



Professional Decision Making: Reframing Teachers' Work Using Epistemic Frame Theory

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Abstract. For many outside the profession, teaching looks simple and straightforward; however, for those working in classrooms, it can be a challenging task. In this paper we argue that teaching is a complex profession that requires both novice and expert educators alike to engage students in sets of activities aimed at transforming their understanding of a subject area. This work requires complex planning, enacting instruction, and reflecting on outcomes. In a moment to moment basis teachers must make decisions and iterate on previously made decisions in order to provide effective opportunities for students to engage with the materials, skills or content to be learned.

In this paper, we aim to highlight the complexity of the decision-making process and, in doing so we make the argument that individual teachers' decision-making draws upon a personal epistemic frame which includes factors such as skills, knowledge, identity, values, and epistemology. We provide examples of previous research efforts that have attempted to explore such factors and the limitations, both philosophical and methodological shortcomings of such attempts. Finally, we propose that the use of Quantitative Ethnography and Epistemic Frame Theory provides new opportunities to interrogate teachers' practices and decision-making as a way to better understand the complexity of teacher work.

Keywords: Teachers · Decision-making · Epistemic frame theory

1 Introduction

For decades the work of defining what constitutes a profession has been a topic of active study [1–3]. In this paper, we follow the lead of Evetts [4] in approaching “professions as a generic group of occupations based on knowledge both technical and tacit...Professions are essentially the knowledge-based category of occupations which usually follow a period of tertiary education and vocational training and experience” (p. 397). In line with these ideas of professions, Shaffer [5] suggests that:

professionals work on problems that involve uncertainty and that therefore require discretion and judgement. For a professional ... no two problems are quite ever the same,

and no set of routines tell a true professional what to do next. This is as much true for a master carpenter as a transplant surgeon. (p. 95)

Further, people working in these socially constructed professions, and the accrediting bodies that grant the licensure usually associated with such vocations, almost always require professional members to engage in continuing education. Highlighting the importance of always improving, adapting, and developing a deeper understanding of the profession.

While each profession requires their own unique set of practices, engaging in professional activity often requires a series of decisions to be made in the moment of the work being performed that require the professional to quickly synthesize into action prior knowledge, an understanding of their skills and practices, values, beliefs and ethical standards and the goals of the work being completed. These actions are often in service of accomplishing some short term and long-term goals and often require reflection in and on action [6] if the professional is to improve their understanding of the field and improve their own actions.

Given this vision of professional work, we argue that teaching is a complex profession that requires educators, novice and expert alike, to engage students in sets of activities aimed at transforming their understanding of a subject area. The process of teaching requires planning, enacting instruction, and reflecting on outcomes. In a moment to moment basis teachers must make decisions and iterate on previously made decisions in order to provide effective opportunities for students to engage with the materials or content to be learned.

In the sections that follow, we aim to highlight the complexity of the decision-making process. In doing so we argue that individual teachers' decision-making draws upon a personal epistemic frame which includes factors such as knowledge; skills, practices and epistemology; and orientations, and epistemology. We provide examples of previous research efforts that have attempted to explore such factors and the shortcomings of such attempts. Finally, we propose that the use of Quantitative Ethnography and Epistemic Frame Theory provides new opportunities to interrogate teachers' practices and decision-making as never before.

2 Attempts to Better Understand Teacher Decision-Making

Teaching is often cast as something that has been passively observed by students for a long time and therefore appears to many to be relatively straightforward and simple. The stereotypical impression created is that there is a set of routines that help to ensure the delivery of information in class, but that some teachers bring to bear an idiosyncratic edge to their practice that makes them stand out as being good teachers. In essence, then, to the casual observer, teaching looks easy. ([7] p. 119)

In contrast to this often-held perception of teaching, Shulman [8] among many others described the work of educators as an "outrageously complex activity" (p. 11). Researchers have argued that a large part of this complexity results from the myriad of pedagogical decisions that educators need to make (for example, see: [9, 10]). Almost 50 years ago, Shavelson [11] highlighted the centrality of decision-making in the work of educators characterizing it as "the basic teaching skill" [emphasis in original] (p. iii), a

perspective supported by Madeline Hunter [12] who suggested that “teaching is decision making” (p. 62), and Fenstermacher [13, 14] argued that the role of teacher education is not to program or train teachers to behave in predetermined ways, but to educate them to reason soundly about their teaching.

