/Writing?

Computers?

Has science.net changed the way you think about any of your classes in school?

What kinds of changes have you noticed?

What about the workshop made those changes happen, do you think?

#### Science—

\* Is science interesting to you?

How so?

\* Since the beginning of science.net, have you found yourself studying science on your own, beyond the research you did for your article?

(If so) what kinds?

Why?

\* What do you think science is?

\* Is science important?

Why is that?

\* What do you think it means to be a scientist?

Have you ever thought of yourself that way?

Has your thinking about science changed from how you felt before science.net?

(If so) what about it changed your feeling?

#### Writing—

\* Do you like to write?

What kinds of things do you like to write?

\* Do you think of yourself as good at writing?

When do you feel that way?

Do you think differently about writing now than you did before science.net?

How so?

#### Info Literacy—

\* Do you use the Internet?

What do you use it for?

Has this changed from how you felt before science.net?

Do you remember any specific experience in the game where you noticed this change?

- \* How would you use the Internet to learn about something new?
- \* How would you decide if you should use information on the Internet?

**Journalism—**

- \* What do you think journalism is?
- \* Is journalism important?  
Why?
- \* Is journalism interesting to you?  
Why?
- \* What do you think it means to be a journalist?  
Can you say more about that?
- \* Do you read any newspapers?  
(if yes) What parts do you read? Why?

Do you think differently about Journalism now compared with before the game?

If so, what about the game changed your feeling?

- \* **Science Transfer Tasks** [Repeated from Pre-interview]
- \* **Cost-Benefit Cases** [Repeated from Pre-interview]
- \* **Journalism Task** [Repeated from Pre-interview]
- \* **Concept Map:** [Repeated from Pre-interview]

## Appendix 2: Science.net copyediting task sample information

### Story information - Form A.

#### MEAT GENETICALLY ENGINEERED FOR HEALTH

##### Facts:

- Scientists have discovered a way to change the genes of animals to make their meat more healthy for people to eat.
- They have created mice with a gene that produces a chemical called omega-3 in their bodies.
- Omega-3 is an important chemical that helps the human heart to stay healthy.
- Scientists want to use the technology to create cows that would produce omega-3 in their meat and in their milk

##### Questions:

- Scientists don't know yet whether the meat and milk will be completely safe for people.
- Environmentalists are worried what might happen if the genes from omega-3 cows accidentally spread to other animals.
- Other people believe it's never right to change animals' genes.

+++

### Story information - Form B.

#### FLASHY GENETICALLY ENGINEERED FISH?

##### Facts:

- Scientists have discovered a way to change the genes of animals to affect appearance, behavior, or other traits.
- They have created fish with a gene that would cause them to glow when there is pollution: the fish could be useful in finding out whether water is polluted or safe.
- Omega-3 is an important chemical that helps the human heart to stay healthy.
- One company wants to make the fish glow all the time and sell them as pets because people think that these glowing fish are pretty and unusual.

##### Questions:

- Scientists don't know what might happen if the fish are released accidentally.
- No one knows what might happen if the glowing fish mated with wild, non-genetically-engineered fish.
- Other people believe it's never right to change animals' genes.

+++

**Story information - Form C**

## CLONED PONIES

Facts:

- Scientists have discovered a way to clone horses.
- Horse cells mature in a similar way to human cells, but the rate at which horses get diseases like diabetes and cancer is dramatically lower than humans.
- This discovery could help medical researchers understand why people get diseases like diabetes and cancer, as well as develop new treatments for these diseases.

Questions:

- The scientists do not know yet whether the cloned horses will be useful in this research.
- People are concerned about what might happen if genes from these horses accidentally were to spread to wild horses.
- Other people believe it's never right to change animals' genes.

+++

**Interview questions.**

Do you think this information might make a good news story? Why?

If you were a reporter given this information, what would you do?

What do you think a good opening sentence for the story would be?

## Appendix 3: Story drafts for copyedit task, part 2

### Story draft - Form A.

In the desert about 30 miles out of Reno, there lies a mountain, Mount Yucca. What has been suggested to happen there is unjust and ignorant.

The government is planning on filling a large metal vat full of toxic waste, and burying it deep within Mount Yucca. This is possibly the worst idea since backyard wrestling. When asked about alternatives to this plan, one woman said "Well, it's not really my job to make a new alternative, but I believe that if it was funded properly, we could make some sort of alternative to just burying toxic waste in a mountain."

