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Interacting Epistemic Systems Within and Beyond the Classroom

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My first exposure to Perry's (1968) work hit me like a lightning bolt. At the time, while I was not so naïve as to think that students' personal epistemology was the sole determinant of their success in education, the model did align with my experience that some students just seemed more critical, with more sophisticated understandings of concepts, than others. I thought that if educators made personal epistemology development an explicit goal, then students would be more likely to display the kinds of argumentative (Iordanou, Kendeou, & Beker, 2016/this volume) and logical reasoning (Moshman & Tarricone, 2016/this volume), needed for high-level comprehension and critical-analytic thinking (Murphy & Alexander, 2016/this volume) across contexts. With time, the literature on epistemic cognition became more and more complex, with the introduction of multiple dimensions on which students could vary (Hofer & Pintrich, 1997; Schommer, 1990), domain-differences in epistemological understanding (Buehl, Alexander, & Murphy, 2002; Kuhn, Cheney, & Weinstock, 2000; Muis, Bendixen, & Haerle, 2006), useful but challenging insights from philosophical epistemology (Chinn, Buckland, & Samarapungavan, 2011; Murphy, Alexander, Greene, & Edwards, 2007), and empirical evidence of connections with other psychological phenomena (Hofer, 2016/this volume; Sinatra, Hofer, & Kienhues, 2014).

In parallel, researchers in disciplinary education were elucidating how epistemic cognition was intimately tied to the norms and practices within scholarly fields (Sandoval, 2012) such as science (Elby, Macrander, & Hammer, 2016/this volume), history (VanSledright & Magglioni, 2016/this volume), mathematics (Depaepe, De Corte, & Verschaffel, 2016/this volume), and literature (Lee et al., 2016/this volume). Other scholars illustrated that epistemic cognition extended beyond formal learning contexts, and influenced phenomena such as the

public's understanding of science (Bromme & Goldman, 2014), how jurors made legal decisions (Weinstock, 2016/this volume), and how people navigated and understood resources on the Internet (Stromso & Yammerer, 2016/this volume). While these contributions have moved the field far from Perry's original scheme, they have not diminished my enthusiasm for the potential of epistemic cognition research and application. However, they did open my eyes to a much larger, and somewhat daunting, problem space than I had anticipated. I realized that some of the only things in epistemic cognition research that could rightly be called "naïve" were my beliefs that people's personal epistemology could be developed fairly easily, and that such development would have commensurate effects across domains and contexts.

The chapters in this section of the Handbook push on the boundaries of this problem space, by reviewing how epistemic cognition occurs within and beyond the classroom. By doing so, they illustrate that students and learners do not engage in epistemic cognition in a vacuum, but rather leverage their thinking, or not, throughout the many contexts of their lives. In addition, these chapters highlight that when people engage in epistemic cognition, they do so within multiple spheres of social influence. A better understanding of how people engage in epistemic cognition, and a better understanding of how to help them do so more effectively, must take into account the social aspects of epistemic cognition (Chinn et al., 2011). In this chapter, I describe the field of social epistemology (Goldman, 1999), and then argue that scholarship in this area provides a useful framework for understanding issues within and across the chapters in this section of the Handbook. Just as ideas from classical philosophical epistemology have informed scholarship in epistemic cognition (e.g., epistemic aims, reliable processes; Chinn et al., 2011), so can ideas from social epistemology.

Social Epistemology

Classical philosophical epistemology has been accused of being too focused on individuals and their attempts to justify knowledge qua knowledge, without sufficiently acknowledging how such attempts occur within, and are influenced by, social contexts (Goldman, 2010). For example, people do not engage in their own deliberations about the truth-value, or lack thereof, of every knowledge claim they encounter. Indeed, as Chinn et al. (2011) discussed, it is not reasonable to presume that individuals could vet every knowledge claim presented to them; rather individuals depend upon others to do that work. This division of cognitive labor (Bromme & Goldman, 2014; Kitcher, 1993) is necessary for effective epistemic cognition in both academic (e.g., relying on peer review processes) and non-academic settings (e.g., trusting governmental agencies that regulate motor vehicle safety). Goldman (1999) used the term social epistemology to refer to the study of how individuals interact with, and are influenced by, others when engaging in the pursuit of epistemic ends (e.g., knowledge, understanding, useful models; Chinn, Rinehart, & Buckland, 2014). This acknowledgement of the social aspects of epistemology has led to increased interest in two related phenomena: testimony and epistemic systems (Goldman, 2011).