While such accounts highlight the importance of pedagogical decision-making, better understanding how such choices are made is important in capturing the sophisticated nature of teaching. Recent attempts to better understand what underpins effective teacher decision-making continue to be reported in the research literature (for example, see: [15–17]) suggesting we are yet to develop a way of effectively interrogating what, why and how teachers make their decisions. Loughran [18] makes the point that many past investigations of teachers’ decision-making and their practices examine *what* and *how* teachers do what they do. He argues, however, that to better understand the decisions teachers make, understanding *why* teachers make particular decisions “is crucially important” ([18], p. 526). In support of this argument, the following sections capture just some of the past investigations that have considered three different factors that contribute to the *what* and *how* of pedagogical decision-making: knowledge; skills, practices and epistemologies; and orientations.

2.1 Teacher Knowledge

Developing a clearer sense of what teachers know and how they use their knowledge to enhance their decision-making has been an area of interest for education researchers, teacher educators, and educational policymakers [19]. A great deal of focused research in the 1980s and 1990s considered teachers’ knowledge from differing epistemological viewpoints. For example, Tom and Valli [20] developed a philosophically grounded review of professional knowledge, Grimmit and MacKinnon [21] analyzed craft conceptions of teaching and Shulman’s [8, 22–26] program of research sought to “show what forms and types of knowledge are required to teach competently” ([27], p. 6). It is this extensive program of research that has led Valli and Tom [28] to suggest that Shulman “probably has gone as far as anyone in his thinking about the forms of teacher knowledge” (p. 6).

Shulman’s work resulted in a widely cited ‘knowledge base for teaching’ which comprised seven categories of knowledge: content knowledge; pedagogical knowledge; curriculum knowledge; knowledge of learners; knowledge of contexts; knowledge of educational ends, purposes, and values; and pedagogical content knowledge. While Shulman’s work represented a great leap forward understanding the multi-faceted nature of teacher knowledge, it has largely been discussed in a homogenous way. That is, all educators, irrespective of contextual differences, should aspire to develop all of these forms of knowledge to help them make better pedagogical decisions. Despite the extensive use of these categories in subsequent research efforts, the connections between teacher knowledge and the ways in which particular forms of knowledge influence certain types of decisions remain largely disconnected.

2.2 Skills, Practices and Epistemology

In addition to efforts to better understand the influence of knowledge on decision-making, past research has focused on the skills and practices of educators in different contexts including effective literacy teachers [29], mathematics teachers [30], and science teachers [31]. Interestingly, the findings from such studies differ, sometimes subtly and in other cases markedly, from what is considered effective in particular domains. Bartholomew, Osborne, and Ratcliffe [31] worked with 11 science teachers from the UK and found that teachers' conception and use of learning goals had an impact on a teacher's ability to teach effectively. In contrast, McDonough and Clarke [30] found that "attention given by [Australian] teachers to individual children" (p. 3-267) was particularly important practices for Mathematics teachers of 5 to 7-year-old children, whereas Wray et al. [29] found that effective literacy teachers in England contextualized their teaching which appeared to make it possible for pupils to make active connections between different forms of literacy knowledge.

While these studies contribute to a body of work researching teachers' classroom skills and practices, it quickly becomes clear that what is considered 'effective' is highly contextually dependent and the underlying epistemology of teachers is likely to play a substantial role in the determination of what skills and practices underpin effective teaching. For example, it is reasonable for Chemistry teachers to be interested in the development of skills that allow students to cognitively break down or atomize materials to their constituent components. A Biology teacher, on the other hand, is more likely to be interested in having their students think in 'big picture' ideas or in systems. It is clear that these kinds of epistemological underpinnings have some connection to knowledge and the kinds of skills and practices that need to be concurrently developed but as yet, we do not have a comprehensive understanding of the connections between these different elements and the ways in which they influence educators' pedagogical decisions. A challenge confronting researchers is how to quantify and represent the connections between teachers' epistemology and their skills and practices.

