This chapter presents the bottlenecks identified by seven faculty members from diverse disciplines, and an inductive content analysis of their Decoding interviews. Representative quotations illustrate themes in the interviews and we consider the implications for both faculty development and pedagogical research.

Uncovering Ways of Thinking, Practicing, and Being through Decoding across Disciplines

Janice Miller-Young and Jennifer Boman

Decoding the Disciplines is a process designed to help instructors and educational consultants articulate expert approaches to difficult, or "bottleneck" concepts, and to find new ways to help students learn these concepts (Pace and Middendorf 2004). After identifying a bottleneck, the process continues with an interview which helps the instructor better articulate their own thinking, in order to then model it for students. Most Decoding work has focused on procedural and cognitive bottlenecks in specific disciplines such as humanities, history, and geology (e.g. Ardizzone, Breithaupt, and Gutjahr 2004; Shopkow, Diaz, Middendorf, and Pace 2013; Zhu, Rehrey, Treadwell, and Johnson 2012). The related scholarship has typically described pedagogical changes and resulting learning outcomes for students, with less attention given to the commonalities in themes that emerge across groups of experts. In the following chapter we will demonstrate how there is much to be learned by looking more closely at what Decoding interviews can uncover through applying the Decoding framework across disciplines.

Because the focus of most Decoding scholarship to date has been primarily on student outcomes, there is little written about the Decoding interview process itself. Pace and Middendorf (2004) describe the interview as intellectually demanding for the interviewee. They recommend that interviewers should keep the focus on the interviewee's thinking process, use questions such as "How do you do that?", probe at the place where the interviewee cannot

explain, and summarize their thinking back to them at an abstract level (Shopkow, Diaz, and Pace 2013). In one example from the History Learning Project, Shopkow (2010) used interview excerpts to illustrate how the interview process can push faculty to recognize their own tacit knowledge and generate surprising realizations that what is simple and self-evident for them is likely not so for students. This dearth of literature about the Decoding interview itself was one reason we set about to practice and study the interview process and outcomes.

Decoding work has primarily focused on procedural and cognitive processes, and its utility in decoding other types of bottlenecks, and in multidisciplinary contexts, has only begun to be explored. Shopkow (2010) used Decoding interviews of cognitive and procedural bottlenecks in history to demonstrate that epistemological and emotional bottlenecks may also be unearthed and that the conceptual and ontological are inextricably linked. Similarly, Middendorf, Mickute, Saunders, Najar, Clark-Huckstep, and Pace (2015) write about revealing affective bottlenecks in history. In a multidisciplinary faculty self-study (Miller-Young, Dean, Rathburn, Pettit, Gleeson, Lexier, Calvert, and Clayton 2015) participants explored the utility of using the Decoding interview for studying faculty learning about reciprocity in service-learning. By analyzing each others' interviews within their community of practice, they found the Decoding interview to be useful not only in uncovering participants' thinking, but also in generating new learning. Such work has demonstrated the value of more deeply analyzing the interviews in order to better describe the layers of complexity involved in the bottlenecks that teachers identify as well as the learning that is generated from the interviews. However, while there have been calls in the Scholarship of Teaching and Learning (SoTL) literature for more interdisciplinary SoTL efforts (e.g. McKinney 2013), the Decoding the Disciplines framework has rarely been used for non-cognitive bottlenecks nor applied in an interdisciplinary way.

In separate but parallel work, the Thresholds Concepts movement also began with a disciplinary focus (Meyer and Land 2003, 2005; Meyer, 2008). According to this framework, learning a threshold concept resembles passing through a portal, towards a transformed understanding. The original premise of their work was that threshold concepts are key concepts in a curriculum which students must master on their learning journey within a discipline. More recently however, the threshold concepts framework has been applied to interdisciplinary concepts such as social justice (e.g. Kabo and Baillie 2010), environmental sustainability (e.g. Levintova and Mueller 2015), and becoming a researcher (e.g. Kiley and Wisker 2010). This work has generated rich, interdisciplinary conversations and debate as evidenced by the multiple conferences, articles, and edited volumes on the topic. One criticism, however, is that the movement invites instructors to examine their disciplines rather than their own teaching practice (Cousin 2007).