Testimony. In the literature on epistemic cognition, the recognition of the importance of social aspects of knowledge and knowing has led to a move away from characterizing justifications based on authority or testimony as naïve (Chinn et al., 2011; Greene, Azevedo, & Torney-Purta, 2008). Reliance on testimony to substantiate and act upon knowledge claims is necessary regardless of an individual's age (e.g., how infants rely upon adults to build knowledge; Clement, 2016/this volume), degree of expertise (Greene & Yu, 2014; Samarapungavan, Westby, & Bodner, 2006), or context (e.g., academic versus non-academic; Bricker & Bell, 2016/this volume). This realization of the importance of testimony does not

undermine the basic idea found in many models of epistemic cognition that unquestioning faith in "omniscient authority" (Schommer, 1990, p. 499), without vetting the reliability of the source, is unlikely to lead to desirable epistemic ends. The real question is: How do people determine whether a particular source of testimony is reliable? Such questions have been the focus of the growing literature on source evaluation (e.g., Barzilai & Esher-Alkalai, 2015; Braasch, Bråten, Strømsø, & Anmarkrud, 2014; Bråten, Britt, Strømsø, & Rouet, 2011; Porsch & Bromme, 2011; Sandoval, Sodian, Koerber, & Wong, 2014). As the chapters in this section of the Handbook illustrate, today's world presents people with the challenge of vetting and reconciling an ever-growing number of possible sources, including teachers, the Internet, and museums (Bricker & Bell, 2016/this volume; Buehl & Fives, 2016/this volume; Strømsø & Yammerer, 2016/this volume). How people think about knowledge and knowing is certainly influenced by these sources of testimony.

Epistemic systems. Scholarship on social epistemology has brought to light another important social aspect of knowledge and knowing: epistemic systems (Goldman, 2011). Individuals can cohere, either intentionally or in an emergent manner, into epistemic systems (e.g., institutions, organizations) that endorse particular epistemic norms (e.g., substantiating particular knowledge claims qua knowledge), as well as particular epistemic procedures or practices (e.g., the scientific method, meta-analysis, etc.). Epistemic systems affect the behaviors and outcomes of both their members as well as those who interact with these systems. For example, as Weinstock (2016/this volume) has shown, the American legal system is an epistemic system, with its own norms (e.g., what is meant by "reasonable doubt" during a trial) and practices (e.g., legal reasoning). These epistemic norms and practices influence how members of the epistemic system behave (e.g., legal education, judges' actions) as well as what

happens to laypeople that must engage with this epistemic system (e.g., people accused of a crime, juries). Education is another epistemic system, affecting both the students who matriculate through that system as well as the educators and other adults who participate in its continued activity and evolution. Epistemic systems can be evaluated in terms of their reliability in producing desired epistemic ends, and such evaluations should inform which epistemic systems individuals heed, and which they do not (Goldman, 2011). The debate regarding whether students should use Wikipedia is, in part, a question of whether Wikipedia is a reliable epistemic system in terms of producing and disseminating "knowledge."

Another epistemic system is science, writ large. Nature of Science (NOS; Osborne et al., 2003) research derives, in part, from the belief that students would benefit from an enunciation of the epistemic norms and practices of science. For example, epistemic norms in science are not "fixed" or "certain" (Hofer & Pintrich, 1997), and illustrations of this can help students to better understand scientific phenomena and practice. While NOS has been a contentious idea, with concerns that it can lead to educators oversimplifying the diversities and controversies in science (Allchin, 2011), many scientists and science educators have worked to develop NOS-informed common standards and foci (e.g., National Research Council, 2012; NGSS Lead States, 2013). These standards are one example of a product from this epistemic system.

