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Chapter 4. Bottlenecks of Information Literacy

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Bottlenecks of Information Literacy

Joan Middendorf and Andrea Baer

In recent years academic librarians have expressed great interest in the places where students get “stuck” in their learning process. By identifying where students struggle most, librarians, like many college educators, can develop more effective pedagogical approaches both to their individual instruction and to collaborative teaching with disciplinary faculty. Librarians’ interest in the “stuck places” of learning have been especially apparent in work on information literacy “threshold concepts” and in the adoption of the *ACRL Framework for Information Literacy for Higher Education*, which is largely informed by threshold concepts theory.¹

A related instructional approach that is also referenced in the *ACRL Framework* is *Decoding the Disciplines*.² *Decoding the Disciplines* (hereafter *Decoding*) is a model for instructional design that begins with identifying these stuck places, the “bottlenecks of learning.” The *Decoding* framework offers a process for teachers to address these bottlenecks through modeling, opportunities for student practice and instructor feedback, and assessment.

While *Decoding* is most often discussed in relation to student learning, it is also a powerful model for fostering cross-disciplinary dialogue and collaboration among educators. The *Decoding* process grew out of work in a faculty learning community at Indiana University in which professors from different disciplines developed their disciplinary teaching largely through interactions with colleagues in other fields. These exchanges helped participants to gain deeper understandings of their own fields’ epistemologies and practices and to develop more effective ways to teach these to novices in their disciplines. *Decoding* takes the differences in disciplines seriously and often utilizes cross-disciplinary groups to uncover the mental moves and assumptions that underlie teaching so that disciplinary knowledge can be made available to students. As educators work across disciplinary lines, they gain fresh insights into their own fields.

We, the authors (Joan and Andrea), believe that *Decoding* can also be a rich tool for librarians and teaching faculty in cultivating meaningful partnerships as they identify and address the “bottlenecks” that often stand in the way of learning, teaching, and librarian-faculty collaboration. We first became acquainted with one another in 2015–2016, when we shared an office space at Indiana University. Joan is an educational developer who, along with historian David Pace, developed the *Decoding the Disciplines* framework at Indiana University. Andrea is an instruction librarian who has used the *Decoding* model for her own teaching, as well as for professional development workshops for instruction librarians and teaching faculty. As Andrea became further intrigued by *Decoding*’s relevance to the recently adopted *ACRL Framework* (which also focuses on “stuck places” in

learning), we began to discuss the ways that Decoding can inform work in both of our professional communities. When Joan was approached about contributing to this book, the questions that she had been asked to address seemed to lend themselves naturally to collaboration: What do educators need to learn and to experience in order to build meaningful cross-disciplinary teaching and learning communities, and how can the ACRL *Framework* serve as a catalyst for librarian-faculty dialogue and collaboration?

We began considering how we might draw from the Decoding model in order to explore these challenging questions. We reflected on “bottlenecks of information literacy” not only in terms of student learning, but also in relation to librarians’ and disciplinary faculty’s challenges with teaching information literacy and with cultivating cross-professional dialogue and partnerships.

Our investigation was informed partly by an online survey of instruction librarians about their perceptions of the “bottlenecks of information literacy.” The most prominent survey finding was that the most pervasive bottleneck of information literacy for students, faculty, and librarians may be the misconception that information seeking is a simple mechanical process of source retrieval, rather than an inquiry-driven, analytical process. (Many librarians will immediately see connections between this bottleneck and the ACRL *Framework*’s “Research as Inquiry” frame.) In this chapter we discuss how Decoding can help educators develop effective responses to this bottleneck, as well as how Decoding and the *Framework* can work complementarily to cultivate cross-disciplinary teaching partnerships that address such bottlenecks. Though the scope of this chapter does not allow for an in-depth analysis of the survey findings (which will be a focus of later research), we use the central finding to build examples of how the Decoding process might be applied to information literacy instruction.

What Is Decoding the Disciplines?

Decoding the Disciplines is a theory of pedagogy that guides the teaching and learning process. Based on the gap between expert and novice thinking, the Decoding process uncovers the mental moves of experts in order to make those moves available to students. Instead of starting with the information or content that students need to learn, Decoding begins with the bottlenecks, the places where students struggle to learn. In the seven-step Decoding model (see figure 4.1), educators first identify the crucial bottlenecks. They then “decode” what an expert does to get through a bottleneck. This process reveals the expert’s mental actions. The ensuing steps reveal the mental action to students, encourage students to rehearse and to strengthen their ability to perform the action, motivate them to persist with the new mental action, and frequently check students’ proficiency with that action (assessment). The final step of Decoding encourages educators to go public with their efforts as they share their Decoding and teaching process with peers, invite feedback, and encourage the spread of ideas. (For a detailed explanation of each step of the Decoding process and accompanying exercises, see *Overcoming Student Learning Bottlenecks*.³)

The steps are not linear, and one does not have to do all of the steps, though it is usually essential to find the bottleneck and the underlying mental action. Then a teacher can use any of the remaining steps to develop instruction that will help students to get through the bottleneck. The Decoding model can be applied at the lesson level to bring

1. What is a bottleneck to learning in this lesson, a place where students regularly struggle to learn?
2. What do experts do to get through the bottleneck? What mental action do they use?
3. How can this mental action be explicitly modeled? What analogies are helpful?
4. How will students practice tasks and receive feedback on this mental action?
5. How can students be motivated to persist in using this new mental action?
6. How will students be assessed on their proficiency (or lack thereof) in using the mental move?
7. How will the results of this decoding work be shared with others?

