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Bayerisches Zentrum
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Decoding the Disciplines

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Editorial

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Dear readers,

Let's face it: teaching and learning are difficult. Hence, it appears reasonable to approach by a theory of difficulty. Decoding the Disciplines is such a theory. It posits that difficulties in teaching and learning are often inherent to features of subject matter and the academic discipline. Expertise and difficultness are seen as two sides of the same coin. A wealth of research from Decoding and other approaches supports this. Decoding adds to all this a structured pedagogical approach for overcoming such difficulties.

This volume features five contributions. Joan Middendorf reflects on the duality of Decoding as theory and practical pedagogy. David Pace looks twenty years back and five years ahead analyzing what Decoding still needs to achieve in order to fulfill its mission. Michelle Yeo and Odd-Rune Stalheim approach Decoding hermeneutically and report how experts in disciplines narrate their coming to know and their existing knowledge. Niall Palfreyman decodes Decoding itself and summarizes some work of the BayZiel working group on how to introduce people to Decoding. Peter Riegler analyzes and expands a time-honored Decoding exercise: clock reading.

This volume is part of a set of publications featuring contributions to the first international conference on Decoding in Aachen in late 2023. Contributions which are related to specific disciplines will be published in a dedicated issue of die hochschullehre (vol. 35/2025) while this volume presents work on more general aspects of Decoding.

This volume also celebrates a double twenty of Decoding. 20 years ago, first work on Decoding was published. And 20 meetings ago in 2018 the Decoding working group at BayZiel met for the first time.

May you, the readers, and your students profit from the Decoding work featured here and elsewhere,

Miriam Barnat, Joan Middendorf, David Pace & Peter Riegler

The Theory Bottleneck and Decoding the Disciplines

Joan Middendorf

Abstract

Academics are used to thinking about theory within their disciplines, but instructors and scholarship of teaching and learning (SoTL) researchers may not be used to thinking theoretically about teaching, even while teaching rests on implicit theories. This article will explain what Decoding the Disciplines as theory is and what it does and address the following questions: What is the value of theory? What are the practical benefits of Decoding the Disciplines as theory? Why do people resist using Decoding the Disciplines or other theory in their scholarly teaching and their SoTL research? What are the bottlenecks to applying theory to teaching and to Decoding the Disciplines? How do we overcome the resistance? Throughout the article I will raise a series of questions to encourage reflection and discussion of the points raised herein[1].

Why Theory Matters

Researchers and scholarly teachers who use Decoding the Disciplines are using theory, whether they are consciously aware of it or not. ISSOTL 2006 keynote speaker Graham Gibbs famously critiqued SoTL's troubled relationship with theory, arguing that the field was not only under-theorized, but studies were so localized it hurt their visibility (Gordon, 2012). He challenged scholars to base their work on stronger conceptual and/or theoretical dimensions to have greater strategic effect for all the time and effort invested in the work.

While I will explain what Decoding the Disciplines does as a theory, I will not delve deeply into definitions of theory – a topic many volumes have been devoted to. Briefly, theory explains a natural phenomenon based on independent, general principles.

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[1] I'd like to acknowledge the collaboration of the three historians from Indiana University's History Learning Project (Díaz, Middendorf, Pace, & Shopkow, 2008). Leah Shopkow showed me how to connect theory to the Decoding the Disciplines framework. Arlene Diaz helped me to apply the Decoding the Disciplines to racial justice inside and outside the classroom. David Pace and I encouraged each other to continue to probe when trying to get an expert to explain their mental process, and thus we co-invented the Decoding interview.

MERKWÜRDIGES

Note to the non-German reader: In contemporary German "Merkwürdiges" signifies "oddity" while literally it means "worth remembering".

The Wheels of Teaching

Peter Riegler

"But when we really dream … we imagine an academy […] in which faculty will cease reinventing the basic 'wheels' of teaching in their field, and the achievements of one insightful teacher will become the property of all members of a discipline […]" Recently, no other statement about the reality of teaching has made me more desperate, frustrated, upset than this line by David Pace and Joan Middendorf written in 2004 and restated in David's contribution to this issue. It goes without saying that I share this dream.

And yet it hurts. It tells me that on a macroscopic level nothing has changed within the past 20 years. Two decades is a substantial part of the professional lifetime of most teachers. Coincidentally the statement was written about the time when I started my personal search for the basic wheels of teaching in my own field. I am not saying that nothing has changed on a microscopic level. It certainly has. I am grateful to all people who keep pointing that out to me. ▸

Fig. 1: Decoding the Disciplines
(courtesy Erika Lee)
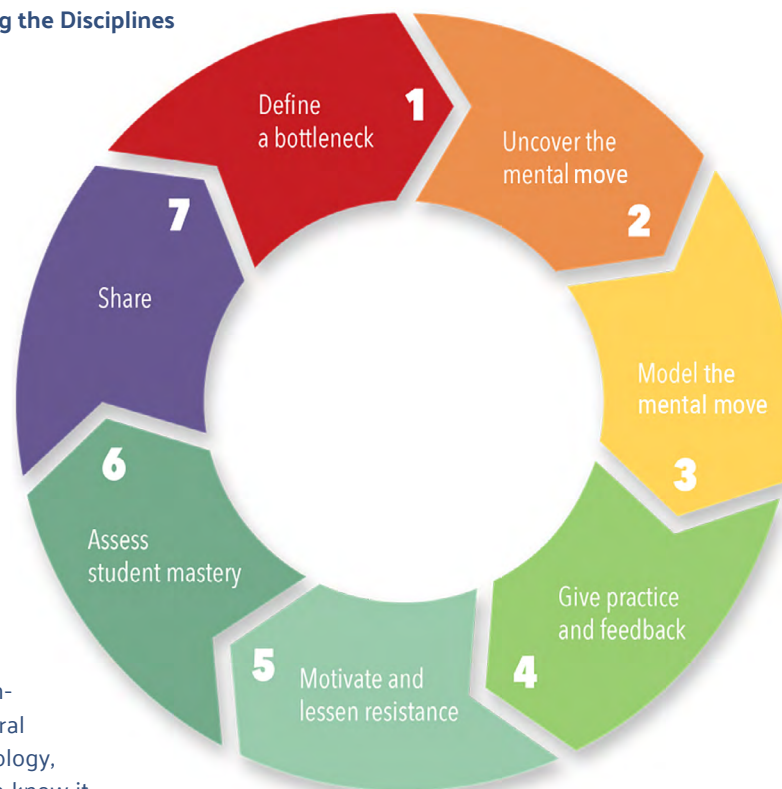
Theories matter because they have explanatory power. For example, theories in natural science explain the natural world. In cosmology, theories explain the Big Bang–how life as we know it started; the speed of light–how light can travel around the earth 7 ½ times in one second, and supernovas–the death of a star (including the future of our sun), etc. Learning theories in the social sciences explain how people learn and how instructors can effectively organize the teaching and learning process. Decoding the Disciplines is a two-part theory, a system of related ideas that both marks and explains the hurdles of content where learners struggle to learn, and then scaffolds pedagogical practices for improved results (see Fig. 1: Decoding the Disciplines). I will explain more about Decoding the Disciplines as learning theory following some background.

Benefits of Decoding the Disciplines

Decoding the Disciplines is one of the core theories in SoTL. Decoding appeared at the same time as SoTL with the first ISSOTL conference and first Decoding book emerging in 2004. Steps 6 and 7 place Decoding firmly in the realm of SoTL–an assessment of learning step and a going public step. These two steps can ease entry into SoTL (Middendorf & Pace, 2008) for novice researchers. One of the things that makes Decoding the Disciplines a robust

Moreover, the situation could be worse, and the achievements of insightful teachers would not even get reinvented. In that vein, I have learned to be grateful when I encounter reinventions of teaching wheels.

In writing these lines, I could proceed by analyzing why the situation is as it is; I could suggest what to do about it. Most likely, neither will have any impact. If I really want to see impact, I must ask myself how I can contribute and then commit myself. My hopes are that I encourage you to do likewise.

So, let's begin: I commit myself to making the achievements of insightful teachers a property of my own teaching. I will read/listen to the work of others regularly. I will seek opportunities to visit them teaching. When I find a wheel, I will be willing to use it to drive my teaching.

I must admit that this is not really challenging as I like to study things and make use of them. And then, at best I would only infinitesimally contribute to making basic wheels of teaching a common property of members of my discipline. ▶

theory is that it not only contends with teaching, but simultaneously builds in assessment of students' learning. Statistical significance of the Decoding the Disciplines method has been established in studies by Elliott & Middendorf (2024), Lee-Post (2019), and Pinnow (2016). While a recent study of published SoTL work (conducted through one of ISSOTL's international collaborative writing groups) found the most SoTL studies do not incorporate explicit theories of learning or teaching (Manarin, Adams, Fendler, Marsh, Pohl, Porath, & Thomas, 2021), Decoding inherently builds it in. Decoding theory has helped address solutionism in educational development, building in an analytical pause before attempting to solve problems.

Some Decoding studies use all of the Steps (1-7), while others focus on a few steps, such as using bottlenecks and the mental moves for learning practice (Steps 1, 2, 4) in game design (Mondelli, 2023). While Decoding can be used to frame SoTL studies, the entire Decoding theory can be a vital part of explanatory analyses, or to extend Decoding when combined with complementary theories. Examples of such research were presented in the Aachen Decoding conference (2023) proceedings volume.

The Evolution of Decoding

Decoding the Disciplines did not spring from whole cloth but evolved over several years from a framework to a model to a theory. It was born in 1996, when the Vice Chancellor of Indiana University Bloomington invited me to form a team for an eight-day leadership institute facilitated by Pat Hutchings (Hutchings, Sciame-Giesecke, & Bender; 1996). Teams from all eight Indiana University campuses were tasked with creating new programs to enhance teaching. One of the professors I invited to join the Bloomington team was David Pace. The Bloomington team's idea was to bring together instructors of large gateway courses and place them in conversation with the literature on teaching and learning in a two-week, cross-disciplinary summer seminar, entitled "The Freshman Learning Project" (FLP). Upon the FLP's inception, we immediately encountered a problem: With thousands of teaching methods to choose from, but no organizing theory, it was as though we had available to us both everything and nothing.

After learning of the bottleneck idea (Anderson, 1996), we worked it into the second FLP seminar. Bottlenecks did not offer a solution to our too-many-methods problem; nevertheless, it gave us the first step of our framework and afforded each instructor autonomy in choosing a focus for their efforts. Those familiar with David Pace and me know

I realize that there is a missing component: I need to openly talk about copying & pasting achievements of insightful teachers. I need to encourage others to do likewise. I believe we collectively need to do so. But I can only commit myself.

Here's my start: https://j2n.eu/r/ugMNg – a post on a wheel that I adopted, tagged as #adoptnotreinvent.

Will you join in?

that each of us is inherently disinclined to abandon learners or instructors stuck in the bottleneck. Together with the FLP participants, we began experimenting with ways to get through the bottlenecks.

Some of the experiments turned out better than others. For example, we challenged one of the deans, an administrator and project funder, to re-experience novice learning. After a one hour knitting lesson, he demanded that we "NEVER DO THAT TO ANOTHER PROFESSOR AGAIN!" In our next experiment, we interviewed a religious studies professor and dean, inviting him to pick something that his students struggled with in class. It turned out that his students were not reading in the ways he wanted. His course used different kinds of texts, requiring four kinds of reading: skimming for popular fiction; close readings for translated Biblical texts; analyses for research articles; and positionality for author identity. He realized he had never explained the differences in reading approaches. This experiment resulted in our first Decoding interview. These two administrators became key boosters of the FLP and funders of the change we were bringing to campus (Middendorf, 2001).

With their ongoing support, we led the seminar for eleven consecutive years, which allowed for continual refinement of the Decoding framework. In collaboration with instructors and other partners over the early years of the summer FLP seminar, we refined activities into a model and eventually a theory. In 2004 we presented at the first ISSOTL conference and published our model (Middendorf & Pace, 2004), editing the volume that featured the ways instructors from various field applied Decoding, evidence that the sharing Step (Step 7), which we deliberately designed to encourage analysis and inquiry in SoTL, worked. With Decoding the Disciplines, we had found an elegant structure to guide our work, a framework that filled a gap in theory, and a model for lesson design.

Admittedly, there has been some confusion in Decoding terminology. Some people think of only Step Two when they hear the term "Decoding" and not the wider theory and methodology. We could have avoided this confusion if we had not used the same word for one of the Steps and the entire theory. I used to differentiate between "Decoding the Disciplines" as the full seven-part theory/model versus Step Two "Decoding" of the model, where we try to uncover the implicit mental moves of the expert. But the terminology is currently in flux and for brevity's sake, I mostly use the term Decoding throughout the article as a shortened form of Decoding the Disciplines.

Further, Decoding has been enriched and transformed by Disrupting the Disciplines (Lindstrom, Easton, Yeo, & Attas, 2022), with its focus on the heretofore hidden or avoided bottlenecks of colonialism, racism, identity, implicit bias, and related antiracist pedagogies. Decoding is incomplete without Disrupting, because Decoding was leaving out crucial bottlenecks that instructors and disciplines did not acknowledge (Easton & Middendorf, 2025). The Disruptors realized that, as Kuokkanen (2007) put it, "As mechanisms of social and political control, disciplines consolidate certain ways of looking at the world while excluding others," (p. 14). Due to the new insights from Disrupting, we will most likely be changing the name from Decoding the Disciplines to Decoding and Disrupting as we create a formal organizational home for this work.

Decoding the Disciplines as Theory

To elucidate Decoding the Disciplines theory, I will present a series of comparisons between Decoding the Disciplines and Threshold Concepts. I learned much of what I know about theories from my colleague, Leah Shopkow, theoretician and pedagogical researcher whose The Saint and the Count: A Case Study for Reading Like a Historian teaches how to evaluate and make sense of evidence, current or past, whether one is a historian or not (2021).

The History Learning Project (Díaz, Middendorf, Pace, & Shopkow, 2008) had the good fortune over the years to present and publish with the inventors and researchers of Threshold Concepts, Jan Meyer, Ray Land, Bettie Higgs, James Cronin, and Julie Timmermans (Meyer, & Timmermans, 2019; Higgs, Diaz, Middendorf, Shopkow, & Pace, 2013). It became clear through these conversations that both approaches share a disciplinary learning focus. Shopkow and I (2019) previously explained that both are theories of 'stuck places' where learners cannot improve their performance without figuring out some essential element of the discipline. While both are metaphors, Threshold Concepts offers the metaphor of a doorway, but it is a doorway that is often blocked to the student. The Threshold Concept is a paradigm shifting bottleneck, meaning, once the student shifts the paradigm, they usually cannot go back to the prior way of thinking, like one's perspective before and after experiencing touching the ocean or viewing a total solar eclipse for the first time. Paradigm shifts are exceedingly difficult kinds of mental moves. Bottlenecks as metaphors, on the other hand, offer an intellectual traffic jam with many major routes and smaller byways–a variety of kinds of difficulties, not limited to the paradigm shift. For example, a bottleneck can be procedural, such as not knowing the procees for rewriting drafts in composition, or can be attitudinal, such as believing one is not good at math, neither of which necessitates a paradigm shift.