### Story draft - Form B.

In recent times, one issue has made a spark in the greater Madison area, Toxic Blue Green Algae. Is this a scare, or is it the 9:00 news over-exaggerating?

One woman is not afraid of the blue-green algae "scare". "I think it is just blown out of proportion" she plainly says. This whole crazy scare was based around the fact that one dog had a seizure after swimming in the lake and lived. Some people also like to tag the fact that there was a boy who died from Toxic blue green algae, which is probably true, but it happened in 2002 and it was in a golf course pond.

### Story draft - Form C.

People all around the world are destroying our earth without even knowing it. All around the world people are littering. Littering is a very destructive thing to do.

When you are littering you are destroying the earth. One man says, "Many people know that pollution from cars and factories is making the hole in the ozone layer even bigger. The hole allows too many dangerous rays through." As you can see, polluting can destroy parts of the Ozone Layer. The balance of our environment is off and humans must find a new environmentally healthy balance.

### Interview questions.

You have been asked to copyedit this story for the newspaper:  
 How would you change it (if at all) before publishing it in the paper?  
 Would you ask the author to provide any other information?  
 (followup) What would you ask for?

## Appendix 4. Full transcript of excerpted mentor copyedit feedback from journalism practicum.

...Overall, the report succeeds in giving readers a sense of what's in store for Madison's 150th birthday. Would be strengthened with fuller development of characters and greater use of data to describe the city's population growth and the budget for the big party. Keep striving, too, to incorporate the voices of people who are being left out of an issue.  
...

... a nice try in the lead. The light touch is a good idea. But can't we come up with something grabbier than hitting the readers with "democracy, creativity and visionary thinking?" Maybe mention that the city has ranged from being a cradle of Progressivism to hosting a replica of the Statue of Liberty on Lake Mendota. One more suggestion: after poking fun at the word "sesquicentennial," the story would be livelier if it bounced along with short words and terse writing, avoiding the cumbersome word "decentralized" and the phrase "honor the city on his or her own terms." Just say something conversational, such as, "Party plans range from tame scrapbooking get-togethers to boisterous block parties."...

... story needs to spell out how much the party will cost and how it's being financed. Sure would be good to say something about how this compares to the city's centennial celebration....

... ugh. Check grammar. Next graph should begin with "Its responsibilities are..." Same problem several sentence below when discussing the golf course. ...

... would be better in next graph to quote someone talking about this, rather than resorting to the Web site. People can make a story come alive and can tell interesting tales about their work and their struggles. Web sites just sit there. ...

take care not to overload a sentence. In the following sentence, "regrettably" implies the source is sorry that there is hope for the future.  
wagner content above is fairly strong. keep striving, though, to elicit dramatic tales - what pushed him to become involved, what conflicts have erupted, what surprising pieces of history has he unearthed? and remember to describe his appearance and voice to help draw readers into the report.

... in above graph, don't settle for letting a source promise "good music." Provide specific examples and provide a hint why music matters in madison.strive, too, to pursue more energetically the question of who got left out of the party...

... an effective tie to history within this section. But don't stop at such a shallow level. Bring in census data and descriptive writing to portray madison's growth and its effect

on the landscape. And don't shy from portraying the disparities within the community. Not everyone has come a long way - yet.

... Ahh, but the readers of this story would like one or two of those stories of history and aristocracy. Don't let sources skate by too easily. And some neighborhoods were segregated. Tell those tales, too, or at least allude to them.

... some good specifics in the Sensenbrenner section. Just add a little more color about who he is, a tale about why he's concerned, and it'd really sing.

... a good idea to include this info from Glendale. but again, the package could drill more deeply into some aspects, such as this interesting school project, more fully bringing to life some of these People and places in the community. should describe where Glendale elementary is, how old it is, and what it looks like, to help readers slip into the scene.

... a nice detail in next graph - the photo of the Capitol, pre-dome

... clever ending!

... leads works well. please remember, though, to type in broadcast format as shown by Professor Mitchell - all caps and most numbers spelled out, for example.

... ugh! In next graph, it's City Council - not Counsel. Although it's broadcast and listeners wouldn't know the difference, I have to deduct .25 for misspelling a proper noun. Sorry.

... an effective report, lean and well-focused, with a fitting ending.