Figure 4.1

The seven steps of Decoding the Disciplines.

students through the bottlenecks. At the course level, teachers identify the main bottlenecks and then tackle them one at a time, scaffolding the concepts and enabling deeper understanding. At the curricular level, faculty groups determine the predominant mental moves students should acquire over the course of their program and in which courses they will learn these.

Decoding is useful on both a practical and a theoretical level. When educators teach in the absence of theories, they can get overwhelmed in an ocean of content and a vast array of teaching methods. Decoding the Disciplines is a theory of pedagogy, while bottlenecks are one of many theories of difficulty that guide Decoding.⁴ The two theories of bottlenecks and Decoding the Disciplines can be used to organize teaching. As a theory of difficulty, the bottlenecks point teachers to where the critical assumptions and mental moves in their discipline are not being made clear and where it would be worthwhile to focus their efforts. As a pedagogical theory, Decoding the Disciplines provides a solid framework to get students through the difficulties.

Theories of difficulty, such as threshold concepts and bottlenecks, focus on what makes a given concept difficult.⁵ In other words, what is the nature of the problem that is blocking student learning? The theory of difficulty that helps educators understand why bottlenecks exist is that of tacit knowledge.⁶ According to this theory, many faculty gain their expertise through academic study and applied work in the discipline, but it remains tacit, or implicit, knowledge.

A central tenet of Decoding is that knowledge and learning are disciplinary and that different disciplines present different challenges to learners. Experts have learned to do many tasks simultaneously. If educators want students to do the “critical thinking” of the discipline, they have to break down what the expert does. The bottlenecks, the places where students struggle, point to where the expert is making leaps that may leave students behind.⁷ Faculty practice the disciplinary “game” at a complex level.⁸ At this advanced stage the focus is on the further creation of disciplinary knowledge, rather than on making

explicit the nature of one's own reasoning process. Thus, disciplinary and trans-disciplinary assumptions and mental moves are hidden. When it is time to teach undergraduates about the discipline, it is difficult to explain one's own tacit knowledge. The degree to which experts can be unaware of the nature of their own knowledge-creating process can be surprising.⁹

The Survey

As noted previously, to explore our central questions, we developed an online survey for instruction librarians about the bottlenecks for students, faculty, and librarians of teaching and learning about information literacy. The survey responses would help us explore what the bottlenecks of information literacy are for students, faculty, and librarians. Identifying these bottlenecks is essential to building and growing meaningful faculty-librarian teaching partnerships. Ideally such an investigation would also involve surveying faculty and students about their perceptions of the “stuck places” in seeking, evaluating, and using information. Given the timeline for writing this chapter, we approached the survey as a tool for guiding our discussion of *Decoding the Disciplines* rather than as a thorough investigation into information literacy bottlenecks. Our discussion of the survey is therefore focused on its purpose for the writing of this chapter.

In January 2018 we invited librarians through the ACRL Information Literacy Instruction Discussion List (ILI-L) to respond to the survey during a two-week time period. We received responses from 129 individuals. Our analytical strategy applied the constant comparative method to uncover patterns that emerged from the survey results.¹⁰ Responses were sorted into categories inductively rather than assigned to predetermined categories. Because the scope of this chapter does not allow for an in-depth and statistical analysis of the survey findings, we concentrate on the most prominent emerging theme—that an overarching bottleneck for librarians, faculty, and students in teaching or learning about information literacy is an understanding of information seeking as inquiry-driven, rather than as a simple process of information retrieval. In the survey we asked librarians what they perceived as the stuck places, or the “bottlenecks,” of information literacy for students, faculty, and librarians through the following questions:

- Where do students get stuck when seeking, evaluating, or using information for their academic work?
- Where do faculty get stuck in teaching students how to seek, evaluate, or use information?
- Where do librarians get stuck in teaching students how to seek, evaluate, or use information?

Because we were particularly interested in barriers to faculty-librarian collaboration, we also asked survey participants what barriers, or “stuck places,” get in the way of meaningful faculty-librarian teaching collaborations. The survey also included two additional questions, which were intended to help us investigate “emotional bottlenecks” of information literacy. However, responses to these questions proved to be less directly relevant to our current discussion. This data therefore is not described in this chapter; it will instead be used for later research that focuses more narrowly on emotional bottlenecks. Drawing

from the findings from the first four survey questions, we examine common bottlenecks of information literacy.