Groups of scientists can come together as an epistemic system to make decisions about various knowledge claims in the discipline, such as when the Astronomical Union decided to reclassify Pluto as a dwarf planet, rather than a planet such as Earth or Mars. Likewise, epistemic systems, such as the American Statistical Society (2015), can produce commentary upon the reliability of particular epistemic practices, such as null hypothesis statistical testing. The publicized norms and practices of an epistemic system have consequences, even in localized

educational settings; when instructors choose a textbook, teach a method, or critique a student's logic, they most often do so based upon what particular epistemic systems (e.g., scholarly groups, training programs, etc.) have claimed was "normative" or accepted within a field.

These epistemic systems, and the norms and practices that they endorse, may be intentionally developed, but they may also emerge over time. Scholarly epistemic systems, such as the learning sciences (Sawyer, 2014), are not created in a single day; rather, over time individuals cohere into groups and develop their own norms that may eventually be more or less distinct from other epistemic systems (e.g., educational psychology). Likewise, epistemic systems continue to evolve, and there may be varying amounts of consensus around particular epistemic norms or practices within those systems. Most scholarly disciplines have a core set of foundational theories or ideas, as well as epistemic practices, which are rarely questioned or tested (Thagard, 2004). Few astronomers question the heliocentric model of the solar system. On the other hand, even within fairly narrowly defined epistemic systems there are debates about the reliability of various epistemic practices, and the knowledge claims that utilize such practices. For example, within the epistemic system of latent variable statisticians, there continues to be much debate regarding the proper ways to evaluate the adequacy (i.e., knowledge status) of structural equation models (cf. Hayduk, Cummings, Boadu, Pazderka-Robinson, & Boulianne, 2007).

Thus, epistemic systems can influence both practice and education. However, the appropriate "grain-size" for conceptualizing and analyzing epistemic systems is not always straightforward or clear. Samarapungavan et al. (2006) have shown that epistemic cognition in subdisciplines of science, such as chemistry, can be quite specific and somewhat distinct from "science" as a whole. Therefore, it can be difficult to determine what the "epistemic system" of

science really is. Is science, writ large, a coherent epistemic system whose norms and practices can be outlined and taught, such as NOS (Osborne et al., 2003) initiatives? Or, is it more appropriate to characterize particular subdisciplines of science, such as chemistry, as an epistemic system given the evidence of the specific ways that research chemists engage in knowledge vetting and creation (Samarapungavan et al., 2006)?

Social epistemology as a lens for contexts. Therefore, social perspectives on epistemology not only highlight the necessity of testimony as a form of justification (Chinn et al., 2011), but they also provide a way of thinking about testimony from both individuals and epistemic systems. Importantly, social epistemology scholarship highlights that individuals make decisions about which sources and epistemic systems they deem reliable, and then those decisions influence their own epistemic aims, practices, and ideals (Chinn et al., 2014). Such decisions are likely to be influenced by both rational and non-rational factors (e.g., motivated reasoning, Sinatra et al., 2014).

The chapters in this section illustrate an additional nuance: to be successful in school, students must not only learn the epistemic norms and practices of a particular discipline (e.g., science), but also the norms of the local context in which the student encounters those norms and practices (e.g., a classroom, a museum, or the Internet). In essence, what "counts" as knowledge in a science classroom, and how knowledge claims are justified, are the result of sometimes complex interactions between multiple epistemic systems at differing levels of granularity: the science community, the science education community, the teacher in the classroom, and fellow students. Such interactions may lead to a particular set of accepted epistemic norms and practices in one science classroom, and very different ones in another. And those epistemic norms and practices may be very different than the ones that people experience outside of school, such as in

museums, in the home environment, or on the Internet (Bricker & Bell, 2016/this volume). As the chapters in this section of the Handbook show, contexts in which people engage in epistemic cognition are influenced by multiple epistemic systems. The literature on social epistemology, therefore, leads to important questions for epistemic cognition researchers: To what degree do students intentionally, or unintentionally, navigate and reconcile the expectations of these various epistemic systems, and how does epistemic cognition, particularly issues of testimony, manifest in these various contexts?