Problem Analysis	Navigating the Problem
Steps 1-2	Steps 3-4-5-6
Theory of Difficulty	Theory of Pedagogy
Bottlenecks; Threshold Concepts	Decoding the Disciplines
Concerns the hurdles of content; foregrounds what aspects prove consistently troublesome; uncovers tacit knowledge; designs the challenge (Perkins, 2007, p. 33)	Organizes the teaching-learning process for good results, with recommendations about the kinds of activities likely to foster learning. (Shopkow & Middendorf, 2019)

Table 1: Theories Comparison

To continue the comparison of Threshold Concepts and Step 1 of Decoding the Disciplines, Table 1 Theories Comparison shows how both use theories of difficulty (Perkins, 2007) and focus on the hurdles of content. They both foreground the aspects of learning that prove consistently troublesome to uncover the tacit or "secret knowledge" of the discipline. Theories of difficulty design the challenge, but do not solve them. However, as Disrupting scholars point out, many disciplines, with their purported neutral and unbiased stance on knowledge, have ignored colonialism, implicit bias, and racism and thus, have been complicit in upholding structures of colonialism (Attas & Yeo, 2025).

Table 1 also shows the main way the two theories differ in that Decoding the Disciplines from the start had a second theoretical component. Steps 3-4-5-6 navigate the problem using pedagogical theory. They organize teaching and learning processes for good results, scaffolding instructional techniques to foster learning (Perkins, 2007). "The great strength of decoding is the methodology that undergirds the theory … ," (p. 41, Shopkow & Middendorf, 2019).

Referring again to learning theories, Decoding Steps 1-2 might be viewed by some as opening the "black boxes" of cognitivism through uncovering the specialists' disciplinary tacit knowledge. As well, the pedagogical theories side of Decoding Steps 3-6 might be viewed as based in constructivism, which explains knowledge as actively and socially constructed by the learner. But these learning theories are limiting because Decoding addresses more than cognitive bottlenecks and is more specific than constructivism. Decoding can address affective and metacognitive bottlenecks, which such learning theories do not. Plus, there are so many learning theories (Millwood, 2014), that we are back to the same problem as with teaching methods, too many that it's overwhelming and we don't know

what to do with all of them. Decoding brings together practice and theory by analyzing the problem and organizing the pedagogical theories side, bringing together multiple teaching and learning principles to guide teacher explanation, student practice, motivation, and assessment. Decoding turned into a theory of lesson design, which higher education was previously lacking, but can also expand to forward course design, difficult concepts, emotional bottlenecks, and has further applications to curricular and organizational levels with its basis in the bottleneck.

Decoding brings together theory and practice by bringing an analytical lens to view where others are working theoretically, whether inside SoTL or elsewhere in higher education. With tens of thousands of teaching and learning ideas being argued in higher education, Decoding theory organizes this world. The theory is directly aimed at teaching and learning and can guide teaching or research in teaching and learning. It tells me there is some other theory at play when the topic is classroom management or student development, for example. At the 2023 international SoTL conference in a session titled "Pedagogical Tools," one of my five co-presenters asked, "How did we all get placed in this same session?" We represented a wide range of pedagogical practices and different research methodologies. For me the Decoding framework created a sense of cohesion across these otherwise disparate presentations, because Decoding provided an overarching theory of difficulties and pedagogy. It gave me a theoretical lens to view what each presentation was doing, instead of becoming overwhelmed by a metaphorical firehose of ideas. Decoding offers a language and concepts for locating one's own or another's work theoretically and provides a powerful coherence for viewing teaching and learning and related areas of scholarship.

Though the Decoding steps appear in numerical order, the model is not linear; a misconception about Decoding is that all steps must be completed, and completed in order for the methodology to be helpful. However, a person can start at any point in the Decoding wheel, though the bottleneck is almost always a consideration. An instructor or SoTL researcher looking for ideas about the lecture or "teacher presentation" part of teaching might start from a particular difficulty for students in a particular lecture (the bottleneck). Seeking out analogies for what someone does to get through the bottleneck will most likely uncover the mental move. For example, a physics instructor expressed frustration that his students could not understand the difference between velocity and acceleration in the physics of motion. Two analogies helped clarify his lecture on the different forms of motion: Velocity is analogous to how hard it is raining; acceleration is like how fast it is changing from a drizzle to a downpour. In another example a sociology instructor's students scored poorly on a quiz about sociological imagination following her lecture, especially in seeing the social systems at play around them. She revised the lecture, developing an analogy of seeing the sociological factors (ethnicity, socio-economic status, religion, language, etc.) as like size, shapes, and colors of a Lego set. Having made a key to the sociological factors of interest for the campus "Lego set", student teams photographed a location on campus and analyzed the sociological structures, marking it with their Lego key factors. What groups were they looking at? What was their ethnic make-ups? Age? What were they wearing–possible clues to identify their cultural backgrounds and SES? What was their accented or non-accented languages? How were they interacting with others (individual, dyads, triads, etc.). The analogy is an important tool for building a bridge to the difficult concept in lectures. These efforts did not require ALL the Decoding steps; working with just one or two steps can make a difference to student learning.

I have worked with instructors and SoTL researchers to whom I did not even mention that we used Decoding or the technical language of Decoding, much less that we were guided theoretically (as in the physics and sociology examples above). However, I have found that when they explicitly learn the theoretical framework, instructors can use the bottleneck model again and again. As one instructor reported several years after participating in the FLP, "Every week when I teach, I think about the bottlenecks and the CAT," meaning he prioritized learner difficulties

and regularly monitored understanding with Classroom Assessment Techniques (CATs) (Angelo & Cross, 2012). Decoding as a theory has practical application at the individual level for instructors and SoTL researchers. SoTL and educational development leaders bring group through the process from picking a bottleneck to designing a lesson or study around it.

In the session where this paper was originally presented, to better understand the ways Decoding methodology/theory is currently used, I asked the participants (educational developers, SoTL scholars, instructors, and higher education administrators) to participate in an exercise (Wentworth, n.d.) that asked, "Where do you expend most of your effort on Decoding?" The forty participants stood along an imaginary number line from 0-10, where 0 represented mostly problem analysis (Steps 1-2: the difficulties, including the bottlenecks and uncovering the tacit knowledge through interviews or other means), and 10 represented completely working on the pedagogical methods and navigating the problem (Step 3-6: modeling with analogies or narratives, active or anti-racist pedagogies; motivating for persistence on the mental move, and CATs). Those doing both approximately equally (Step 1-6: problem analysis AND pedagogical actions) were asked to stand in the middle of the number line. The line-up revealed that that on average more people were standing in the area representing Steps 2-3. That is, more of them were working

with the problem analysis, difficulties and the Decoding Step, and fewer were applying the pedagogies. As we debriefed this exercise, people expressed interest in applying the pedagogical theory but wanted to know how to do so. Because I do that consistently, this was an eye opener for me. Why did it seem so easy and readily apparent to me? Where was the mismatch?

It seemed like they were almost "stuck" spending the preponderance of their time on Decoding interviews. I have gotten past the interviews and into scaffolding the mental moves because almost from the start in the FLP summer seminars, each seminar participant presented a bottleneck lesson including all the Decoding Steps and received feedback from seminar colleagues and would not receive remuneration without doing so. More recently, participants complete a written bottleneck lesson and receive written feedback from other teams, which takes less seminar time than verbal presentations. Completing the bottleneck lessons, whether written or verbally, gets instructors ready to bring the mental moves into the classroom with the pedagogical theory side of Decoding.

Interviews were a side task in the eleven years of summer seminars, conducted prior to the start of each seminar, but once our original funding ended, and with less supportive administrators, there was limited time for interviews. To lead Decoding workshops for groups as large as 100 at

other campuses in the U.S. and internationally I have adopted alternative (non-interview) methods for the participants in teams to Decode each other's mental moves a few of which are described below.

- Swantje Lahm's (2016) Bottleneck Writing Tour emerged from a program that centered reflective writing as part of the Decoding process.

- Sue Hines (2015) invented a Decoding method with no interviews, building 3-d models of the mental moves out of playdough.

- I brought the inferential frameworks of analogies, metaphors, and narratives into the modeling step because inferences help learners transfer related ideas to new domains (Jones, et al., 2011).

- Tori Mondelli uses Decoding as a key component in building instructional games (Bisz & Mondelli, 2023).

- Decoding can be used in constructing rubrics by connecting frequent student mistakes to a desired performance (thus Decoding the mental move) for assignments.

The alternative Decoding methods proved enjoyable, easy ways of uncovering the mental move. At each of the different pedagogical steps, we re-encounter and re-interrogate the mental move as we model it through analogies, provide practice, motivate learners to persist or assess it. Even feedback on the bottleneck lessons recursively discusses where we can make the tacit reasoning and concepts clearer. I encourage those who lead Decoding and Disrupting to try out the alternative methods if interested in devoting more of group process time to scaffolding learning for the classroom (and the pedagogical theories side of Decoding).

To summarize, in leading groups I spend about half of my Decoding/Disrupting group process time applying the first part of the theory–uncovering bottlenecks and imagining new ways to think (interviews and especially alternatives to interviews). I use the other half of the time in the second side of theory–guiding instructors in teams to scaffold the new way of thinking/being into classroom practices; the goal is not to simply leave people on their own for the implementation stage.

Questions for further research:

Where do you spend most of your time with Decoding or Disrupting? A. Problem analysis of the difficulties and interviews (Steps 1-2); B. applying pedagogical practices (Steps 3-6); C. the SoTL steps (6-7); D. all the Steps

Barriers to Theory

Teaching and learning in higher education is more comprehensible through theory, but there is resistance to using theory. Why are people resistant to using Decoding theory and why are people generally resistant to using theory in the first place? Many of those who regularly use Decoding run into resistance. Barriers to using theory may show up in scholarly teaching, SoTL, educational development, and/or wider departmental or campus efforts such as curricula or program review.

I am not advocating that everyone uses Decoding the Disciplines theory, but it has been my experience that when teaching and research are theory-based, they function better. For an example of a complementary theory that enhances Decoding, the Disrupting collective introduced me to Ermine's ethical space (2007) as a complementary theory where disparate worldviews engage and, by experiencing very different views of the world, we can imagine new ways of thinking and being. Ethical space informs Disrupting interviews following consideration of where one's discipline upholds racism or colonialism, by asking the open-ended question, "What can you imagine doing differently?" There can be resistance to Decoding the Disciplines and Disrupting theories or any of the complementary theories that play well with Decoding and Disrupting for the explanatory power the combination brings.

Not using theory is a bottleneck, and potentially even an emotional bottleneck. Emotional bottlenecks (Middendorf & Shopkow, 2018) can be of two kinds: the first is procedural, in which a participant does not know how to use theory or what theory means. The second is worldview: the bottleneck conflicts with their identity or relationship to the ways things have always been done in their discipline. Worldviews are not the creation of an individual and are more difficult to overcome. They may be the social construction of a discipline and thus have the solidity of the field behind them. We do not necessarily need to make a distinction between these two kinds of bottlenecks, but the dual views can help in analysis.

To overcome emotional bottlenecks, it helps to attempt to discover the reasons for the bottleneck. Resistance to teaching from theory can spring from teacher identity; theory can seem like a personal threat. Some teachers might resist teaching from theory because it might make

them feel less like they might not be a competent teacher. Instructors in a study who successfully made changes to their courses reported that it was "humbling" to be willing to admit a change was needed (McGowan, & Graham, 2009). Research shows that when instructors do try new approaches, they can initially experience lowered student ratings (Arthur 2009; Darwin 2017); instructors may thus sense a risk in teaching from a new theory. Some may resist theory broadly as teachers seem to be feeling overwhelmed following the educational shifts stemming from the pandemic and have understandable reasons underlying their resistance: the pull of other campus initiatives, or not enough preparation time, among other pressures in their professional roles might give them less room to explore theory.

Other patterns of resistance to using theory include what Jerome Bruner (1999) describes as "folk pedagogies," or the way teachers instruct being based on lay theories, gained from personal experience or from their disciplinary teaching culture, and implicit assumptions about how children or students learn. These unsurprisingly have immediate implications for teaching; for example, if students are viewed as innocent, they must be protected from vulgar society; if they are viewed as empty vessels, they need to be filled with information. For Bruner, the teacher's conception of learners shapes the instruction. Subsequently,

it makes sense to equip teachers with the best available theories of student mindsets, emphasizing the significance of applying theory.

Louise Drumm found little theory-driven teaching practice in her study of educational technology lecturers, but instead "popularly held concepts misconstrued as learning theories, [or] 'pseudo theories,'" (2019, p. 4) such as digital nativism and the much-debunked learning styles. Another misconception Drumm repeatedly found instructors teaching from is orthodoxies of teaching–"the way we do it" in our department or in our field, which relies on an explanatory vacuum. The educational technologists' practices, such as ice breakers or teaching with videos, were justified by explanations of wanting to expand student thinking with no real research base or rationale for their choice of methods. The problem, as Drumm sees it, is that pseudo and folk pedagogies, or disciplinary orthodoxies, represent a threat to teaching from actual theory. An additional block to teaching from theory is the oft expressed, "This is the way I learned it" (a sign that a Decoding interview may have gone off the rails), or the variation: "this is how I learn best," which assumes that students will also learn with the same approach. Again, choosing teaching methods from personal experience and even personal success is not evidence-based.

Pseudo and folk pedagogies, orthodoxies and "how I learn best" are strongly held misconceptions, and when one views teaching and learning with a misconception, it is not an empty space; there inherently exists an idea there that blocks people from teaching from theory. We want people to teach from theory, with evidence-based practices. If their career has thus far relied upon pseudo theory or some folk pedagogy, then they may be resistant to this new way of thinking about their teaching.

Questions about use of theory for further research:

1. **What resistance have you encountered to teaching/ SoTL from Decoding or Disrupting theory or any theory?**

2. **What are folk pedagogies or pseudo-theories that instructors teach from in your field?**

3. **Interview someone who does not currently use theory as a basis for their teaching methodology: "What principles or philosophies guide your teaching?" (Be curious as you inquire – do not criticize them for not teaching from theory.)**

Overcoming resistance to Theory

Because I endeavor to never abandon people stuck in the bottlenecks, this next section will briefly describe the bottleneck approach to overcoming resistance to misconceptions. When we were building the Decoding framework, Step 5-Motivation was initially just a holding space. Over time, we came to understand the importance of emotions in teaching and learning. Not until our experiments with the History Learning Project (Díaz, Middendorf, Pace, & Shopkow, 2008) where instructors had meticulously designed lessons, and yet assessments showed learners still not adopting new disciplinary procedures, did we realize we had encountered emotional bottlenecks. Studying how to uncork resistance to these bottlenecks, we scrutinized the research on overcoming resistance (Middendorf, Mickutė, Saunders, Najar, Clark-Huckstep, Pace, 2015).