Key Survey Findings

One striking quality of the survey was the remarkable consistency of participants' responses. Themes surfaced not only across individual participants' responses, but also across answers to the different questions. The most prominent (and perhaps most significant) pattern to emerge was that of contrasting conceptions of information literacy. Respondents repeatedly described understandings among students, faculty, and librarians of information literacy as either simplistic search mechanics or as inquiry-driven research and information use. The common view of information literacy as a fairly clear-cut procedure—whether held by students, faculty, or in some cases librarians—appeared to be at the root of the majority of the information literacy “bottlenecks” that all three groups experience. In other words, students, faculty, and librarians struggled with how either to engage with or to represent information seeking and selection as an inquiry-based process, rather than as a mechanical act of source retrieval.

Other obstacles to teaching and learning about information literacy could often be traced back to this conception of information literacy. For example, the challenge for librarians of teaching primarily within “one-shot” library sessions can be tied to the notion that an hour is sufficient time for students to learn the “basics of library research.” The one-shot approach, many respondents suggested, may reinforce misunderstandings of information literacy as simple, mechanical procedures that either can be learned quickly or are “picked up” without explicit instruction.

These findings align with those from other research studies, such as those of Project Information Literacy (PIL). In their 2010 study *Truth Be Told: How College Students Evaluate and Use Information in the Digital Age*, PIL researchers Alison J. Head and Michael B. Eisenberg provide data that suggests that “the large majority of students conceptualize research, especially tasks associated with seeking information, as a competency learned by rote, rather than as an opportunity to learn, develop, or expand upon an information-gathering strategy which leverages the wide range of resources available to them in the digital age.”¹¹ Wendy Holliday and Jim Rogers drew similar conclusions not only about how students often conceive of information seeking and information sources, but also about how course instructors and librarians often teach about searching for and using sources. In “Talking about Information Literacy: The Mediating Role of Discourse in a College Writing Classroom,” Holliday and Rogers observe that information literacy instruction often reinforces the conception of sources as objects to be found and inserted into a paper (rather than as resources for learning about an issue).¹²

All of this research indicates that an understanding of “Research as Inquiry” is fundamental to information literacy, a point that is reflected throughout the ACRL *Framework* and in particular in the *Framework's* sections “Research as Inquiry” and “Searching as Strategic Exploration.” These studies moreover illustrate that conceptions (and misconceptions) of information seeking and use matter. Students and often faculty often view a library search as a retrieval of sources, like hunting for a set number of animals, without being quite concerned about the type of animal. Librarians, in contrast, most often want

students to think of a search as more of a genuinely interesting question. Librarians often play with different search terms, evaluate the quality of the answers they receive based on those search terms, and revise their searches accordingly. The end result is usually not a clear-cut answer to a simple question. Instead the searcher usually must interpret the results of several searches and synthesize key pieces of information. Educators who pay attention to the learners' struggle can apply Decoding the Disciplines to help students get through the bottleneck.

Applying Decoding to a Conceptual “Bottleneck”

Given that inquiry-centered research is perhaps the greatest information literacy bottleneck, how might Decoding help students, librarians, and faculty to approach information seeking and use as inquiry-driven? In other words, how can librarians and their fellow educators address misconceptions, such as seeing research as a simple, linear process of information retrieval, and how can Decoding the Disciplines help with this? We will illustrate how Decoding can be applied to teaching about both conceptual understandings (such as inquiry-driven information seeking) and concrete tasks (such as developing effective search terms) that are done most skillfully with an inquiry-centered mindset. We focus first on applying the Decoding model to unpacking the most significant bottleneck that was apparent in our survey: inquiry-driven information seeking. In the first two steps of the Decoding the Disciplines model, teachers select a bottleneck and decode the implicit mental moves of the expert.

To decode inquiry-driven information seeking, Joan conducted a brief Decoding interview with Andrea about what she does when beginning to find library resources in order to explore a research question. This is a complex process that involves numerous tasks and mental moves, so it is unsurprising that during the interview we were identifying numerous places where students may get stuck. The interview answers served as the basis for the first two steps in the Decoding process that is outlined below.

1. **The Bottleneck:** The main bottleneck we found in the survey was conceptual in nature: most students appear to approach information searching as a mechanical, linear process. Students frequently struggle with library database searches, which they often see as a process of retrieving a source as quickly as possible in order to meet basic assignment requirements. Often students believe that a research assignment is primarily about finding a certain number of sources, rather than selecting sources strategically in order to learn more about the topic or issue. This contributes to numerous challenges in finding, evaluating, and using information effectively.
2. **Mental Action** (What mental actions does the expert perform to get past this bottleneck?): Though database searching varies depending on context, the overall mental action of inquiry-driven database searching can generally be broken down into the following mental actions:
 - a. **Question development:** Often the question is developed and refined during the search process. In this example, we work from the assumption that the

researcher has already formulated a genuine, meaningful question, though that question may still need to be refined during the searching process.