Social Epistemology Interactions Between Contexts

Bricker and Bell's (2016/this volume) chapter on science learning across contexts did a wonderful job of illustrating how an individual's epistemic cognition can manifest differently in lab studies, classrooms, museums, and the home. These findings certainly have implications for how, and where, research on epistemic cognition occurs. Decontextualized tasks in artificial environments seem likely to elicit different kinds of epistemic cognition than inquiry science activities, or museum visits, an idea that advocates of situated views of epistemic cognition have long argued (Sandoval, 2012). The questions raised for me are: How are students making sense of the various epistemic systems that they encounter? How do students' interpretations of these epistemic systems influence their epistemic cognition in these contexts? How do students understand and navigate situations where multiple, conflicting epistemic systems are relevant?

The social epistemology perspective affords some hypotheses about how people experience these context differences. Interactions among epistemic systems can be conceptualized in an almost Bronfenbrenner-like (1979) manner (cf. Feucht, 2010). Within a science classroom, there are at least two epistemic systems at work. Science, as an epistemic system, exists at what Bronfenbrenner called the macrosystem, or the cultural context. In

addition, the classroom itself is a kind of epistemic system, perhaps largely influenced by the teachers' epistemic cognition (Buehl & Fives, 2016/this volume). The classroom epistemic system exists within a student's microsystem, or the system of direct influences upon the student's context. However, the microsystem is the result of influences from several other higher-order systems in Bronfenbrenner's theory. An example of another relevant epistemic system is the exosystem consisting of science teachers and the district or state curriculum specialists, and how they interact to determine the science content to be taught and resources to be used. Bricker and Bell (2016/this volume) illustrated how context can be physical, social, and cultural spaces, and I would argue that different epistemic systems can be salient in each of these spaces. There is a need for much more research regarding how these multiple epistemic systems, at different micro-, exo-, meso-, and macrolevels, interact to create contexts like classrooms and museums, and how people perceive, understand, and navigate the many epistemic systems at play within those contexts.

Of course, the people within these contexts also bring with them some prior knowledge about epistemic norms and practices, even if much of this knowledge is tacit (Chinn et al., 2014). Students with some knowledge of the science epistemic macrosystem likely bring that to science museums, but as Bricker and Bell illustrated, to understand and evaluate the knowledge claims they encounter, they must also determine the epistemic norms and practices at play in the museum itself. A student's source evaluation behaviors in one context may differ dramatically from those enacted in another context, even when dealing with content from the same academic discipline. In Bricker and Bell's chapter, Brenda displayed very different epistemic cognition in the science museum as compared to her science classroom, which suggests that she interpreted these contexts differently, despite the common epistemic macrosystem. Bricker and Bell's

recommendation for more research involving "the same people's epistemic cognition across contexts and over time, using a variety of methods" (p. XX) could be addressed, in part, by examining how students like Brenda make sense of different microsystems (e.g., the classroom versus the museum) that share a common aspect of the macrosystem (e.g., the science epistemic system).

Bricker and Bell (2016/this volume) illustrated numerous interactions between epistemic systems in their chapter, and one of the most profound, in my opinion, was their discussion of how Western school contexts can negate Native American students' epistemic cognition, and the epistemic systems that influence these students' epistemic cognition. In these instances, there was a direct clash between two epistemic systems: the one outside of school, and the one inside. Bricker and Bell made a strong argument that one desired outcome of education should be that students develop the ability to navigate these epistemic microsystems, and maintain autonomy and a critical perspective throughout. Ideally, of course, educators would be aware of the many epistemic systems at play in a particular context, and thoughtfully develop students' ability to understand and navigate those systems. One challenge is how to do that without encouraging a kind of vulgar relativism (Rorty, 1997) in students, where all views are seen as equally plausible and warranted.