To understand overcoming resistance, I will begin with an analogy. A well-known misconception in science is understanding the causes of the seasons of the year, captured in the video, "A Private Universe," and the follow-up study, "Minds of Our Own" that taught us that traditional educational methods cannot overcome powerful misconceptions. In the video, recent Harvard science graduates are asked, "What causes the seasons?" What makes North America cold in the winter and warm in the summer?" Their response, that the earth gets closer to the sun in the summer and farther from the sun in the winter comes from the misconception that the sun is like a radiator, and if one thinks of the sun as a radiator, then it must be giving off heat and in summer they are closer to the radiator and in winter they are farther from the radiator and thus, colder. But in fact, the sun's energy is not in the form of heat, but radiation. Solar radiation is like water coming out of a sprinkler attached to a hose. To continue with analogies, when the sprinkler's holes are aimed directly at us and we receive more of its radiation, that makes summer's heat. When North America is tilted away from the sun, the spray from the sprinkler is further dispersed, and the solar radiation is lessened on our part of earth and that makes this portion of the Earth cooler. In winter, we receive significantly less solar radiation, so things are colder.

To help learners overcome the original misconception, we show side-by-side images of a radiator next to a sprinkler with a tilted earth behind it. We do not tell them they are wrong, but simply present the concepts, with images of the two ways of thinking about it, (the misconception, and the way the scientists think about it side by side) to help them make the breakthrough in critical reasoning. In education terminology such a helpful side-by-side comparisons is technically called a "discrimination."

My big breakthrough in overcoming misconceptions and emotional bottlenecks was Micheline Chi's work (2009) on student misconceptions where she points out that misconceptions can arise when non-experts use different conceptual categories than experts do. We need to know what theories non-expert learners are operating under before we can engage them in conceptual change.

Emotional bottlenecks can block teaching from theory (and using Decoding the Disciplines), such as identity (I'm a good teacher), fear (of low student ratings or administrative pushback), or workload overload, to name only a few.

In each of these cases, there is a preexisting idea that stands in the way of accepting a new idea, such as theory. Misconceptions arise when learners or instructors are using a different conceptual category than the expert reasoning relies upon. Research regarding strategies for overcoming resistance follow a pattern: First, I want to find out what are the current misconceptions the learners/ instructors hold toward the concept, and what are the patterns? Interviews, surveys or CATs can reveal what learners believe, for instance, about seasonal change–that it is about levels of temperature. Once it becomes evident that they are using a different conceptual category, the instructor can make that side-by-side comparison. We use analogies to avoid triggering a sharp, negative emotional response to 'being wrong' (Middendorf & Shopkow, 2018).

1. Assess what/how they think (using CATs)

2. If using a different conceptual category …

3. Show side-by-side comparison of the expert's view of the concept vs. the misconception

4. Use analogies to avoid triggering a sharp emotional response

Thus, in overcoming resistance to using theory in teaching or SoTL, the starting place is finding out the basis for resistance to use of theory, so we can understand which conceptual category will help to make a side-by-side comparison (through analogies) and encourage a new view of theories.

Conclusion

Theory helps organize teaching and learning, including generating new lines of inquiry between and among areas of teaching and learning research. Decoding organizes the world of teaching and learning for instructors and SoTL researchers so they can apply it to their classrooms and classroom research. Randy Bass (1999) encouraged instructors to view teaching like their research, with plentiful problems, not to be avoided but to be sought out and pursued. Decoding takes that very seriously, using the bottlenecks in our teaching as a starting point to focus our teaching and SoTL efforts. Decoding as a theory places a lens firmly on the difficulties, not only setting up a way to analyze the problems but providing a pedagogical process for getting students through the difficulties, including measuring student proficiency at every stage of the process and sharing the results. Decoding eases entry into scholarly teaching and SoTL with a framework of theory (how teaching and learning work) and practice (what I will do) by offering a shared language and concepts.

Questions about use of theory for further research:
Where do you find Decoding or Disrupting theory most useful in your work?

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Decoding the Disciplines at Twenty-five:
Rethinking the Future

David Pace

Abstract

Since its appearance in the scholarship of teaching and learning in 2004, Decoding the Disciplines has had remarkable success in shaping pedagogy across the world. But there is still work to be done to make it an integral part of everyday teaching. We need to find ways to ease entry into Decoding and to make the result of our work available to a larger audience. We must also present Decoding as a means of addressing the perceived needs of our colleagues and our institutions at the same time that we develop tools, such as Disrupting Decoding, that assure this approach is being used in the service of the real interests of our students and of our societies.

1. The Challenge Facing Decoding Today

But, when we really dream ... we imagine an academy in which there exists within each discipline a literature that defines the kinds of thinking that are commonly required of students; in which learning the nature of disciplinary expectations is a part of preparing future faculty in every graduate program; in which faculty will cease reinventing the basic "wheels" of teaching in their field, and the achievements of one insightful teacher will become the property of all members of a discipline; in which the distance between being a teacher and being a scholar of teaching and learning will begin to disappear; and in which the intellectual powers of the professoriate are brought to bear fully on the challenges of helping students learn. (Pace and Middendorf, 2004,109-110.)

These words, from near the end of the volume that first brought Decoding to the Disciplines to the attention of scholars of teaching and learning, laid forth a highly ambitious project for the new field. The success of the approach would be evaluated not only in terms of its success in finding new ways to increase student learning, but also by its ability to move these strategies into the mainstream of academic life.

Much progress has been made towards making this vision a reality. Decoding has moved from being the work of a faculty learning group at a single university to an international movement and a major strand in the scholarship of teaching and learning (SoTL). It has been the subject of an impressive body of books, articles, dissertations, websites, workshops, and two international conferences (https://decodingthedisciplines.org/), and the original model has been expanded beyond anything that was imagined in 2004. (Pace, 2021)

But some of the hopes put forward in the quotation above remain unrealized. Decoding does not yet have the deep roots in academic institutions that we hoped would one day result from this work. New professors still begin their teaching careers with no real understanding of the bottlenecks to learning commonly encountered in courses in their disciplines. Experienced teachers still scramble for ways to help more students succeed with no sense of how the Decoding process could help them develop more effective strategies. And few educational institutions have any understanding that the paradigm might be useful in solving many of the institutional challenges that they face.

All of this is crucially important because Decoding, like virtually all of the scholarship of teaching and learning, is not just a project for producing another body of scholarship. It

is a movement aimed at making changes in how teachers think about teaching, in how they actually function in their courses, and in how the institutions around them evaluate their work.

This is imperative because the frameworks of education that we have inherited from the past do not serve the interests of our students or of our societies. Pedagogical practices that invite a few privileged individuals into the world of knowledge and "weed out" those who are judged to be inferior are no longer acceptable. We must find new ways to lead ever larger numbers of students through constantly more demanding subject matter. The well-being of our students requires no less, and it is not an exaggeration to say that the functioning of our economies and of our democracies are just as dependent on our ability to rise to this challenge.

Decoding can play a crucial role in responding to these challenges. But to do so, it must be more than another interesting academic specialty. It must become an essential part of the daily pedagogical practices in institutions of education. To put all of this in the simplest terms, it is not sufficient to produce brilliant new strategies for bringing more students into the learning process, if none of our colleagues are using them. And it will be difficult to change the culture of academia along the line suggested above without at least some support from the institutions that shape it.

To overcome this bottleneck, it will be necessary, not only to generate revolutionary new strategies for increasing learning, but also to assure that the attitudes and practices of Decoding spread and put down real roots in academia, and, perhaps, beyond. We can begin by considering what has produced the successes that Decoding has achieved in its short history and then imagining how we might build upon this progress to make this work a more central strategic framework in academia and beyond.

2. Building on Our Strengths

Looking back at the last twenty-five years, it appears that Decoding has spread for three major reasons. First, it was relatively accessible. There was no esoteric language and no need for radical retooling, Second, it was from the beginning a highly collaborative activity that easily generated strong supportive communities. And thirdly, it addressed problems that were already of great concern to many in academia, and it could be easily adapted to their issues.

Going forward, we need to build on each of these strengths, and to create new ways to take advantage of each of these possibilities. We need to think about making Decoding even more accessible and to imagine new ways to bring people together and to organize our collective energies.

And we must present Decoding as an appropriate response to an even broader range of perceived problems. Such an effort will allow Decoding to move towards the kind of impact that was imagined in the 2004 volume and to become a more integral part of the daily life of academia.

3. Easing Entry into Decoding

The acceptance of Decoding has been facilitated by the fact that it is simultaneously a fascinating intellectual journey and a response to the practical problems emerging from particular teaching situations. The interview process provides the kind theoretical challenges that faculty love in their research. It serves as a bridge uniting the practical realm of the classroom with active intellectual exploration. It is not experienced as the imposition of an alien construct. And the process usually begins with student difficulties that are already very apparent to their teachers.

Nonetheless, while Decoding has radically reshaped the pedagogical strategies of a core of its followers, its impact has been more deep than wide. It has had a profound impact on the teaching of many of us, but it remains unknown to the majority of those teaching in higher education and beyond.

We can deal with this problem in part by increasing the number of pathways into this work. As demand for Decoding grows, we will need to replace the existing pattern of occasional conference workshops with regular summer institutes and webinars that provide training in the process. And we can expand the resources available through the Decoding YouTube Channel, blogs, and social media (https://www.youtube.com/@decodingthedisciplines601).

But, while such steps can draw into the Decoding orbit more faculty who are already deeply committed to improving their teaching, there remain bottlenecks to making this work a more integral part of academia. Peter Riegler has captured this situation brilliantly in his description of Decoding as "slow food." Within the world of academia, the advocates of our approach are the equivalent of "foodies." We savor the experience of coming to understand how learning works. We want to know the ingredients, to compare recipes, to find new "cookbooks." We love to get in the "kitchen" and mess around with new possibilities. And we take pictures of our "food" and share them within our community.

To bring Decoding into the mainstream of academia, we must realize that the majority of teachers are not like us. They do not have the time, resources, or inclination needed to pass through the gateway of an intricate, hour-long, public exploration of areas in which their teaching techniques are not working. If Decoding is to achieve its full potential as a transformative agent in higher education, we will need to provide other, less demanding pathways into Decoding.

Fortunately, in this area, as in many others, Joan Middendorf has offered a path forward. Her use of nonverbal modeling, reflective writing, rubrics, analogies, and mind maps to reveal hidden mental operations can provide a pathway into Decoding for many who lack the time or commitment for the full interview process. (Middendorf and Shopkow 2017, 39–48, 59–63; Middendorf 2011) To date, her work in this area has not received the attention that it deserves, but going forward it could provide a real impetus for the expansion of Decoding.

Yet even these shortcuts to the core of the work may be too much for some harried colleagues, who just want some ideas about how to teach better. For Decoding to have an impact on such teachers, we need to find ways to give them access to some of the products of Decoding without requiring them to commit to engaging in the full process that created these insights. We could, for example, share lists of bottlenecks that are worth special attention in particular kinds of courses. Segments of interviews could be presented in an abbreviated form that would give teachers insights into what their students need to be able to do to succeed in their courses. Fortunately, the new Decoding Wiki (http://www.decodingthedisciplines.de/) provides precisely the kind of platform that is needed for such sharing the products of Decoding.

And all of this could be contextualized for those unfamiliar with the field and indexed by discipline and type of bottleneck to ease access. And we could provide more case studies that show novices in the field how teachers in particular fields have moved systematically through the entire Decoding process. Finally, attention could be drawn to relevant parts of this collection of materials through social media, blog posts, and notices in disciplinary publications and websites.

This would probably require the development of a new genre that will allow us to make the essential core of what is being learned from the Decoding process available to those who have not (yet) committed to the full process. Interviews, in particular, are frequently meandering journeys through complex pedagogical territory that are difficult to fully comprehend by those who were not part of the process. We need to find ways to distilling the essence of this journey in a more accessible form.

All of this would take work and a bit of creativity. But it is unlikely that Decoding will satisfy its full potential, if it does not make the products of its labor available even to those who are unprepared to enter into the work of producing

this knowledge. And the availability of such insights into the real challenges of teaching could lead many teachers to eventually engage more fully with the approach.

4. Building Community

As academics, we are well aware of the value of the written word in spreading ideas and sustaining movements. But, as the history of Decoding demonstrates, person-to-person contacts both within and across institutions have been crucial to both the development and the spread of the paradigm. From its origins in the Indiana University Freshman Learning Project, Decoding has been a deeply collaborative undertaking. Sustaining the communities of practice that allow such collaboration must be a central focus of planning as the field continues to expand. As the work of the group at Mount Royal University made clear early on, sharing the interview process, itself, can create strong connections within such communities and develop a common language for talking about teaching that encourages further exploration of the potential of the paradigm. (Miller-Young and Boman, 2017) As we work to move Decoding into new contexts, we need to focus, not only on spreading the paradigm to individual faculty, but also on the creation of ongoing local communities that form strong bonds among the Decoders.

We also need to continue to seek opportunities for creating connections across institutions. An encounter at an ISSOTL conference led to the creation of a strong Decoding community at Mount Royal. A workshop at EuroSoTL helped lay the foundation for the Decoding group at Bavarian Center for Innovative Teaching (formerly known as the DiZ Center). Without these personal encounters generated by such meetings, it is difficult to imagine that Decoding would have spread so broadly or gone so deeply purely through the dissemination of written texts.

So far, this collective dimension of Decoding has tended to emerge spontaneously. As the movement expands, however, it will be increasingly important to do more conscious and collective planning and to maximize such connections. As this piece is being written, plans are in motion for a second Decoding conference and for the creation of a formal organization to support this work. Planning at this level is going to become increasingly essential as the movement grows.

But it will also be important to cultivate subgroups within the larger Decoding community. Those working together on disruptive Decoding and on the transition from high school to college can provide a good model for the future. The work of the History Learning Project (Díaz, Middendorf, Pace, and Shopkow, 2008), could be duplicated in other disciplines. Such groups could create a solid body

of scholarship on the application of Decoding in their field and then spread these ideas through disciplinary organizations and publications.

Increasing ties between our community and other teaching-oriented groups can provide another strategy for increasing the impact of Decoding. The International Society for the Scholarship of Teaching and Learning provides a particularly promising target for collaboration. It may be possible to expand the role of our interest group within ISSOTL or to take advantage of the organization's writing projects.

5. Linking Decoding to Perceived Needs in Higher Education and Beyond

To date, Decoding has spread primarily because it solved essential problems for individual teachers. It is painful for us to return to the classroom year after year knowing that many of our students will never master subjects that are dear to our hearts. And the failure to produce student success in our courses can have negative career repercussions. Decoding offers a coherent and effective strategy for addressing these concerns, and this provides a strong motivation for pursuing this work.

The resulting sense of empowerment of individual teachers has often been reinforced by connections drawn between Decoding and broader social and political concerns. From its beginning this work has been conceptualized as a means of pushing back against inequality in the educational system and of preparing students for their roles as citizens in a democracy. In an era marked by a wide-spread sense of helplessness in the face of gigantic political and social forces, there is great appeal in experiencing one's classroom as a laboratory in which experiments are taking place that might be part of the emergence of a better world.

Finally, in a period in which isolation and loneliness is rampant, the collaborative nature of Decoding can be a major incentive for being involved in this work. Teaching can be a lonely profession, when there is no one to talk to about one's failure and successes and to explore alternative solutions to classroom challenges. Working within a Decoding team can fill that gap.