- b. **Identification of search terms:** The expert generates different search terms that reflect central concepts related to the research question and analyzes the resulting sources in order to determine which keywords unlock sources that better get at the question. (This analysis process may involve evaluating both individual search results and the summative information, or metadata, about one's search, such as the number of search results, subject terms, publication years, or publication sources. This analysis enables one both to identify possible search terms and to better understand the research question and how others have approached it.)
- c. **Tolerance of ambiguity:** When evaluating the relevance of search results in relation to the research question, scholars are comfortable that there is rarely one clear answer or one single source that fully addresses the question. A research question may evolve as the researcher learns more about the related literature.
- d. **Analysis of search results:** Expert researchers evaluate the relevance and authority of sources in relation to their research questions. They synthesize relevant information from the various sources in order to generate an original approach to their questions. Again, this information may lead researchers to revise their questions.

Because processes vary by discipline, a geologist's or sociologist's answers to the interview questions would probably vary from Andrea's responses. It would be useful for instruction librarians to compare these different answers as they consider varying disciplinary approaches to information literacy.

Each of the points above involves a number of complex mental moves, many of which are done alongside one another (for example, evaluating search results, revising search strategies, and revising a research question). As these complex tasks reflect, often while dissecting the mental moves of a disciplinary task, experts realize that they must further dissect the individual mental moves that they have already outlined. In other words, a bottleneck of learning often contains within it sub-bottlenecks, much like a set of Russian nesting dolls. The more specific teachers are about the sub-bottleneck, the better they can help students to work through the larger bottleneck. Just as when teaching a novice to drive a car, many tasks need to be done simultaneously (steering the car in space, accelerating and braking, keeping aware of the location of nearby vehicles, etc.). Each of these involves a different mental move (and a corresponding physical move), but for clarity (and safety!), it is best to introduce each move separately. Teachers are not being clear if they cannot explain the separate tasks.

Strategies for Addressing Bottlenecks and Sub-bottlenecks

A **bottleneck strategy** uncovers a multi-part mental move that students have been left to intuit. The strategy breaks down these mental actions so that students can perform that larger mental move. A good bottleneck strategy appears to be deceptively simple, but it is

powerful. In the case of more complex bottlenecks (such as the conceptual understanding of inquiry-driven information seeking), an instructor may need to develop multiple strategies that address various sub-bottlenecks.

Next we share a sub-bottleneck strategy for the second mental move outlined above: developing search terms. Like the concept of inquiry-driven information seeking, this sub-bottleneck is closely tied to the ACRL *Framework's* frames “Searching as Strategic Exploration” and “Research as Inquiry,” both of which emphasize the nonlinear and iterative nature of research.

The bottleneck strategy below shows one plan for getting students through this sub-bottleneck. Other instructors might make different choices in terms of analogies and methods for practice and assessments. Instructors in different fields would also develop their strategy based on the ways knowledge is created in their disciplines.

A Sub-bottleneck Strategy (Example): Developing Search Terms

1. **Bottleneck:** Students struggle with developing search terms, particularly when they cannot find a source that corresponds perfectly with their research topic. For example, a student researching homelessness in Calgary might think that he or she must find sources specifically about homelessness in that geographic area, rather than identifying key issues or concepts that would help explore a particular aspect of homelessness, such as homelessness among teens or policies and programs that reduce homelessness. (See MacMillan et al. for a more detailed discussion of a Decoding interview on this topic.¹³)
2. **Expert Mental Moves:** Generate search terms based on the more important factors or issues related to the topic, skim the results, and adjust the search terms. Repeat this process until satisfactory sources are found.
3. **Modeling with Analogy:** “Developing search terms that unlock the best sources is like . . .” A possible analogy here is calibrating a rifle for target practice. You take your best shot and then view the target through binoculars. Maybe the shot is off a little and needs to be adjusted to the left and higher, so you use the feedback you received from the previous aim and take a better shot. This time maybe the shot is still a little high or too low, but closer, so you keep trying until you hit the bull’s-eye (not one precise spot, but a circular space).
4. **Practice:** In small teams students create a concept map for search terms about homelessness in Calgary. On large sheets of paper, each team writes the main topic on middle of the paper. They then add synonyms or related broader topics to the map. Students might identify additional terms after a quick database or search engine search. When done, students test out their search terms, choose two to four of the best search terms for their topic, and discuss whether or how their search terms changed. For homework, students individually make another concept map with a new topic and assess the effectiveness of those terms.
5. **Motivating Students and Holding Them Accountable:** By practicing the concept map in teams, students may increase their motivation and sense of effectiveness. Also, because this bottleneck is a misconception (that is, the pre-existing notion of mere source retrieval blocks students from an inquiry-driven approach

to developing search terms), it might be useful to find out more about the misconception. Teachers can ask learners to jot down answers to the following questions in order to encourage students to explain their ideas further: “What are some ways to generate good search terms?” and “Why do you say that?” Such questions can either confirm or disconfirm instructors’ assumptions about prevalent student misconceptions.

