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We Teach as We See the World: Correspondence Between STEM Faculty Family Roles and Identities, System Narratives, and Self-Reported Teaching Practices

ABSTRACT

Despite extensive reform efforts, many STEM professors adhere to lecture-focused approaches, leading education researchers to question what shapes STEM teaching practices and how best to encourage the adoption of evidence-based alternatives. The interdisciplinary field of narrative research has shown that the stories we tell, and the system narratives that underlie them, offer insights into how we make sense of the world and correspond to a range of behaviors and outcomes. System narratives are stories about the nature and structure of the world. Furthermore, the roles we play in our families and our identities in that setting influence our behavior in a variety of other contexts. Our pilot study explores correlations between STEM faculty's system narratives, roles and identities within their families, and self-reported teaching practices using inductive and deductive coding of interviews with 15 STEM faculty at two primarily undergraduate institutions. Through this work, we contribute to a growing strand of literature arguing that STEM faculty make decisions based on how they view themselves, their students, and the act of teaching, rather than defaulting to teaching as they were taught or adhering to disciplinary norms. By focusing on the personal domain of influences that shape our teaching and inviting faculty to shift the system narratives they draw from, we may find new avenues to engage colleagues in exploring active and student-centered teaching approaches that make sense to them.

KEYWORDS

system narratives, family roles and identities, STEM teaching practice, integrated model of professional development, personal domain

INTRODUCTION

For decades, grant-funded research and programs aimed at undergraduate STEM educators have supported the adoption of active, student-centered teaching strategies to enhance learning outcomes and to foster more equitable achievement (Freeman, Eddy, McDonough, Smith, Okoroafor, Jordt, and Wenderoth 2014; Theobald et al. 2020). Despite the millions of dollars invested, relatively little pedagogical change has occurred (Dancy, Henderson, Apkarian, Johnson, Stains, Raker, and Lau 2024; Stains et al. 2018); instructors continue to use a predominantly didactic approach in STEM instruction. This persistence of the status quo has led educational researchers to investigate why

individual faculty members teach as they do, what factors influence their practice, and in what ways (e.g., Bitting, Arthurs, Chapman, Macdonald, and Manduca 2018; Henderson 2012).

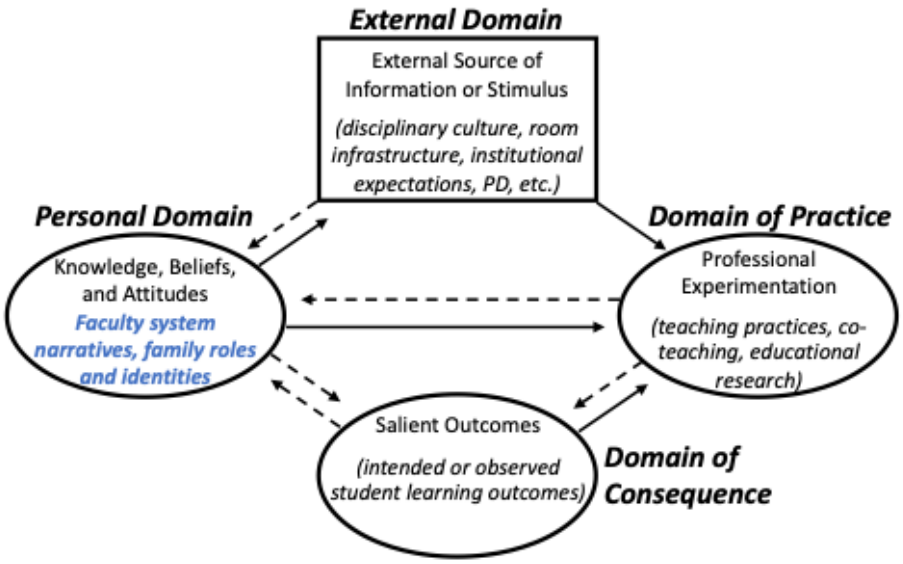
Researchers have proposed a wide range of factors, from classroom infrastructure (Apkarian, Henderson, Stains, Raker, Johnson, and Dancy 2021; Stains et al. 2018) to disciplinary cultural norms (Bouwma-Gearhart, Ivanovitch, Aster, and Bouwma 2018; Stains et al. 2018) to individual faculty beliefs about the nature of teaching and learning (Kane, Sandretto, and Heath 2002; Pajares 1992) that influence STEM faculty teaching practices. However, perhaps due to entrenched assertions of STEM as culturally neutral and value-free (Kayumova and Strom 2023; Shultz, Nissen, Close, and Van Dusen 2022), the influence of faculty beliefs about how the world works and their sense of identity is underexplored. This is despite the fact that scholars have documented that these beliefs influence widely disparate outcomes ranging from political party alignment in voting preferences to personal resilience (Sheafer, Shenhav, and Goldstein 2011; Ramamurthy, Zuo, Armstrong, and Andriessen 2024). This wide distribution of influence suggests that these stories likely impact how individuals behave in many aspects of their lives, including in the classroom.