Such appeals to individual faculty have provided a great base for the initial expansion of our field, and we need to continue to think of ways to explicitly link these concerns to our work. But this involves a slow expansion one course at a time, and such changes will only appeal to those teachers who are primarily motivated by these concerns. To have a broader impact, we will have to make Decoding an integral part of the perceived interests, priorities, and reward systems of our educational systems. And, sadly, student success, faculty satisfaction, and societal well-being are rarely at the very top of the real agendas of most of institutions within which we teach.

Therefore, if Decoding is to become a more integral part of daily life of academia, it will be necessary to link it, at least to some degree, to the priorities that shape so much of that life. To convince academic institutions that such a change is justified, we will need to convince them that supporting our work will solve problems that are already perceived as most pressing on the level of the department, the university, or the discipline.

Fortunately for our purposes, there is no shortage of problems at all levels that can be addressed with Decoding. But to do so it will be necessary to expand our focus from individual courses to the broader arc of student development across time. On the level of an academic department, for example, students often move through a chaotic sequence of courses that has no logical order. This can have major negative consequences for the students, faculty, and the unit as a whole. Faculty struggle to teach students with radically different levels of preparation, and departments lose enrollment. And, in the case of fields like engineering or accounting, outside entities often bring pressure to bear when graduates turn out to be unable to live up to the expectations of their employers.

Decoding could provide a very effective framework within which to create a more rational curriculum. The process can begin by identifying bottlenecks to learning that persist in many students throughout the sequence of courses. Decoding interviews with faculty could make explicit the specific steps that the unsuccessful students were missing, and these could be given specific attention across the entire program. The process suggested by Arlene Díaz for sequencing the modeling, practice, and assessment of particularly demanding mental operations could be used to produce a vision of what should be happening at each level of program. (Díaz, Middendorf, Pace, and Shopkow, 2008, 1221–23) Such a process could produce practical benefits for departments that could be recognized even by colleagues who lack our intense focus on the welfare of students and society.

Decoding could also be used to respond to even broader institutional problems, such as effective online learning, the role of AI, or the retention of students. Indiana University, for example, like so many academic institutions, is concerned about the loss of students in its first year courses, Therefore, it has been willing to generously support the Decoding Transitions to College Project, which uses the

identification of bottlenecks and the interview process to help groups of high school and college teachers develop common strategies for helping more students make a successful transition to college courses. (Beam, Chastain, Darcy, Itow, and Pace, 2023). This funding has allowed both an expansion of our understanding of what is possible for Decoding and the introduction of this process to groups that would have otherwise never encountered it. But this was made possible by presenting our approach as a pathway toward achieving the existing goals of an institution.

It is easy to imagine similar programs designed to support student retention of first-generation college students, international students, and members of other groups whose failure to thrive raises concerns for university administrators. As Christian Briggs has demonstrated, the use of the Decoding interview need not be restricted to faculty. It can also help us identify other hidden forms of expertise. (Briggs, 2023) Students in at-risk groups in a university population, who have succeeded despite the odds, could be interviewed to identify bottlenecks to success that they encountered and to make explicit the steps that successful students took to deal with these. Then these strategies could be made available to others, perhaps through videos of the successful students themselves. A college dean at a Canadian university has even raised the possibility of applying a similar process to helping retain faculty from groups that have not traditionally been represented in academia.

Universities are also increasingly aware that ineffective teaching has a negative effect, not only on individual students, but also on the long-term goals of the institution itself. As the work of Peter D'Sena and Earle Abrahamson at the University of Hertfordshire and of Petra Weiss at Pädagogische Hochschule Zürich are demonstrating, Decoding can be a powerful tool in programs aimed at increasing the pedagogical sophistication of new faculty.

Academia as a whole and many humanistic disciplines in particular are being asked as never before to justify their relevance to contemporary society. The mental operations that emerge from interviews in even the most esoteric fields often have practical uses that can be shared with the general public. Thus, Decoding could play a role in making these valuable skills explicit and, thus, in helping faculty and institutions to explain the value of what we teach.

Presenting Decoding as a highly valuable tool for achieving many goals already prioritized by universities and other granting agencies in education could lead to funding for projects and for rewards and recognition for the faculty involved. But, to close the deal and get the resources we need, we must be able to demonstrate that Decoding can actually make good on this promise. We need more studies that provide clear evidence of student success in courses that are shaped by Decoding. One of the most important

things that we can do to move forward is to assemble such evidence in a form that can be convincing to those who make decisions about funding priorities.

Thus, we need to educate our institutions, our disciplinary organizations, and funding agencies about our work and its potential for addressing a wide range of needs within academia and beyond. Sharing project proposals and applications for funding within our movement might facilitate the development of common language for interfacing with the world outside our community. And we will need to strategize to find the most effective ways to establish connections between our work and the needs of our institutions and of the broader society.

6. Conclusion

We have at our disposal a powerful tool, a great number of promising areas in which to put it to use, and ways that our projects can be linked to the recognized challenges of our institutions and our societies. The potential of Decoding is, thus, immense. We are in a position to dream big.

To realize at least some of this potential, we will need to be flexible. We will need to sometimes move outside our own fascination with pedagogical exploration and imagine how

the results of these journeys might be connected to the goals of academics who have very different orientations. To have a real impact on academia as a whole, we must build coalitions with others and convince them that Decoding is a pathway to their outcomes as well as our own.

There is an obvious trap here. Decoding could be captured by a neo-liberal system that would use it solely to make more efficient the process of producing narrowly trained and subservient workers and consumers. We must assure that the changes that Decoding produces are always rooted in maximizing the well-being of students and of society, not in increasing their utility to economic elites.

Fortunately, we have two tools to help prevent Decoding from being turned into another instrument for exploitation and dehumanization. First, we have strong and growing communities of practice, whose members share a common commitment to a set of values that emphasize the connections between teaching, on the one hand, and the wellbeing of students and of society on the other. In the midst of social organizations that are fragmented and focused on individual gain, such communities are in themselves a source of power and a bulwark against cooptation.

Secondly, the emergence of Disruptive Decoding (Easton and Lexier, 2017; Lindstrom, Head, Yeo, Easton, and Middendorf, 2023) can provide us with a moral compass that helps keep us on course. The initial model of Decoding provided us with a means of providing disadvantaged students with a second chance to find their place in our universities and in the larger society. Disruptive Decoding can help us be sure that in this process we are not simply engineering them for soulless lives in an exploitative society. The standard Decoding interview reveals the hidden curriculum that students must master to succeed in particular courses. The Disruptive Decoding interview seeks to make explicit the values that underlie that curriculum and for recognizing when they are at odds with the real interests of students and society. Just as traditional Decoding makes explicit what students have to be able to do to succeed in existing courses, Disruptive Decoding can reveal the moral contradictions that may creep into the academy.

These two functions are on the surface contradictory. We are both supporting and critiquing the existing system. But, in fact, the two functions are ultimately complementary, and each is essential to the other. Like our students, we must simultaneously function as effectively as we can within existing systems at the same time that we work to understand and to change them. Decoding, as it has evolved over the last twenty-five years has given us new tools for continuing both projects more effectively in the future.

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Further Explorations of Decoding the Disciplines:
Narrative and Hermeneutic Aspects

Michelle Yeo, Odd Rune Stalheim

Abstract

Decoding the Disciplines provides a tool to help unlock expert blindspots in disciplinary thinking. Unpacking tacit knowledge can be helpful to the expert who is attempting to teach those concepts to novices. The original orientation of the work was cognitive. Since then, aspects of disciplinary knowledge have come into focus beyond the strict focus on mental operations, such as emotional, phenomenological, and identity elements. The authors live and work in different national contexts (Canada and Norway), yet share a common background in hermeneutics as a research methodology. This paper explores the results of a small series of Decoding interviews where we focused on what we saw to be hermeneutic aspects of the expert's experience. In the course of analysis, our interest became the narrative aspects of the expert's understanding – how experts in disciplines narrate their coming to know and their existing knowledge as aspects of their being-in-the-world.

1. Introduction

Over the past 20 years, Decoding the Disciplines has provided a tool to help unlock expert blindspots in disciplinary thinking (Middendorf & Pace, 2004). Unpacking tacit knowledge through the process can be tremendously helpful to the expert who is attempting to teach those concepts to novices. Decoding the Disciplines involves a 7 step process as described by Middendorf and Pace (2004), in a cycle of: identifying a bottleneck in learning, exploring in depth how the expert approaches this task or problem, devising ways to model these steps to students, developing activities where students can practice the skill and get feedback, motivating, assessing students, and finally, sharing out to the discipline. The original thrust of the work was cognitive, and the interest in detailed cognitive unpacking of bottlenecks continues apace (Pace, 2021). Over the years, those who have taken up the Decoding practice have not only realized its potential, but also uncovered many aspects that were not initially intended, such as emotional bottlenecks (Middendorf et al., 2015), embodied learning (Currie, 2017), and narrative identity (MacDonald, 2017). More recently, some of the Decoding work has been adapted to a process called Disrupting, whereby taken-for-granted aspects of disciplines are challenged in decolonizing and anti-racism work (Lindstrom et al., 2022).

One of the authors, Michelle Yeo, engaged in a Decoding the Disciplines project a decade ago at her university, and the special issue published from this project looked at Decoding from the perspectives of building community, community service learning, phenomenological, hermeneutic, and (narrative) identity grounds (Miller-Young & Boman, 2017). The authors of the current paper decided to continue this thread, specifically in terms of exploring the hermeneutic potential of Decoding interviews. The authors live and work in different national and professional contexts, yet share a common graduate training in hermeneutics as a research methodology. Presenting together on some early ideas at the inaugural Decoding conference in Aachen, Germany, in October 2023, this paper further explores the results of a small series of Decoding interviews where we focused on what we saw to be hermeneutic aspects of the expert's experience. In the course of analysis, our interest became the narrative aspects of the expert's understanding – how experts in disciplines narrate their coming to know and their existing knowledge as aspects of their being-in-the-world.

2. Literature and Theoretical Frame

2.1 Decoding the Disciplines

The original work, based on the work of Middendorf and Pace, uses an intensive interview process to assist teachers in unpacking their own expert blindspots – difficult tasks or concepts in their disciplines that students consistently struggle with, but for the expert has become so much a part of them that they no longer notice the complexity of what they are asking students to do (Middendorf & Pace, 2004). Quite often these are significant because they can be threshold concepts (Meyer & Land, 2003) that prevent students from progressing until they have gained at least a basic grasp of the concept or task. The interview itself involves focusing not on what the students can or cannot do, but rather, once the concept or task is described, asking, "how do YOU do that." The cognitivist underpinnings of Decoding are apparent here, as the tacit knowledge is envisioned as a series of steps that must be made visible. These steps then become translated into a pedagogical model that is implemented in the classroom (Shopkow & Middendorf, 2021). As described by Shopkow and Middendorf, "Decoding the Disciplines began as a theory of pedagogy" (p. 38); it is a deeply pragmatic approach that emerged from problems of practice at the level of the classroom. They make the distinction between bottlenecks as identified in Decoding, and the theory of threshold concepts (Meyer & Land, 2003), which while often overlapping with Decoding, in contrast is a theory of conceptual cognitive difficulty while Decoding is a theory of pedagogy. In our current work, we are interested in viewing disciplinary thinking from another angle. Learning is about thinking, but it is also about being, and about how we story our understandings. It is this aspect that we explore here.

As introduced above, the embodied and identity elements have been noted by others (see Currie, 2017; Macdonald, 2017). Understanding the process of coming to know a discipline as a being-and-becoming process is, at heart, hermeneutic. Michelle has written previously about the Decoding interview as a hermeneutic practice (Yeo, 2017). In the current work, we wondered if a more hermeneutically oriented interview could yield a richer understanding of expert knowledge from a different perspective. By this, we mean that the interviewers are more attuned to expressions of narrative, metaphor, moments of clarity and understanding, and interpretations of their past experience than we are in identifying specific mental moves, which means that questioning then proceeds upon somewhat different lines.

2.2 Hermeneutics

Hermeneutics is a philosophical tradition as well as a research methodology in fields such as education and nursing. It is an interpretive methodology, as explained by Yeo et al. (2023), which means that an intersubjective stance is taken - the world is not seen as something to be objectively known but rather understood. Hermeneutics sees this "knowing" as occurring primarily through language (Moran, 2002), which makes it particularly appropriate for Decoding work.

We are working specifically with a Gadamerian (1999) concept of hermeneutics for the purposes of this analysis. Moran (2002) describes Gadamer's approach in this way:

> Hermeneutics is the art of interpretation or understanding, and, for Gadamer, always signifies an ongoing, never completable process of understanding, rooted in human finitude and human linguistically … . Humans are essentially involved in the historically situated and finite task of understanding the world, a world encountered and inhabited in and through language. (pp. 248-9).

Hermeneutics understands experience to be a fundamentally interpretable event through language (Smith, 1991). This interpretation is necessarily historically and culturally situated. As a simple example, we can think about how various cultures have first identified and then created stories about groupings of stars into constellations (reviewer personal communication). The stories reflect various aspects and values of the culture, reflecting origin stories and sometimes spiritual beliefs, and are told, retold, passed down through generations, changing in the telling over time. This demonstrates the role of context to interpretation. There is also in hermeneutics a special relationship between the past and the present. Here we can think about legal hermeneutics and case law. When trying a new case before the courts in the present, those making the judgement will consider cases from the past and how it applies in this new situation. Once decided, however, the new case then speaks to the historical cases, and indeed changes how those past cases are understood. The past and present exist in a dynamic relationship (Gadamer, 1999). When applied to teaching and learning, it becomes clear how the role of the teacher is not only to pass down disciplinary knowledge to new students, but has the opportunity to become transformed in their own thinking. The students' learning has the potential to recast what has previously been understood in the discipline. Teachers can intuitively understand this: many will describe how they only truly understood their own subject matter when they began to teach it. Indeed one of our own participants, Henrik, made just such a statement.

Michelle previously outlined other hermeneutic principles relevant and visible in the expert's tacit knowledge as revealed in Decoding interviews, namely, an openness to questions, a special relationship to text (broadly defined), the relationship between knowledge and experience. This last relationship includes the relationship of whole and part (deconstructing and reconstructing), provisionality (deferring judgement), and translating theory to practice (Yeo 2017). In our work on Decoding the authors have been struck by the inherent hermeneutic nature of Decoding, particularly when the line of questioning departs from the strictly cognitive realm. As Gadamer (1999) wrote, "Questions always bring out the undetermined possibilities of a thing" (p. 375).

We wanted to further explore these aspects in our Decoding interviews, by consciously focusing our questions on these elements, along pursuing any hints of narrative identity, embodiment, or story.