As with Threshold Concepts, the Decoding framework holds much potential for bridging disciplinary thinking and teaching practice across disciplines. In addition, the Decoding framework also engages teachers in critical reflection on their own thinking processes by beginning with the Decoding interview. The learning and insights that emerge during the interviewing process have obvious potential benefits for the individuals who participate in them but we suggest that sharing and integrating these insights can have benefits for others. In this chapter, we expand upon existing Decoding work in two ways: 1) interdisciplinary themes: we examine the common themes which emerge from Decoding interviews of faculty from four diverse disciplines; 2) complexity of bottlenecks: we explore not only cognitive bottlenecks, but also ones which we classify as epistemological and ontological, as described in the following section.

Background and Purpose of Study

As described in the previous chapter (Boman, Currie, MacDonald, Miller-Young, Yeo, and Zettel), Decoding interviews were conducted with faculty in the Decoding the Disciplines Faculty Learning Community as well as those who accepted our invitation to participate as part of a teaching development initiative. We conducted interviews with faculty from diverse disciplines and with teaching experience ranging from 10 to 30 years, about bottlenecks which they identified. Interviews were transcribed and were shared with the interviewees for them to further reflect on. The interviews were often followed up with discussions of possible teaching strategies to address the bottleneck. While conducting the interviews, our learning community began to notice common themes emerging across the interviews and decided to pursue a formal, in depth analysis of the interview transcripts. We therefore asked permission from our interview participants to use their transcripts as data for this study. The research question explored in this chapter is "What common themes emerge about expert disciplinary thinking in the Decoding interviews we have conducted?"

Methods

Seven faculty members from four diverse disciplines and with different types of bottlenecks participated in the study. Their decoding interviews were qualitatively analyzed for common themes. This study was approved by the Mount Royal University Human Research Ethics Board.

Participants and their bottlenecks. Four faculty members presented cognitive bottlenecks.

- *Louisa* identified that nursing students in her second year pathophysiology class have a working knowledge of biological processes but have difficulty in understanding how alterations in these processes manifest themselves as signs and symptoms in their patients.

- *Patricia*, an engineer teaching a first/second year Dynamics class, noticed that students have trouble applying Newton's second law of motion (F=ma), especially in pulley problems where students tend to assume that the tension in a rope is equal to the weight of the object hanging from it (which is only true if the object is not accelerating).

- *Bonnie*, a journalist, was concerned that senior journalism students continue to struggle with identifying and articulating good story ideas. In other words, her students not only struggle with identifying story ideas ('I just can't think of anything'), but also with turning those ideas into journalism artefacts - stories - that an audience would benefit from in some way.

- *Colin*, a director and theatre instructor, wanted to help his acting students identify what he called the 'super task', or as he explains, the 'single thing that their character is trying to achieve as an overall, and overarching, purpose... The supertask is the linking glue that pulls all the pieces of the play together, and becomes an overall metaphor that the actor can hold inside of themselves.'

One participant presented a bottleneck that was more epistemological, in other words, related to a misunderstanding of the nature of knowledge construction in the discipline.

- *Juan Carlos*, also a journalist, was concerned with his first year students' beliefs in the necessity of objectivity in journalism. According to Juan Carlos, students will nod in agreement when presented with the objections to objectivity in class discussions, and are shown examples of how the same set of facts differently arranged can lead to two different meanings, but in practice and in their own rhetoric later they revert back to their own naive belief in objectivity.

And finally, two bottlenecks could be classified as ontological bottlenecks, as they were related to being and becoming a nurse. Ontology is one's view of reality and includes one's assumptions about the nature of reality and claims about what exists.

- *Monique* felt that her senior nursing students had difficulty understanding how to apply the nursing code of ethics in their practice. In particular, she noticed that while students may be able to "speak the language", they sometimes respond and react to things that shake them up (especially in their practicum experiences) in ways that indicate they haven't integrated the code of ethics into their practice.

- *Wendy* was concerned that her students "get stuck" with a mindset that nursing is about working in a hospital with people who are ill. In Wendy's community health/population course the bottleneck was the idea that the role of nursing is to keep people well so they never enter the hospital or so if they do they are only there for a short time. Part of this role is understanding the determinants of health which include income level and socioeconomic status, social supports, and educational level.

Interviews and analysis. At least two interviewers conducted each interview, which ranged in time from 54 to 102 minutes. The interviews were audio recorded and transcribed. The members of the faculty learning community then independently read the transcripts and met several times as a group to discuss their perceptions of the interviews and emerging themes. After these initial discussions, the authors of this chapter each independently and inductively coded for themes using the constant comparison method (Glaser 1965) and then discussed to reach consensus.