## Appendix 5. Full transcript of excerpted mentor copyedit feedback from psychology practicum.

This is a great study. I really like the idea that you were able to develop a coding scheme that operationalizes elements of D&D's framework in the context of video evaluation of teaching, and that the scheme can differentiate between expert and novice teachers. Cool.

That having been said, I think you could organize the paper to make this point more clearly. The main issue is that you don't explain the coding scheme in the methods. Once you do that, I think the results section will become more straightforward. You'll also be more clear about which parts of the theory you really need—and need to explain. And the discussion and conclusion will follow more naturally.

Dreyfus and Dreyfus are sometimes hard to use as a theory because it is hard to find data that shows the difference between rules and experience, but it seems like your data shows that. So I look forward to seeing you make the case really clearly and convincingly. This is a great start!

This last sentence is hard to follow, but the rest of the intro is nice.

I'm not sure how this relates to the intro above....

This is a fair summary, but I think it would be hard to follow for someone who didn't already know the theory. Are you really going to use all the stages? If not, perhaps pick the two you will focus on and explain them with an example?

I think you could explain your criteria for experts and novices more succinctly.

Why does this matter?

Again, why do I need to know this?

This seems like it might go in the discussion as limitations of the study. But at this point you've spent almost 300 words (about 15% of your paper) just to tell me who your subjects were.

Again, I think you could be more succinct here. You did more or less the same thing twice, with two different clips, right? Why not say it that way and save space?

Then why not just say they were asked these questions and forget about the others? You're making me as a reader take in information that you just want me to forget about again.

I don't understand what your unit of analysis is here. You seem to be saying three different things.

I think you should just list the specific codes and define how you are operationalizing them. Better to use the space on that than details of your participants.

I don't see how these are facts and features. Or rather, I think you need to explain how you are defining those terms, ideally in the methods section.

I don't see how that follows from D&D actually.

You have a nice implicit coding system here. I think the paper would be much stronger – given the analysis you did – if you set out the coding scheme and then quantified things.

This seems like a lot of data for a small point. What is the significance of this this “hypothetical” thinking....

I'm lost. What am I supposed to take away from this part of the argument?

Your explanation doesn't make it clear how this is different from what the novices were doing. In fact, I'm not even sure whether you are arguing that this is the same or different than the novices.

All of this talk about whether someone is a novice, proficient, or other kind of performer, belongs in the discussion. What you want to do, I think, is use D&D in the theory to identify a set of characteristics of performance. Then explain how you are going to code for those in the methods. Then you show in the results which characteristics novices and experts had. Then in the discussion you make whatever claims you want to make about their status based on D&D's categorization.

I'm not sure I see how that follows.

That part I get

I don't see why that interpretation follows. It feels like you are just assuming that as I reader I will see the difference between what the expert is doing and what the novices did. Your job is to explain it to me – and, actually, to show me that the categories D&D provide are the right tools to make that clear. I think that the fact that your data is heavily weighted to the novices makes this more problematic, of course.

Nice. So that suggests that the framework D&D provide would be a good approach to determining how expert someone is. Which would make your coding scheme (if you provided it) a valuable tool for researchers in this area, no?

You didn't really show this.

Again, I didn't see this in your data.

Was that in your results?

This is all fine, but seems like a lot of summary for such a short paper. And it seems less interesting to me than suggesting that you can actually measure these differences with your coding scheme....

I don't see how this follows. How does your data show that video evaluation develops expertise. You only showed it reveals expertise.

Yes.

## Appendix 6. Full transcript of excerpted mentor copyedit feedback from *science.net* game.

As a reader, I really appreciate how you explain the process of converting manure into biogas. I'd love to see a picture of a biogas converter! You use Professor Reinemann's quotes really well, but I'd like to see more sources. Maybe you can find more sources when you fill in information about the benefits, risks, and price. Start by asking Ted tomorrow. Well done!

YES! Your lead grabbed me! You piqued my senses. Well done!!! Your initial quote is great, but it kind of comes out of nowhere. I'd think about setting up your quote with an introductory sentence that says something like 'In a recent interview with Doug Reinemann, he described the process of converting cow manure into energy.'

Great sourcing and structure. As a reader, I followed your story well and learned lots of valuable information that is important to me. Thanks!

Well balanced reporting! Did Ted say can't or can in the following quote?

Your readers will appreciate your analogy!