2.3 Orientations

In addition to knowledge and skills, practices and epistemologies, teachers' attitudes, especially the beliefs that form such attitudes [32], have received much attention. Empirical investigations also illustrate the impact of the role of beliefs in a variety of teacher decisions [33] including the integration of technology [34], the way students learn languages [35] or develop music identity and skills [36]. Others have discussed similar findings in relation to teacher attitudes, values, preferences and tastes. Shoenfeld [37] acknowledges that each of these terms provides opportunities to gain insights into what teachers do; however, instead of treating these as separate categories, he employs the term 'orientations' as a broad category that incorporates these often-overlapping constructs.

While there has been some synthesis of the influence of particularly closely aligned components that shape teachers' decision-making (for example Shoenfeld's categorization of orientations), researchers have, more often than not, treated these as separate, siloed influences on teacher decision-making. We argue that instead of looking at each of these in isolation, revealing the *what* and *how* of teacher decision-making, we can

better explore and explain the complex reasons *why* teachers make the decisions they do by considering the connections between the range of factors that underpin their pedagogical practices. To effectively understand teachers' decision-making, we do not need to quantify individual factors but instead to consider the relationships between teachers' epistemology, skills, values, and knowledge – a collection of factors called an *epistemic frame* [5].

3 Epistemic Frame Theory: A Window into Teachers' Decision-Making

To dive deeper into how people learn to think, Shaffer [5] proposed *epistemic frame theory* to describe the pattern of associations among skills, knowledge, and other cognitive elements that characterize groups of people who share similar ways of framing, investigating, and solving complex problems.

The concept of a frame is from Erving Goffman [38] who argued that people use a set of organizational principles, or what he calls *frames*, that structure our perception of what is happening and what is important during an activity. During our everyday experiences, people filter information, discard certain details, and build frames that organize an understanding of the current situation for future actions. Importantly, these organizational structures exist and are shaped by the person, activity, context, and interactions with other people. When people go to a coffee shop to work, their actions are shaped by individual choices and beliefs about the situation (we enjoy coffee, being around people that are also working is motivating, we want to support local businesses). But this view of the coffee shop is also shaped by the context (there are shared tables and solitary tables, other people are working or not working, the wireless internet connection is reliable). Given this premise, frames are the collections of both individual and social norms, values, and actions that shape how we see the world.

Shaffer [39, 40] builds on Goffman's frame analysis by considering what it means for a person to know something. In this way, *epistemic frames* consider how certain groups of people think. Epistemic frame theory suggests that in specific communities there is a systematic pattern of relationships among skills, knowledge, identity, values, and epistemology that form the epistemic frame for that community. For example, in education, a teacher may learn to develop questions that require students to respond with more than a 'yes' or 'no' answer, therefore revealing not just whether they understand a particular piece of content but also how they came to know this information. Such a response provides the teacher with insights into the emerging metacognitive processes of that individual student. With these new insights, the teacher is able to reconsider how she might shape future learning activities for that student. In this example, the teacher is learning to make decisions by weighing competing factors and eventually justifying why they made those choices.

While frames are core to this theory, another critical component is that these frames are about epistemology. Epistemic frame theory is grounded in Perkins' [41] description of epistemology which he described as "knowledge and know-how concerning justification and explanation" (p. 85). Shaffer [5] extends this notion claiming that epistemology "is a particular way of thinking about or justifying actions, of structuring valid claims.