6. **Assessing Students on the Mental Action:** An Approximate Analogy Classroom Assessment Technique (CAT), such as the prompt “Finding the best search terms is like...,” can be used to check whether students are still thinking of information searching as a process of finding one perfect result or as an iterative process of testing out various terms in order to move toward a better result.¹⁴ Alternatively, an instructor could use a Focused Lists CAT, in which students list the steps for determining the best search terms. This activity could be used as a pre- and a posttest.
7. **Instructor Reflection and Sharing:** What were the results of your assessments? What did the pre- and posttest show? What did you learn about your students’ learning? Where might you like to share what you learned using the bottlenecks and Decoding frameworks?

The sub-bottleneck strategy corresponds with the steps of Decoding. Below is an explanation of how we applied Decoding to developing the strategy.

1. The Bottleneck: What Are Students Unable to Do?

We chose our bottleneck based on our central survey finding: the conceptual understanding of information seeking as information-driven. Most instructors, however, identify the places where students struggle based on their own teaching context. When there are several bottlenecks to choose from (as is usually the case), a teacher may choose the one that seems most troublesome and that is central to knowledge creation in their field. A bottleneck in formatting a paper is probably not as important as a bottleneck in identifying and using search terms.

2. Mental Action: What Mental Actions Does the Expert Perform in Order to Get Past the Bottleneck?

Our inventory of the overall mental moves in inquiry-driven information seeking uncovered four mental moves, one of which we further decoded with the sub-bottleneck strategy outlined above. These mental moves or mental actions, the most difficult part of the process, were derived from an interview, but identifying mental moves (which often have become intuitive to an expert) can also be done with analogies, rubrics, model building, reflective writing tours, and mind maps.¹⁵ These mental actions can serve as student learning outcomes. They are also the foundation for the remaining Decoding steps.

3. Modeling the Thinking: What Do Experts Do to Get through the Bottleneck? What Mental Action Do They Use?

Here a teacher shows students how the mental action is done. This is done first through an analogy or a metaphor. Then the mental action is performed on a disciplinary example.

Analogies work as inferential frameworks: they help students tap into ideas with which they are already familiar and show them which “mental muscles” to use. In this way analogies encourage students to draw connections between experiences and concepts and to transfer their understandings from one context to another. Because analogies enable students to identify where they have used this kind of thinking before, they allow students to transfer that thinking into the new domain. Analogies should be brought from outside of the focus discipline because too much discipline-speak camouflages the key parts of a within-discipline analogy.

In the example of developing effective search terms, students are encouraged to ask themselves, “Where have I done something similar, in which I am initially unsure about my approach and have to test it out, see what result that gets me, and then generate something even more useful?” To explain the ambiguity in developing effective search terms, a teacher might use the analogy of golfing: when teeing off, golfers don’t aim for the hole. Sometimes they can’t even see the hole on the first shot. They aim for an area toward the hole, and it takes several strokes to get there. It is when they are putting that they aim for the hole.¹⁶

When inventing analogies, it is important to take into account the misunderstandings of the target mental action, as well as to anticipate and eliminate the analogy-caused misconceptions. Chi advises making a side-by-side comparison between a misleading concept and the disciplinary mental move in order to help students recognize the difference.¹⁷ For example, a teacher might employ a shopping analogy in order to compare an inquiry-based search to retrieval of an already identified source. Consider the following analogy. When shopping, sometimes one knows exactly what one is looking for and where to go. At other times shoppers just know that they need something, but they are not sure how they can find it (e.g., shopping for the perfect white shirt). Then they have to look at a few of those items, in a few different stores or databases, in order to narrow down their criteria.¹⁸

The analogy is followed by a specific example of inquiry-driven information seeking. The teacher highlights exactly where the mental actions come into play in the example (e.g., how experts come up with some search terms, how they determine which terms are getting them the best results, and how they then revise the search terms in order to further strengthen the search results). If the teacher fails to point out where the specialized mental moves take place, students may not know where to focus their attention in the example and can get lost in the details.

4. Practice and Feedback: How Will Students Practice These Mental Actions? How Will They Receive Feedback to Make Improvements?

Students need a chance to practice in class so that they can try out the new ideas with instructor support. They also need practice outside of class that reinforces the new mental action. Teachers need to match the mental action with methods of practice. Methods that are good for idea generation (as when generating search terms) include list making, concept mapping, and drawing (visualization).