2.3 Narrative

While we do not propose for this project to use the specific research methodology of narrative inquiry (Clandinin & Connolly, 2000), narrative as a means to understand our lived experience in a hermeneutic sense became central to our analysis in this set of interviews. Goodson (2010) wrote that "in a very fundamental sense we exist and live our lives 'in' and 'through' stories" (p.1). Narratives become tools for individual interpretation and understanding of experiences, or in this case, glimpsing tacit knowledge, thus facilitating personal processes of meaning-making or new insights for participants' teaching and learning strategies (Bruner, 1986; Gee, 1985) (as cited in Jones, 2011, p. 111).

Moreover, narratives can serve as a conduit for transforming knowledge into storytelling, acting as a mechanism for creating and conveying meaning (White, 1991) (as cited in Jones, 2011, p.111). The Danish philosopher Søren Kierkegaard has famously said that life must be lived forward but can only be understood backward (Goodson, 2010). Decoding the Disciplines is a method that allows the participants to dwell on their growth and development in their subject area. Humans' told and lived stories can be one way to fill their world with meaning. The storied life compositions form our identity and a story to live by, and our surroundings shape these stories.

The Decoding process can act as a catalyst for transformative learning (Mezirow, 1991), which entails shifting our frames of reference and seeing the world in a new way (Kligyte, 2011, p. 203). Transformational change can be seen as a process of gaining critical awareness of how and why our presuppositions limit our perception, understanding, and emotions about our world. In the context of decoding the disciplines, this transformative awareness could help unravel the constraints imposed by our preconceptions, thus enabling a deeper understanding of our practices (O'Farrell & Fitzmaurice, 2013).

As will be seen below, our participants made sense in various ways of their expert understanding through telling stories or using metaphors to suggest what it is "like" when they are "doing" their discipline. There is an important relationship between narrative and learning:

Narrative learning is not simply learning from the stories we tell about our lives and ourselves. It is learning that happens 'in' and 'through' the narration. The stories we tell about our lives and ourselves are therefore to a large extent already the result of such learning processes (see Tedder and Biesta 2009[a]) (as cited by Goodson, 2010, p. 2).

3. Study Approach

As a research method, "hermeneutics asks us to be attentive to our being-in-the-world, and is thus oriented toward ontology" (Yeo et al., 2023, p. 166). Because the process of Decoding relies on dialogue, particularly relevant is Gadamer's (1999) view of understanding as a conversation "between people and their transition – the common understandings which emerge in a dialogue and which go beyond the intentions of the speakers" (p. 249). In a hermeneutic reading, interviews are read thematically, yes, but iteratively and seeking insight. In this way, experience becomes interpretable:

> Insight is more than the knowledge of this or that situation. It always involves an escape from something that had deceived us and held us captive. Thus insight always involves an element of self-knowledge and constitutes a necessary side of what we called experience in the proper sense. Insight is something we come to. (Gadamer, 1999, p. 356).

Practically speaking, we conducted a workshop in Norway for a research group at Odd Rune's university, where faculty members from different original disciplines but all currently working as teacher educators were introduced to Decoding the Disciplines. Additionally, Michelle Yeo gave a presentation to a virtual research collective at another Norwegian university. From these groups, in addition to one participant referred to us from another university, we conducted four Decoding interviews lasting 90-120 minutes each. Participants did pre-homework, and three participated in a debrief. All interviews were conducted virtually, recorded, and transcribed. We had ethical clearance for this study as required by both the Canadian and Norwegian universities.

Both researchers participated in the interviews, read and coded the transcriptions, and met to identify the hermeneutic aspects of the events. The analysis led to four narrative elements as the bottlenecks unfolded that we will discuss, using one participant to illuminate each aspect: the breach (Ray), being-in-the-world (Henrik), the red thread (Katherine), and the Goldilocks principle (Natalie). In the following section, we will present the four narratives, emphasizing providing a rich extract of the excerpts to gain insights into the participants' attempt to disclose their understanding and insights.

4. Four Narrative Strands

4.1 "The Breach"

A story about coming to know in relationship to the bottleneck

Ray began with a faculty development bottleneck, of working with faculty members on understanding the curricular concept of constructive alignment in writing learning outcomes. As the interview progressed, however, Ray kept coming back to the notion that he wants his students – whether undergraduate, graduate, or faculty members – to become independent in their own learning. He told us that his goal, when he taught English, was to make himself obsolete. It became clear that this was a central element of his teaching philosophy. It seemed to us as interviewers that perhaps his home discipline of English literature might yield a more fruitful line of questioning. We started to ask about what he was trying to achieve with those students, what a bottleneck might be, and then following our hermeneutic line of questioning asked him about his own experience. His initial story was how, as a high school student, he didn't like to read or enjoy English, despite now having a graduate degree in English and becoming a published poet himself.

I was terrible in English. When I was in high school, I hated it. And it was hard to get me to read … and one of my high school teachers would give me extra points on exams. Because I wouldn't read the books, and I would just make s*** up for the answers, and she thought my answers were so clever. She would give me a pretty good grade.

When Ray was challenged to tell us his own story of how he discovered the skills of interpreting poems which he found a bottleneck for students, he started with the struggle he himself experienced at the beginning of his studies. The bottleneck that Ray describes in literary interpretation is similar to that described by Arizzone et al., (2004), where students struggle with learning how to go about analyzing a poem. They write, "learners have to develop a sense that not all products of speculation are equally valid" (p. 45). This article delves into specific modelling and activity that can help students develop this judgement. However, Ray did not express that he remembered this kind of opportunity as a student. Instead, he talks about when "the light turned on." Ray recalled a moment in graduate school when he saw something novel in a poem, and for the first time, he felt a sense of power in his own learning and ability to interpret a poem on his own. Ray's discovery of this power in his learning process through his narrative revealed an understanding and interpretation of his own experience, and he expressed a deeper understanding of his student's

bottlenecks (Bruner, 1986; Gee, 1985) (Jones, 2011, p.111). This is where we see the learning "breach" – a breakthrough to the surface of what had been underneath, like a whale breaching through the surface of the water. Caputo (1987) sees this kind of breach as the active, dynamic potential of a more radical hermeneutics, where our understanding leaps forward in a moment.

So, it was a struggle for me to figure out that I could do it. I think I was late in my Master's program before the light came on that said, Okay, you can do this. You don't need somebody else to help you do this. I had this imaginary notion that there was sort of like this book of secrets, that once you get to a high enough level of education, then you have access to the secrets behind the text somewhere.

This excerpt provides a narrative that can be understood as a breach in Ray's discovery of his understanding of and ability to read and interpret poems. The breach in Ray's narrative can be seen as transformative learning where constraints in literary interpretation, with an inability to truly see on his own, suddenly opened up enabling a deeper understanding of practice (O'Farrell & Fitzmaurice, 2013). His breakthrough sounds like attainment of threshold concept as defined by Meyer and Land (2003), one that is "transformative, irreversible, bounded, and integrative" (Shopkow & Middendorf, 2019, p. 38).

In this course, we pulled out the poem, so I just started reading it and then this just sort of bang. I saw something that I didn't think anybody had ever seen before, and I'm still not sure anybody else has seen it. And the way that I saw it, but it was like, I had that moment of victory where [I saw this is] how you do this … I was like, wait, he's playing a game here, he's actually narrating my act of reading. And that this poem is about reading this poem … . I couldn't find anybody saying that about that poem … . So, I think that was sort of the moment when I thought, okay, I can do something with this.

Ray goes on to talk about how this realization played into, later, his teaching, and his understanding that learning is about students making meaning, regardless of the content, and how he tries to bring that understanding in his faculty development work. Ray`s lived and told story, from being a novice to mastery in studying poetry and literature, can, as Clandinin & Huber (2002) describes, be a way to fill the world with meaning. There is a sense in which the whole of his teaching philosophy is housed in this story of breakthrough, when he saw something in a poem for himself, something he still believes no one else has seen. He used the word "victory" several times, and this in itself is striking in its drama.

4.2 Being-in-the-World

How the world is narrated internally

Our interview with Henrik brought a fascinating conversation about how he experiences the world as a result of his immersion in his discipline. The bottleneck he brought was how students have difficulty in assessing earth science problems in the field in dynamic systems, for example, how to predict and understand temperature changes in a column of water in the fjord. Henrik explained how many variables can affect the situation, such as the salinity of the water, how sunny or cloudy the day is, the wind, the depth of the water, and so on. In the course, Henrik takes the students out onto the water to take measurements and make calculations. While students may be successful in the classroom with the mathematics involved, once out in the field, they tend to reach for formulas without seeming to have any feel for what to expect. One of the things we talked about is how this bottleneck, for the interviewers, called up experiences of swimming in the ocean or lake and how the water usually seems warmer at the surface. Henrik explained that in the fjord, because of the different salinity of the water at various depths due to fresh water coming from the rivers, this may not always be the case.

Yes, so when we go down into the ocean, that's actually not the ocean. It's coastal waters here. But if we go into the water from the top up to even 300 meters down into the fjord here, there will be a change in temperature and that's what we call the temperature gradients changes temperature in the vertical direction and there is quite a lot of change especially in the first couple of meters. It already starts super complex because we not only have temperature changes but also salt content changes. There's a lot of water from river runoff from rivers near the coast, and that's fresh water. That's very low in salinity and floats on the top. And it's often cold, and then below is salty and warm water, which is a little bit of a paradox also. We would think warm water is lighter and would be on top, but because it's more saline - it's Atlantic water. It's sitting below. And so when we lower an instrument that measures the salinity and temperature into the water column, they will see these changes in profile, and then translate that to another property. It's the density that we calculate, for the fluid and the density alternately determines what those layers – so those different vertical segments of salinity and temperature – how they are stacked. It's quite complex to describe that, but that's where we want to be with the students, that they're able to understand and describe and maybe even evaluate this layering, we call that stability.

When we probed for how he understands the bottleneck, Henrik described how, given his experience, he has a kind of intuition about what should happen. This embodied knowing, gleaned through the senses, is what Merleau-Ponty (1945) argued is the inseparable experience of our sensing bodies and the world. He wrote, "my existence as a subjectivity [=consciousness] is merely one with my existence as a body and with the existence of the world" (p. 475). This experience is what we hear Henrik express in his interview:

> I don't know how to describe that really. It's something like an intuitive feeling for what the water is doing. It's kind of what we have as a mathematical model, but I have that ingrained in my feelings in a way not only to make a calculation necessarily, I can just feel what will happen. And the same for the atmosphere and that's what I use.

This conversation led to a fascinating insight about Henrik's day-to-day experience of the natural world, in which he continuously notices and hypothesizes about the world around him. Henrik's encounters and experiences with the world resonate with how Clandinin and Huber (2002) suggest that "storied life" compositions form our identity in relation to our actions and relationships with the world. In the interview, we tried to understand more clearly the form of the embodied intuition:

Henrik:
> mmm for my part, it's a thought that's just really filling my mind. That thought can be of different intensity or it's not really just a thought but it's more like … . it's probably a connection of thoughts, not just a single thought. It's maybe a stream of thoughts. I would describe that. And that I can stop that sometimes if something shows up that's relevant and interesting then I'll stop that and develop that further.

Michelle:
> So it's sort of just running in the background … it's cold at the top right now …

Henrik:
> Yes. It's probably, you could describe it as some kind of streaming service. It's streaming information in my environment. And then sometimes I listen in and turn up the volume. That's my consciousness. I don't know.

We see this as a manifestation of Heidegger's "being-in-the-world" and Gadamer's notion of how we are continuously engaged in understanding "a world encountered and inhabited in and through language" (Moran, 2002).

In Henrik's debriefing, he commented about what he took away from the interview: "We talked about this inner dialogue or this, yeah, tapping into this inner voice, and you can call it inspiration or whatnot, but I think that was one of the things that really kind of struck me a couple of times afterward is just increasing the awareness about what's going on in my mind".

Henrik followed up his reflection and related it closer to his bottleneck and what it meant for his teaching practice, saying, "I think that is extremely valuable if I kind of cultivate this awareness of what's going on in my head, and also, you know, is that something that we can cultivate in a student's minds." As the debriefing continued, Henrik came up with an approach for how he could support students in developing the awareness and understanding of the studied phenomenon in class and talked about how he could encourage students to pay attention to activities or phenomena in their everyday life that could relate to the elements in the course:

> I mean, if you ask somebody to boil water and then observe, what do you see in relation to what you've done in class? Something like that. So simple, simple experience. It's not necessarily just experiments that they do by themselves, but outside of the university teaching context. I think that could maybe force them to, or put them a little bit more in the direction of seeing those things.

Henrik also talked about how the students can capture their stream of thoughts to understand the phenomenon under investigation better, "writing it down . . . I mean we definitely need to capture this stream of thoughts, need to verbalize it yourself either in writing or in speaking, so talking in the classroom is super valuable I think, either they tell each other or they talk to me."

Part of what we're hoping to do here is suggest that metaphor and analogy is actually the means to unpack the tacit knowledge during the interview process itself. It's a subtle distinction – but what we're trying to offer, first to the expert and then to the wider community, is how that particular discipline operates in an interpretive and narrative frame. In this case, it is the expert's description to us about how information is constantly streaming into his mind about his environment through his senses that is valuable. Often there is a sense of incredulousness for the interviewee, as they describe what their being-in-the-world is like, and the interviewers reflect back how other people's experience is different. We all gain insight from that dialogue.

What came out of this in our debrief in practical terms was Henrik's realization that he could do three things. One was to focus students' attention on one or two aspects at a time in a lab environment so they could begin to better predict what happens in the world. Second, to suggest they observe in everyday life how the physical world operates (e.g.

the experience of spreading jam on toast as a way to understand viscosity). Finally, he began to think about how he could ask them to practice "streaming" their observations through language, either orally or in writing.

4.3 The Red Thread

Writing up research as story

Katherine described a bottleneck focusing on student writing for their Master's theses. She explained that she found it challenging to help them understand how the different pieces of a research project should be aligned, and how the argument needed to be sequenced and built through the writing, which she called keeping the "red thread." When we asked her to describe her own process, Katherine explained how she continuously refers back to her research question when she writes, actually copying and pasting it to the top of each section as she writes, to ensure a kind of cohesion and coherence throughout. Our interview spent time on these two terms, cohesion and coherence, and what exactly they mean, and how they might be translated into Norwegian (Katherine's first language is English, but she works and teaches in Norwegian). The "red thread" is a term used commonly in graduate school in Norway as a concept.

I think it's maybe that they don't necessarily know in a kind of language way how to tie together these different paragraphs or how to kind of the language they need in which to kind of connect together these different parts of the thesis. So I think that's one thing. But I think it's also conceptual as well. But I find it really difficult to actually explain what I mean by that to them, and It's almost like they need to tell a story. In some ways, the research process is a process, but it's also a story with a beginning, middle, and end, and they need to have that ability to tell the story and create this red thread that goes throughout the whole story.

Katherine found that the different parts of the students' work did not have logical reasoning throughout the thesis. As we went deeper into how she herself understood and made the red thread, the interview took an interesting turn. We noticed how she was using storytelling as a metaphor for writing up research.