Misaligned Epistemic Systems

Many citizens have only a partial, and often somewhat incorrect, understanding of legal systems. As Weinstock (2016/this volume) so aptly showed, Goldman's (2011) social epistemology scholarship is informed by, and directly informs research on, the epistemic cognition of legal reasoners. The common-law legal system of the United States is an epistemic system, with its own epistemic norms and practices. In addition, this epistemic system makes

assumptions about laypeople, and their ability to understand and use these epistemic norms and practices when they serve on juries. Weinstock's chapter illustrates, in a most concerning way, how laypeople's folk epistemologies may deviate significantly from that of the legal epistemic system, and how the instructions and training provided to laypeople often does not resolve this incongruence. Differences between the epistemic ideals (Chinn et al., 2014) of the legal system and the laypeople who populate its juries may lead to significant variance in legal decisions, and decrease the reliability of the legal epistemic system in terms of producing desirable epistemic ends (i.e., correct verdicts). Such problems with reliability seem particularly likely if the epistemic ideal of "beyond a reasonable doubt" means one thing to a juror, and something very different in the legal epistemic system.

I was struck by the challenges regarding testimony that were illuminated by Weinstock's chapter: common-law juries are placed in a relatively resource-poor position to engage their epistemic cognition. The majority of juries' work, in terms of epistemic cognition, consists of source evaluation of the testimonials presented to them. Such source evaluation likely depends critically on the prior knowledge of the jury members themselves, as would be suggested by the epistemic cognition literature (e.g., Bråten et al., 2011). To use a fictional example, in the movie *My Cousin Vinny*, the vast knowledge of automobiles displayed by Mona Lisa Vito (i.e., actor Marisa Tomei) made her testimony so convincing to everyone in the courtroom, including the laypeople of the jury and the prosecutor, that the charges filed against the defendants were dropped. However, how could this vast knowledge be evaluated by laypeople; what kind of source evaluation could be done in an epistemic system where people could not seek out their own data outside of the courtroom? As Goldman discussed, United States' legal system was designed to absolve juries of the responsibility of making judgments of expertise, but the

likelihood of jury members accepting an expert's specific knowledge claims likely varies depending upon those jury members' amount of prior knowledge about the topics being adjudicated.

To take another perspective on this example, what if Ms. Vito were not a witness, but rather a member of the jury? How would her vast knowledge, directly relevant to the case, have influenced the verdict, if at all? Jury members are not allowed to share their knowledge except when deliberating among themselves. Would her knowledge have been as influential if it was shared in the jury deliberation room, and possibly seen as just one perspective among other laypeople selected for this case? As Goldman (2011) has discussed, the common-law legal model may not be the most reliable epistemic system for deriving true verdicts, and it is unclear how the background knowledge and folk epistemologies of the people who interact with that system, be they the more permanent members such as lawyers or the more transient jurors, affect the achievement of desirable epistemic ends.

While much of the research on legal reasoning to this point has focused upon how differences in epistemic development (Kuhn et al., 2000) relate to legal reasoning, social epistemology, and Weinstock's chapter, suggest additional avenues for generative research and recommendations for practice. Like the students in Bricker and Bell's chapter, individuals who serve on juries are implicitly asked to navigate between the epistemic systems that have shaped their prior knowledge and epistemic cognition, and the legal epistemic system. How much more reliable would the legal epistemic system be if it made the need for such navigation explicit, and provided laypeople with the tools to engage in such navigation? Just as classical philosophical epistemology was critiqued for a lack of attention to social epistemology, so might the United States' legal epistemic system be critiqued for its dependence upon individual legal reasoners,

many of whom do not understand the epistemic norms and practices of that system. There is a great need for research on how prior knowledge and competing epistemic systems clash, and what can be done to help people navigate these clashes.

Sourcing and the Internet as an Epistemic System

Clearly, one of the major challenges for modern learners, and education researchers, is how to best navigate and critically integrate the growing proliferation of online resources (Bråten et al., 2011; Greene, Yu, & Copeland, 2014; Strømsø & Kammerer, 2016/this volume). As Strømsø and Kammerer stated in their chapter, online texts often lack sufficient source information, making it very difficult to evaluate them as sources of testimony. This poses a tremendous problem for students, who depend so critically upon access to, and prior knowledge about, source information to engage in effective epistemic cognition (Goldman, 2011). Physical libraries and classrooms contain curated resources; someone has vetted the resources and determined them worthy of reference. On the other hand, the Internet is populated with resources, some of which are curated (e.g., the National Science Foundation's National Science Digital Library, http://nsdl.oercommons.org) and some not. When someone posts on their website that they are an "expert" there is often little information to either substantiate or refute that claim. Many people have mistaken beliefs about source information online, such as those about the ".org" domain. While originally intended only for nonprofit groups, this distinction has been dropped, meaning that any person or organization can use the ".org" domain, as well as the ".com" and ".net" domains, among others. Yet, many Internet users continue to believe that the ".org" domain is somehow more reliable, or less biased, than other domains. This is not true, but such beliefs persist, and likely influence Internet users' source evaluations (Goldman et al., 2010).