There are countless activities that might provide students with practice in iterative information searching. Many librarians use concept mapping in their instruction and will have numerous other ideas for providing opportunities for student practice. What makes

Decoding unique is that it encourages teachers to be deliberate in breaking down complex mental moves and providing students with ways of practicing these moves one at a time before integrating multiple moves.

5. Motivation: How Can Students Be Motivated to Persist in Using This New Mental Action?

Step 5 reminds teachers to analyze the places where students are especially resistant and where the instructor experiences pushback. The results from our survey indicate that students have (and some librarians and faculty may inadvertently reinforce) a misconception that library research is a linear process.

A misconception is a type of bottleneck in which a pre-existing concept blocks the novice (often a student) from using the conceptual category that the expert uses. Finding out more about student misconceptions through quick assessments can either confirm or disconfirm instructors' assumptions about prevalent student misconceptions.

Step 5 can also help teachers rethink course design in order to ensure that major course assignments build upon one another. This scaffolding can help students to engage in related mental actions in increasingly sophisticated ways. Scaffolding also helps students focus on the mental actions, rather than getting lost in long writing assignments or fact-based test questions that may not provide the same quality of practice with the task at hand.

6. Assessment: How Will I Assess Student Mastery of the Mental Action?

On what tasks are students performing well, and where might instructors need to provide more modeling or practice? Pre- and posttests can provide evidence of the change in students' abilities to complete the mental action (or of the lack thereof).

Bottleneck strategies illustrate that Decoding is not a linear process. Often they indicate the necessity for further modeling or practice or the need to further break down the sub-bottlenecks. In Decoding, a strategy's efficacy is "tested, rather than just assumed."¹⁹ Using quick, frequent Classroom Assessment Techniques (CATs) gives teachers the evidence that they need in order to determine exactly where to dig in further so that students get through the bottleneck.²⁰

7. Sharing the Results: How Will I Share What I Have Learned?

This step encourages the analysis and reflection that help teachers

1. to see what they have learned about students' learning and about applying theories of difficulty (such as bottlenecks) and theories of pedagogy (such as Decoding the Disciplines) and
2. to consider how sharing their teaching experiences may benefit other educators.

Following this reflection, instructors can share their experiences and insights with fellow educators in order to spark further dialogue and collaboration. When Joan and colleagues first started asking instructors to share their results with peers, they were surprised at the extent to which participants spread and benefited from one another's ideas.²¹

Once instructors have identified a bottleneck and decoded what an expert does, the Decoding model shows them how to design an effective bottleneck strategy and how

to assess student learning. But there is room for much individual autonomy. There are numerous analogies, disciplinary examples, methods for student practice, and assessment techniques from which to select, but all are driven by the bottlenecks and mental actions. Step 2 of the Decoding process (identifying the mental actions of an expert) can be used to write specific learning outcomes and auxiliary learning outcomes. A class lesson about the sub-bottleneck may incorporate elements of the strategy, but it is not necessarily the same as that strategy. For example, the instructor may use analogies and assessments of one bottleneck strategy and the practice and assessment of another.

It is important to step back after completing a sub-bottleneck strategy to consider how it fits into the larger picture. How does the sub-bottleneck of developing effective search terms relate to the larger bottleneck of inquiry-driven information seeking? When a bottleneck has a lot of moving parts, the parts must be coordinated. An instructor would want to check student's proficiency with this bottleneck and to develop strategies for the other critical bottlenecks in order to be sure that all of the relevant mental moves have been executed fairly well.²²

Connecting Sub-bottlenecks with Larger Conceptual Bottlenecks

While bottlenecks are often interconnected, it is generally best to focus on one bottleneck at a time. Research on Decoding has shown that when teachers promote a deep understanding of one disciplinary bottleneck, students are better able to understand related bottlenecks.²³ In the example above, a deeper understanding of how to generate and to refine search terms will help students to grasp that skilled library research is usually not a linear hunt for simple answers. Because students don't usually find a single term that will lead them to one source that will provide a complete answer, the sub-bottleneck of identifying search terms can also help students better understand the role of ambiguity and recursiveness in inquiry-driven information seeking, even though the instruction does not focus on ambiguity.

If it usually works best to address one sub-bottleneck at a time, what does this mean for conceptual bottlenecks, which are often conglomerations of multiple bottlenecks? As suggested above, addressing any single sub-bottleneck can make the related bottlenecks easier to get through. After assessing and ensuring student competence on the component tasks, later assignments can synthesize these component tasks (for example, an assignment in which students develop a research question AND related search terms). Students are also asked during such activities to engage in metacognition—reflecting on their own thought processes. For example, students might write responses to questions such as “Has your research question changed since beginning your search? If so how? Have your search terms changed, given what you have learned about your question? In what ways?”