We began to discuss how she might help the students by explicitly talking about their research as a narrative story, even using tools such as storyboarding to help them develop their writing. Goodson (2010) and Clandinin and Huber (2002) emphasize how people story their own existence. In this case, Katherine consciously tries to make sense of the research process through developing a plot, and coaching her students to do the same:

I think for me I would best describe it as the plot development. So the way in which the story is unfolding with the beginning, so that you have the research question and research aim, and then that needs to be followed all the way through the plot development as you go through the philosophical approach to theoretical approaches or concepts, the type of data collected, the analysis, so that kind of aim or objective that they have usually in terms of the research question needs to be followed through this plot development throughout the Master's thesis.

How Karen uses storytelling as a metaphor for research resonates with Jones (2011), who emphasizes that narratives can enhance and create meaning by transforming knowledge into storytelling:

Katherine:
Yeah, it just helped to actually tell the story to actually make it clear to someone else who hasn't been involved in the process what the process actually was, which I kind of implicitly knew because I'd done it, but I needed to write it in such a way that someone else could understand that process. So I think having these kind of different phases related to different research questions really helped. And now I actually do that every time I'm like, how many phases were and where they're in this data collection process. What were the steps?

Michelle:
Are there other ways you think about it as a story?

Katherine:
I don't know. That's really difficult … maybe it goes back to essay writing at school. We will always talk in school that when you're doing academic writing there needs to be a beginning, a middle, and an end, and that there needs to be this sort of plot development throughout the story. But it's really hard to explain what I mean by plot development in terms of academic writing. I think in some ways it is similar to a fiction story because you kind of have your characters, the participants, you have a place in time in which the research is happening or in which the story is happening, you have your kind of where your context is, so whether the researching is in Norway in a primary school, or that's the same in a fiction story as well. And then you have the things that happen to the participants. So maybe there are similarities in the way that it's a story. You're telling the story of the participants and the things that answer your research question, I don't know. Maybe that's not right.

In this excerpt, we can hear Katherine "working out" this idea of how writing up a research study is like telling a fictional tale. In her description, she echoes Kearney (2002) in his work On Stories, when he wrote, "Every human existence is a life in search of a narrative … our lives are constantly interpreting themselves … in terms of beginnings, middles and ends" (p. 129).

In the debriefing interview, we were curious if Katherine had reflected upon her teaching and made any changes. The storytelling metaphor was something she recalled and said she wanted to explore further, "I think that's something I would like to plan into the session that I have with them is to actually get them to do that as sort of almost like a reflection activity maybe which they share with each other or with one other person, try to kind of use that metaphor of the storytelling in my sort of teaching session with them. But I haven't quite worked at how to do that."

Katherine's reflective thoughts about her teaching and the bottleneck she had experienced seem to have impacted her and her awareness of the learning process, which gave her the spark to change and try new teaching strategies to overcome or possibly sneak through the bottleneck. Not only did it seem that Katherine gained new insights about her teaching and possible ways to encounter the

bottlenecks, but she also became aware of the benefit of the decoding interview related to professional development among her colleagues:

> I would like to see this approach being used as part of an obligatory professional development for university teachers, but also explore the possibility for it to be used in teacher education to better prepare our trainee teachers. I think it has a lot of potential if it can be adapted. I think that so many teachers are so confident in their own knowledge/skills that they forget what it is like to live without them. Therefore, they make almost unconscious assumptions about what their students know and subsequently fail to facilitate learning.

4.4 The Goldilocks Principle: A Metaphor

How much is enough in information literacy?

In the case of Natalie, her bottleneck had to do with how students seek out appropriate sources for research papers as undergraduates. She described how students tend to work quickly, doing basic keyword searches and then taking the hits that appear at the top of the list without critically evaluating whether the return of the search is really what they are looking for. We began to probe her own practice, and she described a much more nuanced process of finding out what the big discussions were in the field, who the major players are, and seeking out alternative perspectives. Previous Decoding work has described related information literacy bottlenecks, for example, Middendorf and Baer (2019) report on a survey of librarians and continues through all of the steps of the Decoding process. While the struggle is very similar to what was addressed in Natalie's interview, this previous work first uncovers mental moves, and then devises pedagogy which in some cases makes use of devices such as analogy (for example, trying to hit a target). What we offer below is related, but what we hope for in our hermeneutic and narrative approach to Decoding is to cast disciplinary knowing through an interpretive and storied lens. In other words, rather than focusing on processes as a series of mental moves (which, of course, is still valuable), we are seeing interpretation and

metaphor as a means of unlocking the door of interpretation for the expert themselves during the interview. To be clear, this is not a critique of the previous cognitive focus, but rather meant to add interpretive dimensionality as a process option.

At the beginning of the interview, Natalie started by telling us about her own experience as a student, revealing a narrative that might have acted as a facilitator for her insight into the bottleneck as well as her own teaching and learning strategies as we went further with the decoding process (Bruner, 1986; Gee, 1985) (as cited in Jones, 2011, p. 111):

> Gosh, I was a terrible student, and I was so annoyed when we had to do the library session. I remember we had to go to the library and get to print our articles out and it was a whole different [time]. What was it like, 2000, I think. And yeah, I was just like, I don't care about this topic. So, I understand where students are coming from when they're reluctant and don't want to do it, and I feel like that's helped me improve my teaching to get around that. So I would love to say I learned how to do that as an undergraduate, but I absolutely did not because I was so resistant, I was an awful student. I sort of learned it in graduate school a little bit, but I think mostly really on the job. Just having someone come up to me and say I need to find information about this, how do I do it? And just trying

to figure it out with them. So probably my first professional library job at a community college, I think that's when I pretty much really figured it out.

One observation that seems worth mentioning here. In the original work, Middendorf and Pace (2004) suggest that, "Faculty generally chose to go into fields where they were successful at that kind of thinking … they may have leaped almost automatically over obstacles that can prove daunting for novices" (p. 5). In the case of these four interviews, we noticed that, in fact, all of the interviewees reported having great difficulty with the bottleneck concepts themselves in the beginning. This then can become a very productive moment in the interview, where we ask for the story of when they first broke through, or made progress in their learning. We find it the case that read narratively these stories often contain an important key.

Well into this particular interview, one thing we began to focus on is the question of how much information is enough – how many sources, how many hits in a search.

Natalie:

It's kind of just iteration I guess just trying out different words and seeing what works, testing things out, which I think students can be hesitant to try. And I think that is what blocks them from really progressing. In that step, they think it needs to be perfect on the first try, but it's really just experimenting and trying different words together and seeing what works best.

Odd Rune:

How do you decide? How do you see what works best for you?

Natalie:

I think it's just seeing a decent amount of relevant results. If there's not tens of thousands coming back and there's not maybe only one, but you're getting, at least like five to ten the amount that you would need for your paper of results that seem relevant to what the students are looking for.

Natalie seemed to have an intuitive feel for some searches yielding either not rich enough results, or alternatively, far too much. For Michelle, this called up the fairytale of Goldilocks and the Three Bears (retold by Brett, 1987), where Goldilocks found the porridge first too hot, then too cold, then just right. Same with the chairs (too hard/too soft/

just right) and the beds. It turns out that many fields use something termed "the goldilocks principle" for instances where a "just right" balance is sought. We began in the interview to refer to this as the Goldilocks moment, when Nicole would know that she had gotten the search terms right, and had a result that was "just right." What is the role that intuition plays in disciplinary knowledge? As experts, we say that with experience, we gain a "feel" for the work, which refers to a feeling in the body as well as a process in the mind. What becomes clear is that learning happens over time. In the post-interview reflection and debrief, Natalie found these ideas particularly useful:

The focus is so much on finding the right/best information; we discussed the importance of iteration and failure, and with that also comes knowing when to ignore results, keywords, or rabbit holes. A novice might waste a lot of time reading everything and feeling overwhelmed (or skipping that and just choosing what superficially seems like it fits) and an expert would have an efficient exertion of energy … information literacy is too complex to be effectively taught in a one-shot, especially so when there is no scaffolding in a class … how do we teach skills versus habits of mind and the bigger picture; and how to identify a Goldilocks situation and what feels "right."

Moreover, Natalie continued talking about the next steps related to her bottleneck, which she became aware of after unpacking her tacit knowledge through the decoding process.

> As far as where I've gone with it, I've really been thinking about that gap we touched on between faculty info lit skills and librarian depth of discipline skills and how to figure out how to navigate that space. We are discussing and revising our library liaison program currently and it's something I'm going to bring into planning and facilitation.

This navigation of space again requires a kind of "feeling one's way" in inter-professional spaces where one is sometimes the expert, and sometimes the novice in a potentially playful dialogue in the hermeneutic sense.

5. Closing Thoughts

The concept of narrative, as it might be hermeneutically applied to a Decoding interview, can be a rich means to help us understand the disciplinary expert's tacit knowledge. In these four interviews, the narrative was used to illuminate the expert's own breakthrough moment of understanding (Ray); to describe the expert's narrative experience of the natural world as a kind of auditory stream (Henrik); to describe what the expert wanted the students to achieve in their writing - a coherent red thread (Katherine); and finally, a fairy tale as a metaphor to help illuminate tacit knowledge (Natalie). We argue that looking at tacit knowledge as a rich and descriptive narrative account provides a deeper understanding of the expert experience, rather than solely focusing on cognitive processes. The expert becomes embodied and intuitive in their discipline. In our interviews, as so often in Decoding interviews, participants reveal their early struggles in their disciplines - they were often not initially the most gifted or even competent students. As Gadamer has reminded us, "insight is something we come to" - insight is the primary goal of hermeneutics, more than practical steps to take. Surfacing this narrative knowledge provides another means by which to communicate to students the "how" of the thing, in the same way that a good fiction or powerful poem can reveal knowledge intuitively understood to be true, as well as helping us to empathize with our students. Kearney (2002)

reminds of the deeply human aspect of storytelling. A narrative is an open-ended invitation to our responsiveness, being author or addressee, "there will always be someone there to say "tell me a story", and someone there to respond. Where this is not so, we would no longer be fully human" (Kearney, 2002, p.157). Our hope is that providing this hermeneutic and narrative lens that the potential of the Decoding interview is enriched in new directions.

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Decoding Decoding:
Concepts as embodied competence

Niall Palfreyman

Abstract

Context: Decoding the Disciplines employs dialogue to improve the quality of university teaching. Problem: Teaching staff wishing to adopt Decoding require practical guidelines for conducting this dialogue. Method: We analyse Decoding dialogue from a cognitive perspective. Results: Under this analysis, expertise exhibits three complementary cognitive skills: operational, structural and narrative. Implications: This requires a dynamical, interactional understanding of concepts, and motivates a training framework for Decoding that aligns with Bloom's taxonomy. This narrative framework assists teachers in mapping their expertise onto classroom instructional activities, and furnishes a dialogue tool for use in teaching, problem solving and research.

1. The problem of learning concepts

Jerome Bruner devoted his entire 60-year professional career to understanding how humans acquire concepts through everyday living. While his early work treated concepts as categories, he became increasingly disillusioned with the fact that category-based accounts neglect the bodily praxis of forming, utilising and adapting concepts. Indeed, Bruner became more and more persuaded that concepts are in fact stories:

> "Children produce and comprehend stories, are comforted and alarmed by them, long before they are capable of handling logical propositions. Indeed, logical propositions are most easily comprehended by the child when they are imbedded within an ongoing story. The parts of a story are functions, rather than themes or elements, and one is tempted to ask whether narratives may not also serve as early interpretants for logical propositions." (Bruner 1990, p.80)

Bruner emphasises here that when we construct meaning out of our experience, categorical structures are subordinate to narrative – the coordinated dynamical relationship between a set of actors from some narrating perspective. Narrative cognition is distinct from structural cognition; it lends to our actions precisely that unmediated, in-the-moment sense of natural flow that we experience while acting skilfully.

I wish in this article to demonstrate the importance of Bruner's view for training higher education teachers in Decoding the Disciplines (henceforth, Decoding). Commencing from some expertise that we wish to teach, Decoding analyses (Pace & Middendorf 2004) this expertise as a precursor to designing effective ways in which we can teach it. However, the practical analytical skills employed by expert Decoding practitioners such as David Pace and Joan Middendorf are frequently too complex, tacit and context-dependent for novice Decoders to adopt them easily. In short, Decoding is itself an expertise that requires Decoding for effective training of novices. Bruner's characterisation of concepts as situated building blocks for skilful action offers a useful window onto this expertise, and underlies the training programme currently used by the BayZiel Decoding Workgroup to train university teachers in effective Decoding dialogue.

2. Narrative concepts

For Bruner, a concept is not a collection of attributes, but an active, physically embodied skill. Consider these three ways of thinking about the concept Chair:

- **Operational:** A flat surface maintained above ground level by four legs.
- **Structural:** Generates an upward reactive force located above ground level.
- **Narrative:** Enables one person to sit above ground level with back support.

The first (operational) emphasises how to recognise a chair from its attributes; the second (structural) emphasises the internal relations that characterise chair-ness; the third (narrative) emphasises the dynamical function of chairs.

This division of concerns applies to any concept. For example, early 16th century European mathematics defined the concept of number operationally as the result of counting objects, and structurally as satisfying certain mathematical relations such as commutativity and associativity of addition and multiplication. It was not until the mid-16th century that Gerolamo Cardano emphasised the narrative function of numbers in commerce, thereby paving the way for extending the concept Number to negative values. The core idea here is that while operations and structures relate to supposedly mind-independent statements about the world, narrative is intimately concerned with the function of events in relation to ourselves. Only when we desire to acquire wealth through commerce, do we become aware of the need to account for our (negative) lack of wealth.

In general, operations are verifiable; structures enable us to generalise classifications to new domains; and narratives evoke anticipation and suggest analogies. All three perspectives characterise conceptual expertise, yet while structures lend themselves readily to linguistic communication, skilful operations are often too transient for novices to notice, and the flexibility of narratives transcends linguistic structure.

Narrativity underlies even the simplest of skilful activities. Imagine, for instance, approaching an unfamiliar person along a long corridor and deciding whether to say "Good morning" or "Hi". Choosing the appropriate greeting classifies your relationship to the person as more or less formal, yet your classification depends on neither operational attributes nor structural relations, but on narrative interaction: Is she dressed more or less formally than I am? Is it possible we have met before? How is she responding to my body language? No intrinsic attribute determines whether she is a Hi- or a Good-morning-person: you classify and organise the narrative of your relationship with her by analogy with your previous experiences of relationship. The meaning of any situation in which we find ourselves is the inherently tentative result of blending its narrative with analogous past narratives. Analogy underlies all cognitive acts, by virtue of presenting narrative anticipations from the past that are relevant now. Its dynamical flexibility is intrinsic to creative expertise – for example enabling (Orr 1986) photocopier service engineers to construct novel solutions to maintenance problems by matching and blending stories of past problems.