Epistemology tells you the rules you are supposed to use in deciding whether something is true". (p. 32)

Importantly, Shaffer [5] notes that "epistemology in this sense is domain-specific: Mathematicians make different kinds of arguments than historians do" (p. 32). This challenges the 'straightforward and simple' perception of teaching by suggesting that to be an effective teacher, you have to not only develop particular, discipline-based ways of justifying your actions and structuring valid claims about content knowledge, but you also have to understand the "intellectual and historical justification for the traditional disciplines" ([5], p. 33). To make a decision as a teacher, you need to think in a particular way which is, in part, shaped by the domain or discipline you are teaching as this domain has a particular set of rules that structure valid claims, justify actions and determine whether something is true.

Epistemic frame theory, however, does not solely consider teachers' decisions in light of the underpinning epistemology that teachers bring to their practices. As highlighted earlier, to effectively understand teachers' decision-making we need to consider the relationships between how teachers' skills, knowledge, and values affect their approach to seeing and solving problems.

4 The Multifaceted Nature of Teaching

One way to approach understanding the core practices of teachers is to identify important elements of that culture. Quantitative Ethnography is a way of talking about culture as the ethnographic component of this methodology provides insights into the cultural practices of teaching. Gee [42] describes learning a practice as learning the *Discourse* of that practice, meaning a way of "talking, listening, writing, reading, acting, interacting, believing, valuing, and feeling (and using various objects, symbols, images, tools, and technologies)" (p. 719). As highlighted earlier in this paper, teachers need to develop multiple forms of knowledge to be effective classroom professionals; however, they also need to develop a range of other practices including highly developed interpersonal skills [43] including talking with students in ways that draw upon language that they can comprehend [44], representing content in multiple ways to allow all students access to information while also being inclusive of student opinions but also directing and shaping the classroom culture [45] to name but a few. In the end, learning this Discourse requires developing and transforming their identity as a teacher.

This transformation largely occurs with the help of others. In this way, learning a Discourse involves enculturation into a *community of practice* [46], which is a group of people who see and solve problems in a similar way. Upon entering the workforce as a graduate teacher or newcomer [47], teachers are expected to develop an increasingly sophisticated and diverse range of pedagogical skills through which they can make increasingly complex classroom decisions. This development is often guided by old-timers from within the community [47] and illustrates the power of identity and trajectory as forces that shape teachers' transformations [48].

Importantly, epistemic frame theory shifts the focus of learning from accumulating isolated pieces of cultural knowledge to focusing on the structure of connections among them. Similarly, diSessa [49] argues that deep understanding results from linking basic

disciplinary concepts within a theoretical framework. For example, diSessa describes how novices have “knowledge-in-pieces”, whereas experts have a deep and systematic understanding of how these disciplinary concepts are connected. Other learning sciences theorists have similarly conceptualized learning as the developing patterns of connections between concepts [50, 51]. As we hypothesize that the linkages between components of teachers’ epistemic frames are critical, we choose a methodology that focuses on explicitly modelling such connections.

Taken together, describing the epistemic frame of teachers requires specifying the set of Discourse codes that are core to teachers’ way of seeing and problem-solving, but also the relationships between how these codes are connected. The volume of data required to model the relationships between the codes representing components of teachers’ epistemic frames is understandably large. This becomes particularly true when using visualizations to explore differences between contexts in which teachers work [52]. Therefore, epistemic frame theory can be a valuable way to understand how teachers learn certain ways of connecting ideas, making decisions, and justifying actions in their teacher training and practice. Consequently, we need a way to view the range of components that shape teacher professional practice.

4.1 The Results of a Pilot Study: Opportunities Offered Through ENA and Quantitative Ethnography

Phillips, et al. [52] conducted a pilot study that considered whether it would be possible to use a quantitative ethnographic approach to reveal relationships between different forms of teacher knowledge and various forms of teacher decision making. This pilot study analyzed the lesson plans of six teachers who worked in a specialist Mathematics, Science and Technology secondary school in Melbourne, Australia. A pair of teachers from each of the specialist areas within the school volunteered to participate in the study, and each of these pairs together taught a co-educational class of approximately 50 Year 10 students (around 16-years old). These six participants provided the initial data for this investigation in the form of 45 lesson plans for the first unit of work that was to be taught in the academic year.