Because inquiry-driven information seeking involves numerous mental moves, each of which may itself be a bottleneck, it is more effective to break this large bottleneck into smaller ones, while frequently reiterating how the concept of inquiry informs or is reflected in those mental moves. Even the bottleneck of identifying search terms could be broken down into further mental moves if time allows. It is worth noting that undergraduate education often does not allow for the rich social contexts of graduate education, such as reading 200 articles to understand a particular context in history or doing a comprehensive

literature review on a research topic in order to develop a deep understanding of it.²⁴ Thus, often “teachers are actually trying to design processes that differ from the ones they themselves went through, using much more attenuated materials.”²⁵ The fact that the processes that teachers model to students are often not identical to their own disciplinary approaches can create an additional hurdle for students in understanding a discipline and its practices. A theory of pedagogy can help experts uncover the mental processes that they use, set priorities for their limited time with students, and develop a strategy for students to work on key aspects of information seeking.

In this chapter we have focused on inquiry-driven information seeking and strategic searching, but the Decoding process could be applied to any number of other bottlenecks, including other conceptual understandings described in the *Framework*.

Decoding and Librarian-Faculty Partnership

A bottleneck strategy such as the one that we have shared not only can inform an individual instructor’s work; it can also be an opening for discussion and collaboration among educators from different disciplines. Decoding provides a theoretical framework that can be used when leading learning communities. Participants, instead of being faced with a hodgepodge of techniques and tools that can be very confusing, could choose their own bottlenecks. The concern here is less about what tools or techniques they pick; instead the focus is on using the process so that everyone unpacks their tacit knowledge and develops a strategy that will help to bring students into this kind of disciplinary thinking. In a learning community that applies Decoding in this way, faculty and librarians are brought into the academy more deeply as they learn the ways that knowledge is developed and used across different fields. Through comparing disciplinary practices and approaches, they can gain insights into the methods and mental moves of their own fields. Decoding is a reliable, robust process that can be used for semester-long communities or for those that last for only a few meetings.

Within the context of information literacy instruction, a bottleneck strategy, or simply a discussion about what bottlenecks students experience when seeking and using sources in different disciplines, could be a meaningful starting point for librarian-faculty collaboration. During such conversations librarians and faculty could develop fuller understandings of where students struggle with research and source use and how to respond to students as they experience these difficulties.

For example, librarians could organize groups to work on the bottlenecks in disciplinary research with faculty across disciplines, librarians, and writing center staff (since writing and information literacy processes are closely linked). Faculty in the Decoding faculty learning community would choose a specific bottleneck involved in the research process, such as choosing search terms, asking authentic questions, or analyzing sources or evidence. Over the sessions participants would decode experts’ ways of operating and would develop analogies, practice, and assessments for the mental actions. Once their bottleneck strategies were ready, participants could try them out with each other and could receive feedback from one another before teaching their students. When fellow educators receive feedback from one another, it is particularly important to review assessments to ensure that they pinpoint the mental moves for which students may need further practice

and explanation. (More detailed Decoding exercises are described in *Overcoming Student Learning Bottlenecks: Decode the Critical Thinking of Your Discipline*.²⁶)

As suggested previously, a central benefit of cross-disciplinary Decoding is that it provides faculty, librarians, and other collaborators with a process through which to uncover their own disciplinary tacit knowledge. In a supportive community, participants can see where a colleague is not making tacit knowledge clear or is leaving it to colleagues to intuit parts of that knowledge. Colleagues, in turn, can see when a participant from another discipline is making conceptual leaps that leave them confused. Thus, participants realize where to make tacit knowledge more explicit for students. In this comparative process, everyone gains a better understanding of ways that knowledge is created and of the epistemologies of their fields.

Because librarians have to work across disciplinary silos so often, getting insights into different disciplines can better enable them to cross divides and to build more collaborative relationships. As we discuss in the subsequent section, the ACRL *Framework* can provide information literacy concepts that can be a basis for reaching these mutual understandings.

Decoding and the ACRL *Framework for Information Literacy*

Perhaps the most obvious of the parallels between Decoding and the *Framework* is their shared use of theories of difficulty (that is, theories about where students get stuck in the learning process and how to help them work through those stuck places). While Decoding concentrates on any type of learning bottleneck, the *Framework* presents six *conceptual* bottlenecks. These conceptual frames are sometimes considered “threshold concepts,” complex concepts that are challenging initially to grasp and that are crucial to understanding an area of study. Similar to Decoding’s emphasis on making disciplinary knowledge explicit, the *Framework*’s conceptual understandings reveal much of the tacit disciplinary knowledge that librarians and expert researchers bring to their work. In addition, the *Framework* and Decoding both contrast the thinking of novice learners and experts in order to help students move closer to accomplishing what experts do.