Below, we review in more detail the many factors posited to influence STEM faculty teaching, as viewed through the lens of the Interconnected Model of Professional Growth (IMPG; Clarke and Hollingsworth 2002). We then introduce findings from the narrative research literature that suggest the importance of extending investigations of the IMPG's personal domain into more deeply held personal and individualized system narratives around how the world works and who we are within it. Subsequently, we describe our pilot interview study of 15 STEM faculty members from two primarily undergraduate institutions. We then discuss our results, which indicate that our teaching is fundamentally and intimately shaped by these stories.

Literature review: What influences STEM teaching practice?

Clarke et al. (2002) posited the Interconnected Model of Professional Growth (IMPG) in order to summarize the wide array of forces that might explain why faculty teach as they do and why they might change their teaching practice (Figure 1). In this model, factors from four domains continuously and iteratively influence faculty growth or evolution in teaching practice. These domains include the external domain, defined as information or stimuli coming from the world around the faculty member; the domain of practice, or what the faculty member does in their courses; the domain of consequences, or the outcomes a faculty member observes or intends to foster in the classroom as a result of their teaching practices; and the personal domain, the knowledge, beliefs, and attitudes the faculty member brings to bear on the practice of teaching. Subsequent research validated the influence of factors in each of these domains.

Figure 1. The interconnected model of professional growth, as used in this study (adapted from Clarke and Hollingsworth 2002)



For example, within the **domain of practice** (Clarke et al. 2002), two types of experiences are particularly effective at encouraging faculty to adopt active learning pedagogies. Dancy, Henderson, and Turpen (2016) showed that experience implementing research-based strategies or engaging with curriculum development projects as a graduate student resulted in long-term changes as faculty. Similarly, experience co-teaching with a faculty member who is well-versed in active learning pedagogies produces changes in practice (e.g., Scherer, O'Rourke, Seman-Varner, and Ziegler 2020). Outside the classroom, scholars have associated discipline-based education research experience with an increased likelihood that faculty will use active learning in their teaching (Apkarian et al. 2021).

The domain of practice is intimately linked to the **domain of consequence**, as faculty tailor their practices so they achieve intended learning outcomes (Bouwma-Gearhart et al. 2018). In one study, roughly one-third of introductory physics faculty abandoned active learning practices after experimenting with them (Henderson 2012), suggesting that elements in the domain of consequence (such as perceptions of student resistance; Finelli et al. 2018) frequently dissuade faculty from experimentation.