This data was coded using the NVivo12 software program for evidence of teacher knowledge (based on Shulman’s knowledge base for teaching described in Sect. 2.1 of this paper) and Shulman’s [8] teacher decision making framework known as pedagogical reasoning and action (PR&A). Following the coding of lesson plans in NVivo, we examined the relationship between forms of knowledge and processes of PR&A through Epistemic Network Analysis (ENA) [53]. The results from ENA analysis of teacher lesson plans revealed substantially different connections between knowledge forms and components of the PR&A framework for teachers with differing epistemological backgrounds.

For example, the mathematics teachers involved in this study appear to show greater planned co-occurrences of reflecting, reflection evaluation, and transformation with content knowledge than the science teachers whose lesson plans do not show any evidence of such co-occurrences; however, the nature of the domain is a feature in science teacher lesson plans where it regularly co-occurs with four other knowledge forms and stages

of PR&A yet is notably absent from the mathematics teachers lesson plans. Most strikingly, the lesson plans from the IT teachers showed comparatively few co-occurrences between knowledge forms and stages of PR&A, yet had the most codes represented of all three domains.

These co-occurrences were analysed using ENA – a tool which allows for quantitative ethnographic explorations. One of the main aims of Quantitative Ethnography is to use “Big Data to help us transform it into Big Understanding” ([40] p. 398) and an inherent part of this process is taking etic representations, in this investigation the data represented in Figs. 1, 2 and 3, and working with participants in a study to generate emic understandings.

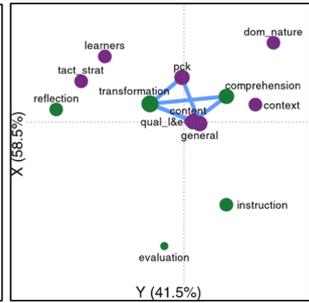
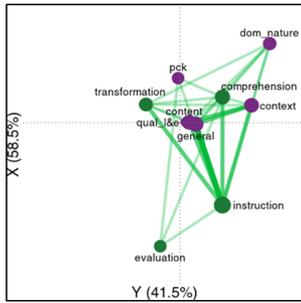
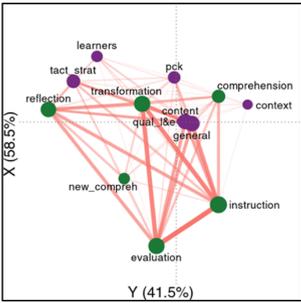


Fig. 1. Co-occurrences between knowledge forms and PR&A in mathematics lesson plans.

Fig. 2. Co-occurrences between knowledge forms and PR&A in science lesson plans.

Fig. 3. Co-occurrences between knowledge forms and PR&A in IT lesson plans.

Phillips et al. (in preparation) conducted interviews with each of the teaching teams who indicated that many of the ENA representations reflected their tacit understandings of their practices. Examining the representation of their lesson plans, one of the science teachers commented that “content is kind of in a way the driving force, as a central part of what we have to do, so it makes sense that content would be such a central part of what’s in there”. The discussion between the mathematics teachers also confirmed that some of the ENA representation reflected conceptions of their shared practice:

Mathematics teacher 1: The other thing with maths is because they all come in from different schools. At least the first half of the year is really trying to get everyone at the same level, so bringing up the students who might have lower skills up to that so there, I guess, the less connection between the PCK and the learners can be explained that we want to get everyone to the same point so that they’re then ready to move into VCE which I guess makes sense.

Mathematics teacher 2: Which is probably why the faint lines are to the learners because we don’t know enough about them, we haven’t taught them before, particularly Year 10 it’s our first year.