At the same time that bottlenecks and the *Framework* are based largely on theories of difficulty, each applies those theories in different ways. This is perhaps most evident in how they engage with the macro- and micro-levels of disciplinary knowledge and practices. Decoding, in focusing on a specific bottleneck, zooms in to the micro-level, using a theory of pedagogy to lay bare disciplinary practices and, more specifically, “mental moves” that have become implicit to disciplinary experts and strategies for bringing students into these mental moves. Decoding can also zoom out to map the larger epistemological bases of a field, as when setting priorities in curriculum development. Decoding moves back and forth between specific bottlenecks and the comprehensive mental moves that underlie the work in a field. In moving between the macro- and micro-levels of disciplinary mental moves, Decoding can dissect the ways that disciplinary knowledge is created.

In contrast, the *Framework* focuses primarily on the epistemological and conceptual levels, though its knowledge practices and dispositions often describe more specific actions. In other words, the *Framework* concentrates primarily on the macro-level view as it centers on overarching concepts that have been identified as central to information and research practices that often cross disciplinary lines.

Decoding also differs from the *Framework* because it begins with teachers identifying where they see students struggling to learn about and engage in a discipline. In a similar but not identical way, the *Framework* describes conceptual “bottlenecks” that have been identified by librarians based on their teaching experiences and observations. Again, these “threshold concepts” are a particular kind of bottleneck.

The intersections and the differences between Decoding and the *Framework* illustrate how they can work together to enrich individual instruction as well as faculty-librarian partnerships. For example, because Decoding concentrates primarily on the specific mental moves of a discipline by breaking larger bottlenecks into smaller ones and identifying the various mental moves, it often does not foreground the larger conceptual frameworks of a discipline. A teacher who uses a bottleneck or sub-bottleneck strategy to develop instruction might therefore use the *Framework* as a tool to take a step back and to consider broader concepts that are central to the mental moves just dissected. In the case of our sub-bottleneck strategy, an instructor who is teaching students about strategic search terms would ideally identify strategic moments during which to reflect with students on how their searching is part of a larger process of inquiry-driven research. Here again, analogies could be a powerful teaching tool. (See step 3 of the sub-bottleneck strategy above for examples of applying analogies to teaching about research as inquiry.)

In return, Decoding outlines a process for educators to be more explicit about such implicit knowledge and to improve the teaching and learning process so that students are more likely to get through the bottlenecks. By taking a deep dive into a discipline’s epistemologies and practices, Decoding provides teachers with two different, but related and robust, theories through which to frame their efforts. It shows teachers how to identify the places where students get stuck in the discipline and to find effective strategies to teach the underlying mental moves that are holding students back. Moreover, it provides openings for cross-disciplinary exchanges that help instructors to identify their own tacit knowledge and thus to develop more effective teaching strategies.

The *Framework*, in describing key concepts and epistemologies of information literacy, also offers numerous openings for librarian-faculty dialogue and for instructional and curricular design. In a sense it reflects a “decoding” of academic practices. The *Framework*’s main starting point is conceptual understandings, while Decoding’s point of departure is identifying specific places where students struggle before moving on to addressing areas of learning difficulty.

Using the *Framework* and Decoding together may help educators both to identify core concepts that can guide instruction and to ground those abstract concepts in concrete tasks that students find challenging. Used together, the *Framework* and Decoding can help librarians and fellow educators as a collective to identify tacit disciplinary knowledge and bottlenecks of learning. The *Framework* may be particularly helpful for identifying conceptual bottlenecks that are crucial to inquiry-driven research. In turn, Decoding’s use of analogies may be particularly useful when teaching about *Framework* concepts, which are often challenging when students have misconceptions about information seeking or use.

The complementary nature of Decoding and the *Framework* is reflected in the bottleneck and sub-bottlenecks on which we have focused in this chapter. As noted previously, our survey findings suggest that one of the most prominent bottlenecks of information literacy identified by the librarian participants is inquiry-driven information seeking.

This bottleneck is closely tied to the *Framework's* conceptual understandings “Research as Inquiry” and “Searching as Strategic Exploration.” These two frames describe a constellation of complex ideas that inform numerous research and information practices. These broad concepts can help students see the bigger picture of why their research matters and why information seeking is more than a process of random collection.

Instructors can highlight and encourage students to explore these concepts through numerous activities, some of which we have suggested in this chapter. Instructors can also use core concepts to structure curriculum and activities and to invite students to consider the bigger picture. Such understandings, of course, develop over time and through repeated experience and reflection. Students will still likely get stuck at numerous points in their research process when they are new to an area of study. Often they will benefit from further guidance on how to do research or use information in purposeful ways and within specific contexts.

The commonalities and differences between Decoding and the *Framework* suggest how, used as complements to one another, these two approaches can further open dialogue and collaboration between librarians and faculty. Such cross-professional dialogue is essential to addressing one of the greatest “bottlenecks” of librarian–faculty collaboration that our survey participants identified: limited understandings of one another’s work and, more specifically, of information literacy instruction.

Notes

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