Perhaps due to the ease of testing correlations, studies show a relatively large number of factors in the **external domain** influence STEM faculty teaching practices. Examples include established disciplinary or departmental cultural norms around teaching practices (Bouwma-Gearhart et al. 2018; Stains et al. 2018), institutional expectations around student evaluations or research output (Apkarian et al. 2021), class size (Apkarian et al. 2021; Stains et al. 2018), and physical layouts, such as whether the classroom is auditorium-style or includes furniture that can be rearranged to facilitate group work (Apkarian et al. 2021; Stains et al. 2018). Social network analysis of faculty relationships suggests that teaching professors and discipline-based education researchers can serve as important departmental change agents as they influence STEM colleagues (e.g., Saitta and Donnelly 2023; Wilton, Maloy, Beaster-Jones, Sato, Lo, and Grunspan 2024).

Numerous researchers have investigated the role of professional development (PD) as an important factor in the external domain. PD opportunities for faculty range from workshops and

learning communities offered by on-campus teaching centers to topical professional development programs provided by disciplinary societies. Studies assessing the impact of PD report particularly positive outcomes from long-term (academic year) programs and for early career (graduate student or postdoctoral) participants (e.g., Biswas, Benabentos, Brewe, Potvin, Edward, Kravec, and Kramer 2022; Emery, Maher, and Ebert-May 2020; Emery, Maher, and Ebert-May 2021; Mataka, Saderholm, and Hodge 2022). "One-off" teaching practice workshops or seminars also result in self-reported change in faculty teaching practices in some cases (Brawner, Felder, Allen, and Brent 2002; Rust 1998). Nonetheless, faculty implementation of evidence-based practices after PD varies considerably (e.g., Dancy et al. 2016; Ebert-May, Derting, Hodder, Memsen, Long, and Jardeleza 2011; Turpen and Finkelstein 2009). The observed variation in faculty practice after participating in PD suggests that the **personal domain** (Clarke et al. 2002)—which encompasses an array of different types of knowledge (such as disciplinary and pedagogical content knowledge), attitudes (values, biases, and preferences), and beliefs (including epistemologies and ontologies) that each faculty member brings to the practice of teaching—may have an outsized influence on which strategies make sense to them and when, where, and how they utilize them.

In the personal domain, instructors' prior experiences as students inform their teaching practices (Apkarian et al. 2021), as do their beliefs about the nature of knowledge and the process of learning, such as their view on which learning experiences will lead students to achieve a particular learning outcome or what roles students and instructors should play in the classroom (Kane et al. 2002; Pajares 1992). Those beliefs can shape how instructors understand new teaching practices encountered in PD (Pajares 1992) and can impede or enhance their likelihood of implementing those practices successfully and durably in the classroom (Hashweh 1996; Yerrick, Parke, and Nugent 1997). Similarly, faculty beliefs about themselves—such as their teaching self-efficacy (Emery et al. 2021) and beliefs about the values and priorities they hold central to their professional identities (Brownell and Tanner 2012)—may also shape how they approach their teaching practice.

While the existing literature has explored beliefs that are directly related to the teaching process and faculty professional identity, much remains unexplained in terms of variation in individual teaching practices. We posit that a deeper and more ingrained set of faculty beliefs—those we internalize from our families and life experiences about how the world works, called **system narratives**, and about our roles and identities within larger communities—play a key role in shaping individual differences in teaching practice. Moreover, the beliefs embedded within these narratives, roles, and identities inform a logical but deeply internalized (perhaps even subconscious) framework by which STEM faculty evaluate potential evidence-based alternatives to their current practices (Herbst and Chazan 2011).

System narratives and family roles and identities as likely factors

In this study, we examine system narratives, identities, and roles in order to expand our understanding of how the personal domain may impact STEM teaching practices. Many people assume family stories are just family stories. Oft-quoted stories could seem somewhat random, chosen without a clear reason; it may collectively reflect a family's history, its characters, and its events objectively. But the reality is more complex. For example, when you look in a mirror you may see a complete copy of a physical form, but when you try to describe what you see in the mirror, words cannot convey every detail. You have to pick and choose what to describe and what words to use, even if you make those choices subconsciously. Values, beliefs, and shared norms guide those choices. Similarly, we cannot objectively or fully represent events that have occurred in our past. Our values and beliefs shape the stories we tell about ourselves, our past, and the world we live in. Those

stories then communicate and reinforce, explicitly or implicitly, underlying values and beliefs that inform how we make meaning of our experiences; "narratives are subjective constructions that have objective impacts" (Adler, Dunlop, Fivush, Lilgendahl, Lodi-Smith, McAdams, McLean, et al. 2017, 520).