In addition to confirming elements of the ENA representation, this brief discussion between the two mathematics teachers reveals deep emic perspectives of the context for

which the lesson plans have been designed. As previously discussed, the school in which these teachers worked was a specialist mathematics, science and technology school only enrolling students in their final three years of secondary schooling. The comments from the two mathematics teachers reveal that, despite recognizing the importance of PCK, the need to ensure that all students in their first year at the school (Year 10) have comparable content knowledge overrides the desire for the development of particular approaches for particular individuals at particular points in time for particular purposes (that is, the essence of PCK).

The two IT teachers expressed some surprise when initially examining the ENA representation of their lesson plans. Both teachers commented on the lack of connections between knowledge forms and decision-making processes. When unpacking this representation, the two IT teachers revealed an important limitation in conclusions drawn simply from representations of lesson planning documents. The intense focus on mathematics and science in this particular school is reflected in large numbers of teachers of these two subjects. As a result, mathematics and science teachers in this particular school are used to working with a variety of different teaching partners. Consequentially, the amount of detail in the lesson plans for these teachers is high as teachers are often working with people who hold varied beliefs and attitudes about teaching. In contrast, there are only two IT teachers in the school who teach all of their classes together. Their desks are also beside one another in the staff room, and they spend a great deal of time outside of class reflecting and discussing previous classes. As a result, the amount of detail recorded in their lesson plans is significantly lower than for the mathematics or science teachers as much of the IT teachers shared practices and understandings are communicated verbally. The importance of presenting etic ENA representations to the teachers to develop deeper emic understandings is, therefore, a vital part of this quantitative ethnographic exploration of teachers' knowledge and decision-making.

Despite the small sample size of teachers involved in this project ($n = 6$), this study provides what we believe is the first Quantitative Ethnographic [40] account of the co-occurrence of teachers' knowledge forms and PR&A stages. The ENA representations provided in this paper allow researchers to develop new insights into teacher knowledge and decision making that challenge the homogenous nature of these two frameworks that was intimated in many of Shulman's publications. The language that Shulman [8] used to describe his knowledge base for teaching was mostly singular: "a codified or codifiable aggregation of knowledge" (p. 4), "*the* knowledge base" (p. 4), "*an* elaborate knowledge base for teaching" [8][emphases added]. While Shulman [8] discussed contextual knowledge, the subsequent applications of his knowledge base for teaching have often been devoid of contextual considerations implying that all effective teachers drew upon all six forms of knowledge irrespective of factors such as discipline taught and age of students.

Shulman's [8] description of stages of PR&A, while helpful with identifying different components of teachers' decision-making processes, did not provide much guidance for researchers or practitioners as these stages "are not meant to represent a set of fixed stages, phases, or steps. Many of the processes can occur in a different order. Some may not occur at all during some acts of teaching. Some may be truncated, others elaborated" (p. 19). The ENA representations presented in this paper provide empirically-based

insights into the co-occurrences of the planned PR&A processes of these teachers. While not suggesting that there is a definitive order for these, nor that the findings from this pilot study are broadly generalisable, it is encouraging to see such representations as the process of coding and representing co-occurrences in this manner promises more in-depth insights than have been previously possible.

While adding to our existing understanding of teachers' professional decision making, this investigation and confirming the utility of Epistemic Network Analysis, this work was limited only to teacher knowledge and did not consider other elements of the teachers' epistemic frames.

The next phase in the progression of this work is to expand this pilot study in three important ways. First, using our literature review and situated understanding of this field we hope to further identify and develop culturally relevant codes that capture the ways teachers approach and enact their decision-making practices. Second, we as researchers can bridge our local understanding of teacher-student interactions with larger scale analyses decision-making patterns. Through the use of tools, such as Epistemic Network Analysis, we can measure and visualize how teachers within and across domains, grade-levels, and other contextual factors may make similar or different choices. Finally, and most importantly, we need researchers to analyze and critique these dual analyses to provide better descriptions and interpretations of how teachers think in these contexts.

In the end, using a quantitative ethnographic approach, we as researchers can use our understanding of local connection-making to develop and analyze broader patterns across teachers. We call on colleagues in the teacher education field to join with Quantitative Ethnographers to further this endeavor.

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