Narrative concepts are also perspective-dependent. To construct and utilise new meanings, learners must learn to shift flexibly between perspectives that coordinate events according to functional salience. A perspective is not merely a way of viewing the world. It is a way of experiencing events that interprets them not objectively, but as existentially relevant to our own well-being – thereby aligning our perception of events into a coherent, emotional narrative. Please pause your reading now to perform the following two brief exercises:

Exercise: Take a moment to recall some mildly embarrassing incident from your past – do not continue reading until you have represented this incident in consciousness …

Exercise: While recalling this incident, please turn your internal representation of it upside-down (literally turn the representation "on its head") and notice the change in your kinaesthetic response to the incident …

This was a perspective shift. It affects how we approach situations, how we respond to others. Perspective taking starts in late infancy, and its use in guiding decisions and operations undergoes prolonged development, resulting in measurable physiological changes in the brain (Tamnes et al, 2017). It pervades the entire spectrum of human cognition from drifting outside one's body while cleaning the toilet or performing an autopsy, to associating into a mathematical relationship or the plight of a homeless refugee. Perspective is a central aspect of expert competence that surfaces during Decoding dialogue.

In summary, concepts are intrinsically dynamical, interactive and personal. In each instant of expert living, we blend, instantiate and employ concepts – all three activities being fundamentally dynamical processes that impinge on our own survival and well-being. We accomplish this using three cognitive tools: operational attention to external cues, structural classification of those cues, and narrative adaptation of operations and structures to our personal needs in the moment. It is this conceptual complexity that makes the Decoding of expertise such a tricky enterprise. However, being aware of these three cognitive tools of skilful action can assist us as Decoders in eliciting from experts the critical components of their expertise.

3. The BayZiel framework for teaching Decoding

To teach Decoding effectively and to facilitate the construction of expert knowledge in teaching and research dialogue, we wish to decode Decoding: to analyse how expert Decoders deploy these cognitive tools to learn, practise, develop and repurpose competent knowledge. I present here a teaching framework based on such analysis, and which we of the BayZiel Decoding Workgroup in Munich currently use to introduce university teachers to the skills of effective Decoding dialogue.

Decoding uses a dialogue style that helps groups share and repurpose competent meaning-construction by attending respectfully to each other's ideas and experience, and reflecting deeply on their meaning, practical application and communication. When the aim of this dialogue is to promote teaching, the emphasis is on 'cashing out' ideas in operational teaching techniques. When its aim is to promote research, the emphasis is on entertaining multiple narratives in parallel, and cashing these out in operationally refutable beliefs. The following sequence of Intended Learning Objectives (ILO) underlies the BayZiel training framework, introducing the foundational skills for both forms of dialogue.

3.1 ILO 0: Complementarity

Many teachers approach instruction from the perspective that knowledge consists solely in structural models and procedures, and are convinced that teaching involves nothing beyond describing these structures to students in adequate detail. By contrast, Decoding offers persuasive evidence for the following presupposition:

Complementarity: Competence requires both procedures and narrative!

David Bohm (1996) describes complementarity like this: "You know how to ride a bicycle, but you can't state how. If [your] bicycle is falling, you have to turn it [… to keep it upright. T]here is a formula that shows that the angle to which you turn is related in a certain way to the angle at which you're falling. This is what you'll actually do, but you don't work out the formula."

Riding a bicycle is an existential encounter with the world of your experience: your well-being depends upon continually negotiating balance in a way that is intrinsically non-procedural. Each motion of handlebars, brakes and bodyweight acquires meaning only within the systemic context of cycling. This embodied dynamic of maintaining alignment within the entire body/bicycle/traffic narrative is precisely what constitutes the expertise of riding a bicycle.

We might ask how one could ever learn this exquisitely complex skill if it possesses no reliable structural basis. Immanuel Kant (2009; 1787) pointed out that lived narratives exhibit covariant orderliness whose form persists across situations and contexts, such as the angular momentum conservation formula to which Bohm refers. As another example, cycling successfully between two posts requires us to focus our perspective covariantly not on the posts, but on the space between the posts. It would be a mistake to regard this covariance as a structural procedure, since expert cyclists discard or modify it in certain specific circumstances. However, it is a useful heuristic for experts and vital one for adults learning to ride a bicycle. A central aim of Decoding is to alert experts to such previously unnoticed covariances that can serve as scaffolds for communicating their expertise.

3.2 ILO 1: Bottlenecks

Novice Decoders often approach Decoding from a problem orientation – an attitude of being somehow stuck in their teaching or research. David Pace and Joan Middendorf (2004) introduced the term bottleneck to express the systemic and productive nature of this stuckness. The point is that innovative solutions always stem from situations of structural failure – when my current beliefs, procedures and models somehow do not deliver the results I had hoped. And a typical property of structures is that when they fail, they do so catastrophically, leaving us stranded without alternatives.

Exercise: Study the clock-face shown on the right and consider how you read the time from it. How do you direct your attention? What conclusions do you draw? Which models or decision procedures do you use to draw these conclusions? Important: Is your model appropriate for reading this particular clock?

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It is not surprising if your time-reading procedure failed in this exercise – there is something strange about this clock. Pace and Middendorf's elegant insight was that precisely this structural incompleteness points toward something interesting to discover. By viewing bottlenecks as structural indications that we need to modify our narratives, we open ourselves to innovative dialogue.

Exercise: Write down now a single sentence summarising a bottleneck in your own teaching or research – a recurring situation in which you feel unable to make progress.

3.3 ILO 2: Awareness

A very basic quality of all effective dialogue is awareness: a respectful, non-judgemental attitude of curious attentiveness to the possibilities of our current situation. Decoding dialogue can become very personal, and awareness promotes an atmosphere of mutual respect in which such innovation can thrive. Connirae Andreas (2022, p. 5) offers a simple meditation exercise for accessing awareness in everyday life:

Exercise: Take a moment to experience Awareness. … Right now, you can easily sense in and through your body, so Awareness is present throughout your body. … And if a sound happened on one side of you, you would hear it automatically, without effort. … If a sound happened on the other side, you'd also be aware of it without effort. … And even if your eyes are closed, it's easy to have a sense of the space that's all around. … Awareness is this effortless capacity to notice, which is throughout the body, and all around. … and there isn't really any edge or end to it. And you can experience this all, simultaneously, right now. …

In BayZiel Decoding Workgroup trainings, participants first practise entering and maintaining this state of awareness, then use it to conduct simple dialogues in groups of three, in which they present their own, and attend to others', responses to the following exercise:

© Eigene Abbildung in Anlehnung an Laborde (1990)

Exercise: We all possess cognitive expertise: planning a party or shopping list; redecorating; dog-training; playing cards/saxophone; performing skills that are tricky to teach. Discuss with Awareness in groups of three: "Which simple expertise do I perform skilfully?"

3.4 ILO 3: Learning outcomes

Expertise is competence in pursuit of a specific outcome. At this stage in a Decoding training, participants have gathered two experiences: a bottleneck and a personal expertise. They have experienced both disappointment and satisfaction, and will now learn how the notion of an outcome offers a bridge between the two. They first work with the satisfying expertise:

Exercise: What is the specific outcome of your expertise? That is, how, specifically, and in which context, could an external observer test whether you have performed your expertise successfully?

Participants perform this exercise in dialogue-triads. We use this term to describe the interaction between three distinct training roles: Expert, Guide and Friend. During a typical Decoding dialogue, two interviewing people will fluidly alternate the roles of Guide and Friend between each other, thereby assisting a third, Expert, person to analyse

their own expertise. Alternatively, an Expert may investigate their own knowledge by successively adopting each of these three roles. For teaching purposes, we ask participants to each adopt a fixed role in groups of three. After each round of the exercise, they rotate these roles:

- **Expert:** You are a practitioner (not a teacher!) of your chosen expertise.
- **Guide:** Using awareness, assist the Expert in specifying the outcome of her expertise.
- **Friend:** Using awareness, observe and nurture the Guide-Expert interaction.

To assist the Expert in specifying her outcome, we encourage Guides to use the following mnemonic diagram in which the left hand represents linguistic markers that the Expert may use in describing the outcome, and the right hand represents questions the Guide may use to specify this outcome further. We intentionally exclude general descriptions here; on the contrary, we wish to elicit from the Expert an operational recognition procedure for a very

specific outcome that serves as a placeholder for more general contexts. Our observation of expert Decoders suggests that they avoid hours of fruitless discussion by taking time at the beginning of the Decoding dialogue to specify adequately the outcome and its concrete context.

Having specified the intended outcome of their expertise, participants are now better equipped to do the same with their more disappointing bottleneck. This requires them to learn how to step from failure to feedback – from a negatively formulated bottleneck to a positively formulated outcome. Again, they perform this exercise in rotating-role dialogue triads:

Exercise: What operationally specific learning outcome underlies your teaching or research bottleneck? That is, specifically how, and in which context, could an external observer operationally recognise that you (the Expert) have successfully performed the expertise you are finding difficult to teach, or attained this state you seek to achieve in your research?
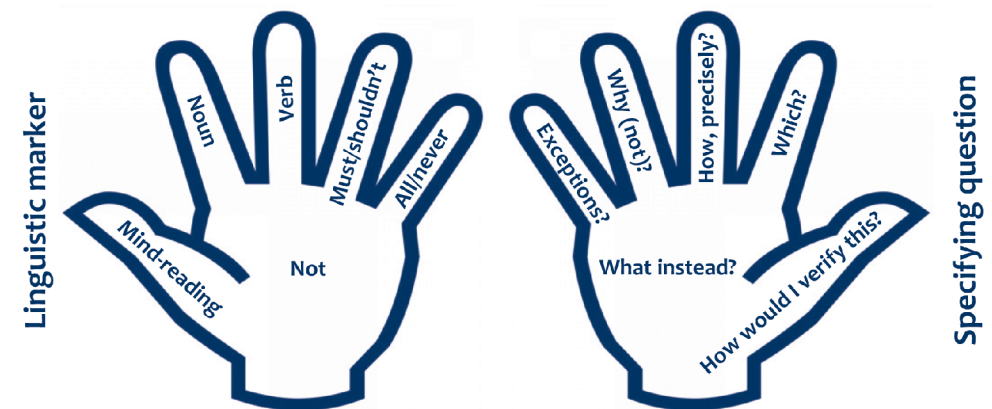
3.5 ILO 4: Cognitive skills

We exhibit expert competence when we construct useful (that is, outcome-relevant) meaning from everyday situations using three cognitive skills: operational attention to available sensory qualities, beliefs about the structure of the world, and narratives of how these structures develop in functional relationship to ourselves.

At this stage in BayZiel trainings, participants possess a specific learning outcome – some operational result that they wish either themselves or their students to achieve. In both cases, anyone achieving this outcome would need to exhibit a certain kind of competence, and the aim of the Decoding dialogue is to mine this competence for its cognitive components. If participants work with a teaching bottleneck, they now seek the cognitive skills that the Expert employs in order to attain the outcome competently in some concrete context. If they work with a research bottleneck, they seek skills that are potentially relevant to attaining the outcome:

Exercise:
- **Expert:** Perform your expertise in your imagination in the specific outcome context.
- **Guide:** With awareness, use the questions below to elicit the Expert's cognitive skills.

- **Friend:** With awareness, observe, nurture and learn from the Guide-Expert dialogue.

A major barrier to sharing and repurposing knowledge is that operations are too transient, and narratives too systemic, for them to be easily expressed in language. In dialogue, experts regularly abbreviate their expertise by:
- Constructing narratives based on unquestioned rules;
- Packaging complex narratives as conveniently static structures;
- Eliding fleeting sensory operations.

Indeed, Joan Middendorf (2024) recommends initially ignoring structure, focussing rather on the expertise's core narrative in some analogous (and hence less structured) context. The following questions aim to deconstruct narratives into covariant heuristics, and to unpack static rules into fluid narrative:

- **Narrative:** Start by taking a broad portrait of the overall story of your expertise. What would be a good analogy for it in some other context? How might it play out in clay, paint, music, dance or kangaroos? What is your perspective (dis-/association, angle of view) on the story? What is ultimately important to you?

- **Structure:** What exactly are the steps and actors of this story? What remains reliably valid across situations or over time? How do you decide what to do next? Take it slowly and tell me more about ! How did you do when you were a novice? How do you compare two quantities? Are you using some procedure, diagram, model or rule?

- **Operation:** Where do you obtain this information? To which sensory cues are you attending right now?

3.6 ILO 5: Implementation

Iterating through these questions uncovers the teachable cognitive components of competence, which in my experience invariably map onto activities that align closely with Bloom's taxonomy (Krathwohl, 2002):

- **Classifying** events based on familiar operations.
- **Describing** situations in terms of familiar relations.
- **Applying** operations to achieve known goals in familiar contexts.
- **Generalising** relations from familiar to unfamiliar contexts.
- **Developing** novel narratives by blending other relevant or analogous narratives.
- **Abstracting** relations that are salient and covariant within and across narratives.

Joe Bisz and Victoria Mondelli (2023) discuss many innovative ways to map these cognitive components onto playful learning activities for teaching. Here, I wish instead to sketch briefly how I make use of Decoding to introduce students to problem-solving and research dialogue.

Unlike Decoding for teaching, where the expert knows how to achieve the learning outcome, Decoding for research and problem-solving starts from a bottleneck in which the expert does not know how to achieve the outcome. Having established an operationally specific outcome, fleshing out the cognitive skills in dialogue has many features in common with George Pólya's (1973) strategy for solving mathematical problems:

- **Classify** the problem situation.
- **Describe** relevant operations and relations of the situation.
- **Apply** these operations and relations to check that they approach a solution.
- **Generalise** relations from familiar to unfamiliar, analogous situations.
- **Develop** hypotheses by blending analogous narratives in novel ways.
- **Abstract** consistent or important relations from hypothesised narratives.

The skills classify-describe-develop-abstract-apply form a flexible problem-solving strategy that I have successfully taught to first-year science undergraduates:

- **Classify** the givens of the problem (typically using a diagram);
- **Describe** general background equations and principles;
- **Develop** a general plan;
- **Abstract** a solution procedure;
- **Apply** the procedure and classify the satisfactoriness of its results.

The skills generalise-develop-abstract extend this strategy into areas of hypothesising and are particularly useful for final-year undergraduates and postgraduates engaged in research and development projects.

4. Discussion

A concept is not a mere feature-based classifier; it is a skilful approach to living a life of constant surprises. Employing a concept involves choosing sensory operations, decision structures and anticipatory narratives – blending these into useful action in a situation that you have never before experienced in precisely this particular way. This cognitive perspective on concept-formation underlies successful Decoding, which explicitly deconstructs the narratives into heuristic rules of thumb, while unpacking structures and operations into the fluid narratives that underlie their expert application.

In his Novum Organum, Francis Bacon exhorted us to reflect on unquestioned idols of thinking such as the contemporary idea that planets moved in perfect circles. When decoding for teaching, idols typically manifest as static structural rules that Decoding dialogue must then unpack into fluid narratives. For example, how, specifically, does a physicist know that an aeroplane's tilt delivers centripetal acceleration? How, specifically, does a mathematician assess that a particular sequence satisfies the Cauchy criterion?

When decoding for research or problem solving, idols often manifest as tacit narratives that Decoding dialogue must then deconstruct into heuristic rules of thumb. For example, when planning a children's party, we follow at our peril the story that all guests eat ice cream; rather, we must consider the expected narrative preferences of our guests. Until 1935, physicists assumed the classical narrative that particles and fields interact only locally; it took a complex dialogue between Albert Einstein and Niels Bohr to deconstruct this story into the notion of non-local quantum entanglement. Einstein's shift of narrative perspective to that of a person falling from a rooftop deconstructed absolute notions of gravitational acceleration into relativistic covariance.