## **Appendix 7: Structural similarity between 'control' condition and 'expert' condition**

While Schon might argue that as practica, the journalism 'expert' condition and the psychology 'control' condition were broadly similar, this study is specifically interested in similarity for a particular form of discourse: copyediting feedback. For the purposes of this study, "copyediting feedback" was defined as brief, targeted comments provided in-line and anchored to particular paragraphs in a story or assignment. An "assignment" was defined as a story or research paper submitted to a mentor that subsequently received "copyediting feedback."

Following these definitions, writing that did not receive "copyediting feedback" was not considered an "assignment," and written comments that were either exclusively evaluative, e.g., only indicating a grade for the assignment, or summative, e.g., comments preceding the assignment rather than being anchored in-line to particular paragraphs inside, were not considered "copyediting feedback."

Looking at the structure and frequency of copyediting comments in both venues, each featured inline comments of roughly the same length and provided a similar number of comments, adjusting for differences in the length and frequency of assignments.

**Table 4. Copyedit structural information**

	<b>Journalism Practicum</b>	<b>Psychology Practicum</b>
<b>Average word count of comments</b>	29	25
<b>Average words in assignment per comment</b>	101	60
<b>Total 'copyedit' assignments</b>	4	2
<b>Average assignment word count</b>	615	2224
<b>Average comments per assignment</b>	6	38

In addition, while there were, of course, many ways in which comments were quite distinct, there were also areas of overlap. Comments were clearly distinct in their respective emphasis on reporting and story concerns,

Keep working to capture drama, and action, to bring readers into your story more powerfully. Tanner is an intriguing source. Think about how to convey what she's really like her voice, her appearance, her mannerisms. Use all of your senses when reporting. [Journalism practicum]

in contrast to emphasizing argument and evidence,

I don't understand this. Did it happen once? Or several times? Putting something in the present tense as an assertion doesn't make it more convincing. You need to be clear about what your evidence is. [Psychology practicum]

However, comments also demonstrated similar concerns. In the following pairs of excerpts, comments from both conditions express similar concerns about writing, reader needs, and the importance of engaging readers.

Great quotes. strive to follow up such powerful content with the specifics and the anecdotes that'll bring it alive for your readers and viewers. [Journalism practicum]

You provide nice descriptions of activity, coupled with telling quotations that sell the examples. But as a reader I don't know what to do with them at this point. Rather than anticipating your discussion, my mind is starting to wander. [Psychology practicum]

The preceding graph is packed with interesting history, but readers will be a bit confused, especially by the suggestion that there's a live badger at every game. Probably could be clarified with a little rewriting, to more clearly identify which sports teams' games warrant a live badger. And I assume this is just home games [Journalism practicum]

Great example of revoicing! But, it would be more clear for the reader if you had actually explained clearly what revoicing is, no? Also, I think it would make more sense for me as a reader if you explained what continuum of services, inclusion, etc are, preferably above in a methods section. [Psychology practicum]

A fine anecdotal lead. Will draw readers into the story by introducing the fear and anxiety experienced by Healey. At some point in story, would need to tell readers how we got the details about this scene Healey, police, documents or a mixture, for example. [Journalism practicum]

This just seems like a generalization without either an example or some structured analysis. Personally, I don't doubt your word. As a reader, though, this is not very convincing. [Psychology practicum]

The structural similarity of the copyediting feedback and the shared emphasis on writing concerns reflected in actual comments suggests that these data would be useful for testing measures of discursive similarity such as Epistemic Network Analysis. In particular, such a measure might help characterize the particular ways in which these shared concerns map onto distinct professional practices.

### Appendix 8: Robustness analysis principal component loadings

	Code pairs	$\alpha_{i1}$		Code pairs	$\alpha_{i2}$
	Proportion of total variance	11.8%		Proportion of total variance	9.0%
Most Positive	Detailed description x Engaging reader	0.3731	Most Positive	Journalistic writing x Reader concerns	0.2926
	Reader concerns x Engaging reader	0.3025		Reader concerns x Informing the public	0.2829
	Detailed description x Reader concerns	0.1406		Detailed description x Informing the public	0.2232
	...	...		...	...
Most Negative	Detailed description x Journalistic writing	-0.1604	Most Negative	Reporting concepts x Transparency	-0.1001
	Reporting concepts x Accuracy	-0.1971		Reporting concepts x Accuracy	-0.1281
	Journalistic writing x Reporting concepts	-0.3041		Journalistic writing x Accuracy	-0.1374