Strømsø and Kammerer (2016/this volume) reviewed important findings indicating that belief in simple and certain knowledge negatively predicted the quality of students' Internet searching and comprehension. It is reasonable to presume that Internet users who believe that knowledge is simple and certain are unlikely to see much need for source evaluation. Such behaviors seem akin to Kuhn's (Kuhn et al., 2000) argument that absolutists see little need for examining justifications, given their naïve views of knowledge and humans' access to it. One question to consider is the degree to which students who believe in simple and certain knowledge recognize different epistemic systems, if at all.

I was most intrigued by the Strømsø and Kammerer's review of research on internet-specific epistemic beliefs. In the parlance of social epistemology, the Internet itself can be viewed as an epistemic system, and philosophers such as Goldman (2011) and Thagard (1997) have explored this idea. The Internet affords many advantages over traditional print methods of distributing knowledge, such as journals or books. The Internet can be updated when errors are discovered, or new information sheds light on previously argued knowledge claims. Knowledge claims can be distributed more quickly online, and the recent move toward posting datasets and other supporting materials online would seemingly help experts vet knowledge claims based on such materials (Thagard, 1997). Nonetheless, is the Internet a reliable epistemic system?

The Internet is large and diverse enough that claims about its reliability, overall, are not truly possible or likely helpful. However, it seems reasonable that learners, particularly those who are relative novices in a particular domain, may evaluate the Internet as an epistemic system, in other words in terms of its reliability as a source of knowledge for that domain, or for domains with which they are unfamiliar. From this perspective, it is not clear that the Internet is superior to other epistemic systems such as edited journals or handbooks, at least in terms of achieving

desired epistemic ends. One particularly interesting phenomenon is that the Internet is both an epistemic system unto itself (e.g., people make knowledge claims online) as well as a means of distributing knowledge claims made by other epistemic systems (e.g., when a newspaper posts a summary of a peer-reviewed article; the Stanford Encyclopedia of Philosophy; Zalta, 2015). Here again, people have to reconcile among many potential epistemic systems (e.g., the Internet, the scholarly or non-scholarly domain that they seek to learn about, and the media).

Therefore, individuals' Internet-specific epistemic beliefs may take many forms. Some individuals may have domain-general beliefs about the Internet as a reliable source of knowledge claims. Other individuals may have domain-specific beliefs about the Internet as a reliable source for knowledge claims in particular disciplines (e.g., the Internet is a reliable source for historical knowledge, but not scientific knowledge). And some individuals may have quite nuanced beliefs about the Internet as an epistemic system, either unto itself or as a means of distributing knowledge claims from other epistemic systems. These beliefs likely interact with other forms of epistemic cognition to influence how individuals navigate, critique, and integrate information from online sources. Describing how people do, or do not, engage in epistemic cognition among varied epistemic systems is a seemingly generative area of future research.

Teachers and Classrooms as Epistemic Systems

Buehl and Fives (2016/this volume) have written a chapter that truly pushes the field of teacher education and practice in new directions. They have identified several intriguing areas for future research. Within the context of scholarship on teachers and teaching, they have expanded Chinn et al.'s (2014) idea of epistemic aims to include not only teachers' epistemic aims when acquiring pedagogical and pedagogical content knowledge, but also the aim of assisting or scaffolding others to acquire knowledge. In this sense, epistemic aims can include

social processes (i.e., a desire to help others engage in epistemic cognition, or not), which further highlights the potential contribution of scholarship on social epistemology to the epistemic cognition literature.