Findings: Common Themes

Common themes were collapsed into 3 main overarching categories: ways of thinking (i.e.,
deconstructing and reconstructing information, and recognizing patterns), ways of practicing
(i.e., valuing provisionality, expanding thinking, attending to the world, and taking agency), and
ways of being (i.e., being ethical and authentic). Despite the variety of disciplines and types of
bottlenecks presented, each of these themes was evident in over half of the interviews (Table
2.1).

Table 2.1. Common themes identified in six Decoding interviews of diverse faculty members and diverse bottlenecks.

Themes		cognitive				epistemological	ontological	
		Patricia	Bonnie	Louisa	Colin	Juan Carlos	Wendy	Monique
ways of thinking	deconstructing/ reconstructing	✔		✔	✔	✔	✔	
	recognizing patterns		✔	✔	✔	✔	✔	
ways of practicing	valuing provisionality	✔	✔		✔		✔	✔
	expanding thinking		✔		✔	✔	✔	✔
	attending to the world	✔	✔	✔	✔	✔	✔	✔
	taking agency		✔	✔	✔	✔	✔	✔
ways of being	being ethical/ authentic		✔			✔	✔	✔

The themes are described and illustrated with example quotes, below.

Deconstructing/reconstructing. An initial theme that emerged from the participants' interviews was the idea that expert thinking involves both the deconstruction and reconstruction of knowledge. In other words, disciplinary thinking often involved both an analysis of individual parts but also a synthesis of the parts in order to examine the whole. Patricia spoke about this kind of thinking in engineering when she explained, "*You have to break [the problem] down into the simple parts and look at each simple part by itself and then put it back together and solve the system of equations.*" Patricia goes on to explain that an important component of her thinking in this regard is the judgment involved in knowing at which point to deconstruct the problem. Similarly, Louisa described that in her discipline of nursing, nurses must be prepared to think about and break problems down in different ways. She explained that nurses must think about their patients across many different levels, such as an organ level, a system level, a tissue level, and a cellular level. For Louisa, a key component of her expertise was her ability to move her thinking across these different levels of analysis in order to come to a clear picture of what was happening for a particular patient.

Like Louisa, Wendy, another nursing participant, also noticed that her disciplinary thinking involved a certain degree of analysis and deconstruction. She adopted the analogy of an onion and explained that she is able to peel back layers of a patient's immediate problem to reveal broader influences and determinants of health that may be influencing the situation. She suggested that while this kind of deconstruction of a problem is necessary to help identify possible routes to prevention, her students seemed unable to do that. In contrast, while Wendy's students struggled to deconstruct a situation, Colin noted that in his discipline of theatre, students often struggled to reconstruct something to build new understandings. He reflected, "*It is easy*

for me to actually show actors what the steps are, it is actually quite easy to show people how to take something apart; it is more difficult for them to understand, or then grasp after they have pulled something apart that it then all relates back together, because they become so interested in each piece individually." Indeed, Colin indicated that discovering the *"linking force between all of the pieces"* is a central component of actors' thinking.

Finally, while it might be expected that deconstructing and reconstructing information might be associated more with cognitive bottlenecks, we found evidence of this approach to knowing in Juan Carlos' interview as well. He explained:

People are going out and gathering some facts and then are arranging them in a way that produces a meaning, but they could arrange them in a different way and produce a different meaning... We can have a bunch of true, verifiable facts; it is when we put them together in a meaningful arrangement that we depart from the one truth and we are actually imposing some sort of meaning. Any story is like that.

Juan Carlos emphasized the idea that meaning is subjective depending on how knowledge is arranged. Indeed, part of his bottleneck is coming to the realization that the meaning of a story may change as a result of reconstructing the elements in different ways.

Yeo further explores the dynamic to-and-fro between whole and part by analyzing Colin's, Louisa's, and Patricia's interviews using a hermeneutic lens (Chapter 4, this issue).