In teaching and in research, Decoding offers tools for uncovering and reflecting on idols, alerting us to their operational, structural and narrative manifestations. It achieves this through respectful, deeply reflective dialogue that honours all three cognitive skills. Narrative thinking in particular, with its emphasis on perspective and blending of analogies, encourages dialogue participants to move beyond purely cause-effect explanations toward recursive explanations that acknowledge the reciprocal causality of complex natural systems.

Training in such systemic modes of explanation becomes increasingly urgent as we tackle the globally complex ecological, social and political challenges currently facing our shared world.

5. Acknowledgements

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The Decoding Clock-Reading Activity

Peter Riegler

WHY IS THIS SO DIFFICULT?
WHY IS THAT SO HARD?
IT'S CLOCKS.
WHY IS THAT SO HARD?
Carl Duzen

Abstract

In workshops introducing Decoding the Disciplines, the clock-reading activity can serve to illustrate succinctly what Decoding is all about. This paper describes the activity and its background. It also reports on a number of recently developed extensions to it and gives the motives that led to these extensions.

Introduction

Decoding the Disciplines rests on the observation that subject matter and skills often are intrinsically difficult. This is not obvious and is an insight that instructors only gain over time. If one asks instructors why their teaching fails, their answers follow a characteristic trajectory throughout their career (Ramsden 2003, Chap. 7 and references therein). Initially, by virtue of the Fundamental Attribution Error, they blame it on attributes of the students. Later, some proceed to blame it on insufficient teaching and, henceforward, invest in teaching methods. A few proceed to blame it on the intrinsic difficulty of subject matter and the curse of expertise.

The latter instructors are presumably readily open to the ideas of Decoding. Conversely, the former groups might struggle to align their models of teaching with Decoding or misconceive it as a mere teaching method. When introducing instructors to Decoding, it is therefore advisable to expect some sort of disbelief or even resistance by instructors toward its ideas. Suitable activities might be helpful for overcoming this. I believe that such activities should help to achieve the following:
- Demonstrate that the concepts and skills underlying a particular expertise are intrinsically difficult.
- Make the particular expertise visible.
- Convince participants of introductory workshops about key ideas of Decoding, such as the implicit nature of expertise.

Note that, in a way, the first point is trivial (but not obvious). If skills or concepts were not intrinsically difficult, everybody should be able to get along with them easily. Instruction would hardly be needed, except maybe for drill and practice. In particular, scientific disciplines should not exist, as humans would spontaneously and effortlessly exchange their preconceived models of the world with scientific ones.

In this paper, I discuss the Decoding clock-reading activity, which by now has some tradition in being used in introductory workshops to Decoding. After discussing its background, I present a number of extensions to the activity as well as related materials. I also add some thoughts deriving from the insights I have gained by extending the activity.

The clock-reading activity

The activity goes back to David Pace who uses it in his introductory workshops on Decoding (Pace 2018). A prompt for this activity is:
> Suppose you meet someone who is familiar with our system of representing clock time but has never seen an analog clock. For instance, this person only has seen and used digital clocks so far. How would you explain to this person how to read the time from an analog clock?

The basic layout of the clock reading activity uses the Think-Pair-Share pedagogical design pattern (Angelo & Cross, 1993). In the Think-phase, workshop participants start to decode clock reading individually, prompted by the task description given above. In the subsequent Pair-phase, participants scrutinize their analysis with a neighbor who simultaneously plays the role of the imaginary person unfamiliar with analog clocks. Finally, in the Share-phase, findings are discussed in the plenary.

The activity comes with the advantage that participants can be assumed to be familiar with reading the clock. This may not be the case for more discipline-specific academic content.

In my experience, this activity usually serves its purpose. Many participants experience the intrinsic difficulties related to clock reading and the implicit nature of their expertise in clock reading. This particularly applies to those whose children recently have learned clock reading or who remember their own struggles with it when they were a child.

Yet, there are exceptions. Some participants point out that clock reading is way too easy compared to concepts and skills in their discipline. Some claim that the expertise needed for clock reading can be readily formulated. This

also applies to the expertise they want their students to acquire. The clock reading activity did not convince them of the often implicit nature of expertise.

The story behind the clock-reading activity

The inspiration for the clock-reading activity came to David Pace via the story of a retired physicist named Carl Duzen, who at age 79 was diagnosed with Alzheimer's disease and dementia (Joffe-Walt 2016).

A widely used instrument in diagnosing dementia and its progress is the clock-drawing test (Sunderland et al. 1993), where the patient is asked to draw a clock showing a certain given time. Carl's physician administered this test regularly and Carl regularly passed it. It then happened that Carl could no longer draw a clock.

Carl subsequently used his remaining analytical skills to decode the process of clock reading in order to again being able to do it:

Carl sat with his tools and his paper and his physicist's desire to decompose the problem before him. And he took apart each element of the clock until it made sense to him, the three layers, the fact that the eye goes to the larger minute hand first and your brain

has to override that to focus on the smaller hour hand, which is actually more important even though it's smaller and not the first thing you see.

And then you're supposed to move to the longer minute hand. But don't be tricked because the second hand is also longer but it's skinnier. And by the end of all this, I just feel like, what the hell, clock? I can't believe this is the system we have for telling time. It's insane. It's a miracle anyone can ever just glance at their wrist and capture information, something Carl works very hard at. (Joffe-Walt 2016, timestamp 48:07-49:10).

Carl summarized the process of clock reading, which he had decoded, by the term "superposition of three types":

1. (Hours) The hours are represented by the shortest hand. They are represented from 1 through 12, even though there are 24 hours in a day.

2. (Minutes) The minutes are represented by one of the longer hands. But a 1 represents not a 1 anymore, but 5 minutes. A 2 represents 10 minutes and so forth up to 60 minutes.

3. (Seconds) The seconds are represented by the skinnier of the longer hands, again ranging from 1 to 60.

Fig. 1: Clock showing illegal combination of hour and minute hands. The clock indicates that it is 7 min after the full hour, which implies that the hour hand should have barely passed the full hour. Instead, the hour hand indicates that it is almost 9 o'clock. When rotated counterclockwise by 90 degrees the combination of hands would become legal. © penubag

Extension of the activity

In my introductory workshops on Decoding, I had used the clock reading activity for some time. Then I adorned my corresponding slide with the picture shown in Fig. 1 (Penubag 2008) without really paying attention to it. After having used this slide for a while, one workshop participant pointed out that the combination of the hands as shown on my slide is impossible. Only then it occurred to me that for whatever reason, the picture had been rotated clockwise by 90 degrees. Unrotated, the clock would read 5:52. But rotated, hour and minute hands are contradicting each other. While the latter indicates a time shortly after the full hour, the former represents a time shortly before the full hour.

As this workshop participant has made me aware, at least some of us do not read hour and minute hands independently, as the analysis of Carl suggests. Rather, we read them in combination. Not only the minute hand but also the hour hand is moving during the course of an hour. For instance, when the minute hand is at 30 minutes, the hour hand needs to be exactly half way between two adjacent hour markers. Mathematically speaking, if the angle $\dot{\omega}$ of the hour hand and the angle μ of the minute hand do not satisfy

$$\frac{\mu}{12} = \dot{\omega} \bmod 30° \quad (1)$$

the combination of hands does not indicate a valid time of day. It seems that this knowledge is implicit to many people and that some people use it for clock reading.

Kaufman et al. (1949) coined the phrase "subitizing" for the human ability to judge the cardinality of a small number of items rapidly, accurately, and confidently (rather than counting them). Presumably humans also are able to subitize clock readings, i.e., they rapidly, accurately, and confidently perceive clock time (rather than locating the individual hands).

The workshop episode also told me that clock reading is far more complex than I had assumed so far. It is fair to assume that many workshop participants make use of the relation between the positions of hour and minute hands described by Eq. (1). However, up to that point, only one person verbalized it explicitly.

This episode also prompted me to modify the clock-reading activity slightly. Now, after participants have discussed clock-reading strategies in the plenary (which always turn out to be similar to Carl's), I sum up the discussion using his algorithmic description. Then, I point to the clock depicted in Fig. 1 and ask participants to read the time of the day using Carl's superposition of three types.

This small extension provides multiple possible gains:

· It provides participants with the opportunity to practice the skill of clock reading - cf. step 4 of the Decoding cycle (Middendorf & Pace 2004).

· It provides participants with the opportunity to test their models, possibly inducing a cognitive conflict, which helps to overcome previous beliefs.

· This helps participants to become aware that their seemingly trivial expertise of clock reading is far more complex than assumed, even after they had analyzed it.

· This in turn can be used to make the point that mere self-analysis might not be sufficient for teaching. As the physicist Arnold Arons famously put it (Arons 1974, p. 157): "Nothing is more ineffectually arrogant than the widely found teacher attitude that 'all you have to do is say it my way, and no one within hearing can fail to understand it.' "

Having used this modification of the clock-reading activity for some time, I have the impression that it makes the activity more convincing and insightful. Since usually only very few participants are aware of the human ability to subitize clock time and the relation between hour and minute hands, the extended activity helps to convince people
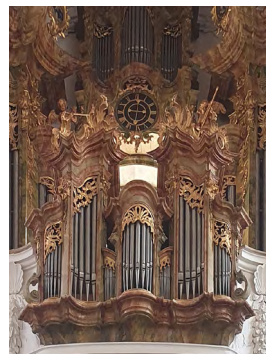
Fig. 2: Left: Pipe organ with integrated clock from 1754 at Irsee Abbey, Germany. Right: Close-up view of the clock. © Peter Riegler

Fig. 3: Historical clock from 1628 inside Lübeck Cathedral, Germany. © Peter Riegler

Fig. 4: Yet another pair of hands, 20th century. © Peter Riegler

of the often implicit nature of expertise. At least in my workshops, the skepticism toward that insight described above seems to have disappeared.

Further extension

In a way, the extension of the activity using Fig. 1 is contrived. It depends on the fact that there are no numbered time markers. Hence, the picture does not give any hints that the clock is rotated (other than the combination of hands). Most real clocks do not satisfy this precondition - even those that do not have numbered hour markers. In contrast, for instance, it is easy to detect whether my wristwatch is rotated by any of at least five indicators even though it does not have numbered hour markers: the location of the watchband indicates the line between the hours 6 and 12. One hour marker is considerably broader than the others, indicating 12, i.e. the full hour. The signature of the manufacturer also indicates the top and, hence, where the full hour is located. Finally, both the date window and the crown point toward 3 o'clock. Of course, making use of any of these indicators is based on acquired knowledge of conventions and, hence, can be considered as expertise.

I extended the clock-reading activity again once I saw the clock illustrated in Fig. 2. Now after having discussed Fig. 1, I bring in a picture of a real clock like that in Fig. 2 as an additional example. I have the impression that adding this touch of reality makes the extension of the clock-reading activity even more fun for participants. As this clock is real as opposed to simply invented by drawing, it helps me to point out that clock reading is a socially constructed expertise depending on conventions.

Meanwhile, I have developed the habit of photographing unconventional clocks whenever I see them. Figs. 3 and 4 show two of my favorites. I invite you to read the time on the depicted clocks before carrying on, using all the expertise of clock reading unpacked so far.

If you are interested in using the photographs shown in this paper, you can download them from Wikicommons (Riegler, 2024).

Remark: The analog and the digital

When explaining the difference between analog and digital, one often uses clocks as a prototypical example. Clocks indicating time via discrete strings of digits are said to be digital devices, while analog devices use the continuous movement of hands. The latter means, for instance, that the minute hand can point to any angle (mathematically, a continuous set). Contrast that with the two digits indicating the minutes on a digital clock and the values they can take on (mathematically, a discrete and even finite set).

Paradoxically, for quite a few "analog clocks" minute and second hands rather behave like digital devices. In fact, the minute hand of many clocks moves only once per minute,

Fig. 5: If analog clocks behaved like digital clocks, the hour hand would only move once during the hour, exactly on the hour. This is exemplified on the bottom row: hour and minute hands move discretely, i.e. the hour hand can only have one of 12 positions, the minute hand one of 60 positions. To contrast, on the top row hour and minute hands move continuously. Note that the minute hand does not exactly point toward a time marker for all times considered. Columns: Respective clocks shortly before 10 o'clock (left), shortly after 10 o'clock (middle), and 45 minutes later, as indicated by the string of digits conventionally used in digital clocks. © Peter Riegler

i.e. it only points to one of 60 possible angles. Also, most second hands jump one time mark ahead every second. Of course, one could argue that these hands still move continuously while jumping.

The issue I want to point out is a different one. I want to argue that the continuous movement of the hour hand is an important constituent of our implicit expertise in clock reading. Imagine a clock where the hour hand also behaves like a digital device, i.e. being located at only one of 12 possible angles. Such a clock is illustrated in Fig. 5. The clock depicted on the lower left would indicate that it is almost 10 o'clock while for a truly analog clock the position of the hands would indicate a time shortly before 9 o'clock.

Such a clock is unusual for us, but tells the time with the same precision as our analog and digital clocks. (In fact, it is a truly digital clock, simply using hands instead of digits. The hands are precisely located at the markers, which correspond to the digits of a digital clock.) What makes it

unusual is the noncontinuous location of the hour hand. This results in combinations of minute and hour hands, which we would consider illegal on our contemporary clocks as the combination depicted on the lower right in Fig. 5.

Final Notes

I would like to finish with some personal reflections and words of gratitude. Some time ago, I was diagnosed with depression likely due to burnout, the latter being a workplace condition (Moss 2019) rather than a disease according to the World Health Organization (2019). Depression can come with symptoms, which are similar to those of dementia.

At that time, my wife who never wears a watch, asked me what time it was. I was staring at my watch, realizing that what I saw did not have any meaning for me. I had (temporarily) lost my capability of clock reading. However, I had

not lost my memories of Carl's story and the fact that I had asked dozens of people how to read a clock. So, with noticeable effort I used Carl's procedure, meticulously reading off the positions of the hands and converting them into clock time.

Ever since I came into contact with Decoding the Disciplines, I gained from it: solutions to teaching challenges, insights, friends, and much more. Usually Decoding was about the bottlenecks of others. Now Decoding helped me to overcome a personal bottleneck. I am deeply grateful to everyone who has supported me on my Decoding journey.

Finally, I need to reveal the times when I took the photographs depicted in Figs. 2-4. Fig. 2 was taken at 6:15. In this clock, the hour hand is longer than the minute hand. That is to say, the more minute of the two literally is the minute hand. Fig. 3 was taken at 12:58. Here as usual, the longer of the two hands indicates the minutes. Its longer end points to the outer circle of the dial, showing the minute

represented by Arab digits running from 1 to 60. Its sun-pointed shorter end (again, actually more minute than the hour hand) indicates the minute in the way we are familiar with today. The hour hand carries a pointing hand at its end and behaves, as we are accustomed to today. Fig. 4 incidentally was taken at 8:27. While the two hands are positioned as if it were 6:45, the photograph is actually not showing a clock face but the smokebox door on the front side of a steam locomotive.

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