Clearly, social aspects play a critical role in teachers' epistemic cognition, such as when they determine reliable sources for pedagogical content knowledge. There are likely significant effects upon teacher learning based upon whether a particular instructor, professional development provider, or peer teacher is determined to be a reliable source. It would be intriguing to investigate how teachers make these source evaluations, how those evaluations influence their pedagogy, whether these evaluations have any influence upon how teachers instruct students in the social aspects of epistemic cognition, and whether source evaluations are updated based upon additional information (e.g., if new information suggests that a source previously determined to be reliable should be reclassified as unreliable).

As I mentioned when discussing Bell and Bricker's (2016/this volume) chapter, teachers create epistemic systems in their classrooms. As Buehl and Fives showed, teachers with varying epistemic virtues, vices, or aims (e.g., knowledge, understanding, avoidance of false beliefs; Chinn et al., 2014) may either explicitly or implicitly create very different epistemic systems, or what some might call epistemic climates (Feucht, 2010; Muis & Duffy, 2013). The classroom, like the Internet, is both an epistemic system in and of itself as well as a conveyor of knowledge and norms of other epistemic systems. To earn good grades, students, either consciously or non-consciously, often have to determine a teacher's desired epistemic ends in the classroom, and which epistemic norms and practices are privileged. A student may understand that there is a diversity of scientific methods (Osborne et al., 2003) but if that student's teacher sets up an epistemic system where only experimental data is deemed reliable, then the student must

reconcile these two systems to determine what kinds of products and processes are rewarded in that classroom. Failure to sensitize to these potential interactions and differences between the epistemic systems at play in a student's microsystem may lead to misaligned epistemic cognition, and poor grades (Porsch & Bromme, 2011).

Teacher training programs are also epistemic systems, and as Buehl and Fives showed, teachers can vary in their assessment of the reliability of those systems. Nonetheless, teacher training programs almost certainly influence teachers' epistemic cognition. Some teacher training programs continue to emphasize discredited ideas, such as learning styles (Pashler, McDaniel, Rohrer, & Bjork, 2009). It takes a great deal of effort for pre-service teachers to construct their pedagogy to accommodate multiple learning styles. When these teachers later learn that learning styles are not an effective means of differentiation, they may experience frustration (Goswami, 2006) and begin to doubt their teacher training program as a reliable epistemic system, such as Buehl and Fives' example of Jill, who ignored knowledge claims made in formal coursework. This unfortunate situation may result in a positive outcome if such challenges lead to teachers taking a more thoughtful and active role by engaging in epistemically informed praxis (Buehl & Fives, 2016/this volume). On the other hand, such challenges may lead to negative epistemic emotions (Pekrun & Linnenbrink-Garcia, 2012) that might promote a form of nihilism or vulgar relativism, where teachers view their profession as more of a set of intuited dispositions rather than as a profession. Such views would be unfortunate, given current pressures to enact evidence-based pedagogies and demonstrate the professional nature of teaching (Slavin, 2008).

Conclusion

The chapters in this section of the Handbook have demonstrated that the recognition that a person's epistemic cognition is intimately entwined with the social and contextual factors in which that thinking occurs (Sandoval, 2012) has positively informed the field. To put it simply, context matters, and characterizing individuals' epistemic cognition without taking into account what they were asked to think about, in what setting, with what tools, and under what conditions, is a dangerous proposition. Epistemic cognition certainly does occur within and beyond the classroom, and reconciling among multiple sources of testimony, and epistemic systems, is likely a significant yet commonplace challenge.

An integration of ideas from social epistemology (e.g., testimony, epistemic systems) into epistemic cognition scholarship will likely benefit education researchers, just as the inclusion of means of justification and epistemic aims from classical philosophical epistemology has done (Chinn et al., 2014; Murphy et al., 2007). The need for a division of cognitive labor makes it essential that individuals develop the knowledge and skills necessary to evaluate others as sources of knowledge. At the same time, epistemic cognition research would benefit from taking seriously the role of epistemic systems in determining and disseminating epistemic norms and practices. At any particular time, individuals' context is formed by multiple interactions among many epistemic systems, and differences in epistemic cognition across contexts may be better understood by investigating how people do, or do not, actively reconcile differences across these systems.

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