Recognition of patterns. The second way of thinking that participants spoke about was their ability to recognize patterns and to see connections and gaps among various pieces of information. Despite differences in their bottlenecks, two of the nursing participants both talked about relying on their knowledge of theory and research as well as their own experience in identifying patterns when diagnosing patients. Louisa explained:

"I would start first with looking at the signs and symptoms and see if there is a pattern with them… I can't put my finger on it, but I know [for the expert nurse] if there is something wrong and they know that the patient is going to go sour, and sure enough that patient goes sour even though they didn't have any clear indication, they can't back it up with any evidence, they just have a feeling because they have seen it with other patients, and that is when an expert is talking…"

For Louisa, this form of pattern recognition was part of the expert's intuitive or implicit knowledge that she was trying to make more visible to her students, a difficulty in common with athletic therapy (Yeo, Lafave, Westbrook, McAllister, Valdez, and Eubank this issue).

Finally, both journalists also talked about recognizing patterns, but for different reasons. Bonnie spoke about recognizing what makes a good story idea. She explained, *"I get excited when the story doesn't fit what we consider to be a pattern of a predictable story… it is like I am always classifying things and if it falls outside that kind of regular pattern, for whatever reason, to me it would seem worth exploring."* Meanwhile, Juan Carlos offered a critical perspective on patterns in the broader discipline. He said, *"A lot of journalism is done on the spur of the moment and people tend to fall into interpretations that are already given… no one is thinking very critically… It is partly that we are all driven by ideology and we all have a perspective on the world that comes from our history, our class, location, our gender, our sexuality, all of these things make us situated in a particular way, and so we see things in a particular way."* For both Bonnie and Juan Carlos, it was important to recognize patterns so that they could also recognize and pursue more unique interpretations or angles.

For the participants who mentioned pattern recognition as an important way of knowing, a prerequisite seemed to be having adequate background knowledge in order to recognize what is

new and what is old or to notice what is different. Being attentive to the world, one of the themes discussed below, outlines some of the ways in which the disciplinary experts seemed to acquire the necessary information and frameworks to be able to make these kinds of connections.

Valuing provisionality. In addition to speaking about ways of thinking in their disciplines, the participants also discussed ways of practicing in their disciplines. A key theme that emerged early in the analyses was the idea that the participants valued the importance of taking time when engaging in disciplinary thinking, a process that often involves waiting and withholding judgment before coming to a conclusion.

For example, Colin spoke of the provisional nature of the task of understanding the role of a character in a play. He described a process of continually rereading a play while remaining open and waiting for new insights about the characters to emerge. He suggested that *"one of the hardest things I have to get young actors to do...is not to make conclusions, to just keep on waiting for more information."* In Colin's discipline, there is value in understanding the provisional nature of the task and trusting that one's understanding will deepen and broaden over time.

Similarly, in her discipline of engineering, Patricia spoke of the importance of not making assumptions and trusting the process when solving problems:
"Remember to draw the free body diagram and not just make that initial assumption…the more and more complex these systems get, the more valuable drawing this out becomes…maybe that is [the source of the bottleneck], that I recognize the fact that this is going to be valuable as the questions become more and more complicated and [the students] just haven't realized that yet…I don't assume. If you are not told something, or something isn't given in the question, don't assume. Don't assume the tension is equal to the weight. Don't assume anything!"

Wendy also spoke of the importance of not jumping to conclusions or judgment in her discipline, nursing. She stated, *"I try not to make assumptions and I try not to have already decided what is wrong with the person before I have talked to them…You start and say 'How can I help you today? What would you like? What is the most important thing you want me to focus on today?"* Wendy indicated that she had learned this process of slowing down from observing her mentors. She noted, *"They weren't rushing – even though it was really busy."*

This idea of being non-judgmental and not rushing also emerged in one of the journalism interviews. Bonnie spoke about the idea of allowing time and space to fully consider her story ideas rather than making quick judgments. What was common across the theme of valuing provisionality was participants' shared sense of the importance of waiting and being open to possibilities rather than jumping to a foregone conclusion. As Yeo (this issue) describes, they exhibited an 'openness to questions'. The disciplinary experts clearly trusted the process of taking the time to think and had the self-discipline to hold back from rushing in or making assumptions.

Expanding thinking. A second way of practicing, expanding thinking, refers to the idea of examining a problem or scenario from different points of view. This theme clearly related to the theme of valuing provisionality because expanding thinking often requires pausing in order to more fully consider different perspectives. Similar to the sense of being open and non-judgmental in the previous theme, the purpose of expanding thinking is not to reduce a situation to a binary or single answer but to be able to think about an issue in terms of the broader influences. When thinking is expanded, individuals are able to come to new insights or perspectives and make sense of something through their own experiences.

All three nursing participants spoke about the importance of expanding their thinking. Monique described her desire for students to learn to examine situations from different angles. She stated that she wanted to see her students *"actually looking at the dilemma they are faced with and actually looking at different sides of it…there are multiple ways of looking at a scenario…[I want them to have] a capacity to think critically with respect and with a broader view."* Wendy also spoke of the importance of encouraging thinking in terms of the big picture or broader view. She suggested that in her own practice, *"I continue to develop it…the art of asking those bigger questions, and the art of seeing that as the role of the nurse…to go bigger and broader. So not just conceptually we talk about it, but also how are you going to do this with your patients or the family so they get more comfortable with that?...it is to also consider the broader influences that have brought them to this place."* Louisa, too, mentioned the importance expanding thinking and gathering a range of information so that you are then able to prioritize and *"know what is foreground, know what is background."* For the nursing participants, the ability to consider multiple perspectives and a broader view was an important component of disciplinary thinking.

Both journalism participants spoke to the possibilities that come from expanding thinking. When looking for story ideas, Bonnie indicated that she shifts into and out of different points of view and looks for missing perspectives such as *"Who did [the reporter] not talk to?"* She remarked that, *"Often what they miss is the face of the story."* For Bonnie, examining multiple perspectives allowed her to identify gaps and potential opportunities. Juan Carlos mentioned the freedom that comes from moving beyond a particular way of thinking about or doing something. He mentioned that subjectivity in journalism is actually a *"liberating idea because if you actually buy into this notion that there is no such thing as objectivity in this*

particular sense, then you are freed to make some conscious decisions about what kind of milieu

you will develop in your reporting...you will be liberated from a lot of rules that constrict and

confine you." Like the nursing participants, expanding thinking is an important way of practicing

in the discipline.

   Attentiveness to the world. Another theme that spoke to participants' ways of

practicing was that they embodied a natural sense of curiosity and attentiveness to their

environments. They did not just exist in their worlds – they were consciously aware of and

engaged with their surroundings. For Louisa, attentiveness to the world included the sense of

being "observant." She explained, *"One of the questions I ask myself all the time is, 'What else*

do I want to know about this patient? What else will help me take care of him?'...a lot of it is

being observant...I think that has really helped me in terms of understanding and gathering all

the information that I need." For Louisa, being observant involved not only an attitude of

inquisitiveness but also the practice of asking questions. Wendy agreed that observation and

questioning were qualities she would like students to cultivate in their nursing practice.

   In addition to questioning, participants described reading as a key practice in being

attentive. For example, Wendy suggested, "*...one of our standards of practice is that we base*

care on evidence and so I know I need to do my research, I need to read and I need to be aware

of what is out there and what the evidence is." Bonnie also spoke of the importance of reading.

She mentioned, "*[Students] don't seem to hear and see the things that I think as a journalist I*

hear and see...I am an avid consumer of news and so I stay abreast of what other people are

doing in terms of news content, and in the way that I engage with that content in terms of story

ideas is that I am constantly looking for - what do they cover? What are the gaps? What is it that

follows?... I scan the newspaper every morning, my homepage is CBC and I am checking that

site at least a couple of times in the day...and I will check what is going on in the Globe and Mail, Washington Post, New York Times through the week." Juan Carlos agreed with Bonnie's need to be aware of the world and indicated, "*I think I am pretty conscious of the general coverage around any given thing.*"

Finally, Patricia did not speak as explicitly about her attentiveness to the world, but seemed to take for granted. After describing the forces you feel when an elevator accelerates and decelerates, she was asked if it was a natural process for her to analyze the mechanical things going on around her. She said "*I don't know, not that I am really aware of, but if I felt something or saw something that seemed unusual I would notice that.*" She also talked about how, when calculating a quantity in an engineering problem "*you get to your final answer - whatever it is that you are trying to figure out - and you go back to the question and look at it, 'Does that actually make sense?'*" It seemed that Patricia, like the other participants, had used her sense of curiosity and attentiveness to develop a framework of how the world works.

Taking Agency. In addition to being attentive to the world, participants spoke of taking agency or moving forward in the world. Participants noted that the act of observing or noticing things often moved them toward action. For example, Monique explained "… *when you noticed something was not quite right, and maybe that is a theory/practice sort of gap that you are living, when you kind of think, 'Yeah, this is not quite what we are talking about here. This was not what it was supposed to be' but then the question is how do you take the next step and what do you do? But I think for me it is just, 'Okay, this is not right and I need to do something…*" Wendy also spoke of the need to translate observations into actions. She commented, "*When seeing the same person or the same issues again…try and think 'How can*

we prevent that? How can I set these people up so they are more prepared when they are discharged so they don't keep coming back again?"

This sense of agency was often coupled with the realization that taking action may include finding ways to move forward. For Louisa, sometimes moving forward meant relying on others' expertise. She explained, *"In my practice when I was teaching on the unit, what I would do is take my case if it was something troubling and I didn't know, I would just look up the signs and symptoms and ask the experts that I was working with - because there is always somebody who knows more than you do, who can lend you some expertise from their experience because they have seen more."* In journalism, Bonnie also talked about taking action by using her contacts in order to move forward with a story idea. She indicated that she moved forward with stories by asking a series of questions like *"Who knows about this? Who would know about this? How would I find out who knows about this?"*

Taking agency and moving forward may also involve a certain amount of persistence and the courage and confidence to take risks. Bonnie identified that one difference between herself and her students was her willingness to connect with possible sources. She explained, *"It is about having the courage to just pick up the phone. It is like a cold call, right?... I actually pick up the phone a lot."* She also noted the importance of having confidence in herself when pitching story ideas. She reflected "…*looking back to my own practice…it was confidence; I had the confidence to bring voice to observations [that] I think had I lacked confidence I would have thought I sounded stupid.*"

Colin also noted that in theatre the idea of agency and moving forward involves persistence and the willingness to try new approaches. He stated, *"There is a central idea within theatre and that I teach my students...which is the idea of offer, so whenever you are at work in a*

scene you offer, and an offer can be...it doesn't matter if an offer is turned down or accepted, because like you just offer something else, and you offer something else and you get very disconnected to ownership or self-worth in your offers, it is just about trying stuff--anything-- because they know that is what is going to spur on the process."

For many of our experts, an important component of practicing in the discipline is knowing how to move forward.

In Chapter 3 (this issue), Currie further explores, through a phenomenological lens, how these ways of practicing had been learned through lived experience, had become unconscious for faculty members, and how the Decoding interview helped to increase their own awareness of their tacit expertise.

Ethics and authenticity. A final theme that emerged across the interviews was that of the expert being ethical and genuine in their practice. Participants spoke about the need to be authentic and to have a critical awareness of the impact of their actions on others.

Monique described her sense of ethics in nursing in this way:

"Well and this is why I think nursing is different from other disciplines because it is not the safety, and I used to say it was the safety that makes this different...it is actually the ethic, I think, that is different...it goes back to would you want someone like this taking care of your family?... I think it has something to do with a more fulsome view of ethics that is saying, 'I want to know more.'"

Wendy also spoke about the importance ethics in nursing. Like Monique, she felt that ethical practice included but went beyond immediate safety or competency concerns and involved figuring out how to work with others in an ethical, genuine, and respectful way.

Juan Carlos also identified a broader sense of ethical practice in his discipline of journalism. He spoke about the tension between the pressures of acquiring an audience but also needing to move forward with a particular perspective knowing that it may not be popular. He explained:

Journalists want eyes on what they have done, and if they don't get eyes - or ears - on what they have done they have actually failed. Some of the things they might write at certain times just turned people off and they know it, and so do their editors. So there is nothing pure about that sort of thing and it is always infected by the commodification of journalism which I think now has reached a point where it is extreme, and it takes some considerable effort and courage to write and report against the grain.

Finally, the participants acknowledged that while being ethical and genuine in their practice was something they strove for, it was not always an easy process and took time to develop. Bonnie reflected that how she practiced the ethics surrounding searching for story ideas was something that changed over time.

"*It is a real negotiation if you are going to use first person sights and sounds as story observations, it is very challenging if you want to maintain trust in all those relationships… I am not actively pumping my circle of friends for story ideas, although I think I did when I was younger… which is plagued with problems. There were some personal costs there that I wish I had handled better.*"

Monique also spoke about the challenge involved in being ethical and genuine, both from the perspectives of both the expert and the student. She noted, *"…going back to the code of ethics, like it is sort of an authenticity that I think a lot of people aren't prepared to go to. We have to be vulnerable in order to understand vulnerability, that is what it comes down to."*

For this group of disciplinary experts, being authentic and practicing in a manner that was principled and fair was not easy but seemed to be an important hallmark of being an expert in their chosen field and one that they wished to pass on to their students.

Discussion and Implications

The literature on expertise and teaching suggests that "expertise can sometimes hurt teaching because many experts forget what is easy and what is difficult for students" (Bransford, Brown, & Cocking 2000, 44). Psychologists call this the curse of knowledge (Brown, Roediger, and McDaniel 2014). In this analysis, we can see how the bottlenecks identified by faculty members as being difficult for students are not necessarily simple concepts but actually require many different types of expert thinking which go beyond ways of thinking and practicing (Entwistle, 2005) to include ways of being. Indeed, our interviews uncovered layers of complexity associated with each bottleneck which our participants indicated, when pressed, that they had not truly understood until they either had years of professional experience or until they started teaching or both. Participants often left the interviews with a greater appreciation for the amount of time and experience required to become truly expert at addressing their bottlenecks. One participant, in her own article reflecting on the decoding process, said the process was a "game changer" (Haney, 2015).

While this study only involved a small group of faculty from four diverse disciplines, the findings support similar findings of expert-novice differences more broadly. For example, Shopkow (2010) showed that bottlenecks in learning history can be grouped into three categories related to the nature of the discipline and its practices, evidentiary practices and primary sources, and affective understandings and abilities (i.e. maintaining emotional distance, overcoming affective roadblocks, willingness to wait for an answer, and dealing with ambiguity). Wismath,

Orr and MacKay (2015) demonstrated that problem-solving skills in a liberal education science course require mental habits of patience and persistence, a valuing of understanding over determining the correct answer, and a realization of the importance of careful and complete modeling before "plunging in". Similarly, in design fields such as engineering, provisionality is part of practice; expert designers take an iterative and exploratory approach and consider many alternative approaches and solutions to a problem (Cross 2004). Indeed, research shows that, in general, experts have acquired "extensive knowledge that affects what they notice and how they organize, represent, and interpret information in their environment" which in turn improves their practice (Bransford, Brown, and Cocking 2000, 31).

It is useful to consider how the shared themes about expert disciplinary thinking apply to our own disciplines and how we can use these ideas to help inform how we approach bottlenecks to learning in our own teaching. In particular, our findings show how acquisition of knowledge and skills (ways of thinking) may be insufficient for mastering even the cognitive bottlenecks, let alone epistemological or ontological. Rather, as Dall'Alba (2009) argues, learning to be an expert occurs through integration of knowing, practicing, and being. If we conceptualize learning this way, we might consider whether our teaching decontextualises knowledge from the practices to which it relates, whether we prioritize content and 'efficiency of transmission' over deep understanding, and whether we focus on epistemology and narrow conceptions of knowledge at the expense of ontology. Similarly, these themes could inform curriculum planning and related teaching and learning research in one's course, program, or discipline. Finally, as Yeo, Currie, and MacDonald suggest in the following chapters, we might consider different lines of questions in the Decoding interview, particularly when interviewees get stuck and the interviewers might need to find another way to "open the door" into the expert's thinking process.

The advantage of the Decoding the Disciplines model is its engagement of the practitioner. We know that traditional research on pedagogy and novice-expert differences will not necessarily convince faculty members to change their teaching practice (e.g. Burn 2007; Singer, Nielsen, and Schweingruber 2012). In our study most participants, at some point in their interview, articulated a sudden and unprompted realization that describing their own thinking process or describing a personal experience that was influential to their own learning might be helpful for their students. In the words of Bonnie, "*I have always really shied away from talking with students about my own practice. …. And yet as I talk to you [I realized] if done the right way maybe my students could benefit from my making those steps, if you will, a little clearer.... ... with these stories a little can go a long way.*" While other chapters in this issue (Pettit, Rathburn, Calvert, Lexier, Underwood, Gleeson, and Dean; Yeo, Lafave, Westbrook, McAllister, Valdez, and Eubank) will describe how the Decoding method has been used effectively in faculty-driven curriculum and research projects, our observations described above suggest that using the Decoding model has a potentially transformative effect on faculty's teaching practice even if they are not actively involved in such a project as research or within a community of practice. For these reasons we suggest that the Decoding model holds much promise for a variety of faculty development initiatives as well as a method for pedagogical research.

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