Family stories carry embedded beliefs about how the world works as a whole, or system narratives. System narratives (Roselle, Miskimmon, and O'Loughlin 2014) contain overarching messages or ideas about how the world works. The narrative psychology field demonstrates that these types of stories affect how individuals perceive and understand the world. These system narratives can be identified by and communicate a variety of themes. Some examples include (Habermas and Bluck 2000, 748):

- Life is unfair
- Hard work is the key to success
- Things always work out
- Life is a struggle
- Life is a series of ups and downs

Narratives serve as reference points for understanding. For example, seeing life as a series of ups and downs has a different effect than saying that life is unfair (Fivush 2019; McAdams 1993) And what is extremely interesting is that the lessons learned and values shared through narratives are often not consciously recognized or assessed (Stone 2017).

As adults, we carry these narratives with us throughout our lives, as they play a key role in shaping relationships, individual psychological growth, and our understanding of how the world works (Adler et al. 2017; Costabile, Shedlosky-Shoemaker, and Austin 2020; Fivush, Merrill, and Marin 2014; Gagalis-Hoffman, Zabriskie, and Freeman 2016; Read and Miller 2014). As faculty, we also carry these narrative constructions, internalized as children and reiterated throughout our personal lives, into the university every day—sometimes unknowingly or unwittingly allowing them to inform how we plan our courses, design our assignments, interact with our students, and make sense of teaching-related PD experiences.

In addition, research from the fields of narrative psychology, sociology, and folklore, among others, illustrates that family stories are part of what young people use to build their own identities and roles. As Kate McLean (2016) says, "We use family stories above all others to create and understand ourselves" (7). Identity comes from how individuals are described by others and how they describe themselves, both within and in reaction to these stories. For example, are you portrayed in your family as the smart one, the organized or disorganized one, the joker, the kind or serious one (Stone 2017)? These descriptions can shape your identity and the roles you understand as yours. Examples of roles include caregiver, intellectual, taskmaster, and diplomat, to name a few.

Research question and hypothesis

How, if at all, do STEM faculty system narratives, family roles, and personal identities influence their pedagogy? In this pilot study, we investigate the hypothesis that faculty members' system narratives and their roles and identities within their families shape their self-described teaching practices and values in various observable ways.

METHODS

We recruited 15 STEM faculty from two private, mid-sized, primarily undergraduate institutions during summer 2022 (Table 1). We followed a semi-structured interview protocol for the initial virtual interviews, drawing questions from established family narratives interview protocols (Habermas et al. 2000; McAdams 2013; McAdams and McLean 2013) and teaching interview protocols

(Hora 2014; Luft and Roehrig 2007). Each faculty member also participated in a 30–45 minute virtual follow-up interview approximately a month later, where we verified key observations and asked for clarification or elaboration on ideas from the initial interviews.

Table 1. Interviewee disciplines and demographics

Institution	Discipline	Gender	Rank
A	Statistics	Male	Assistant professor
A	Mathematics and statistics	Female	Assistant professor
A	Engineering	Male	Assistant professor
A	Chemistry	Male	Associate professor
A	Biology	Female	Assistant professor
B	Mathematics	Male	Associate professor
B	Mathematics	Male	Professor
B	Statistics	Male	Associate professor
B	Chemistry	Male	Professor
B	Chemistry	Male	Professor
B	Mathematics	Male	Professor
B	Chemistry	Female	Professor
B	Biomedical sciences	Male	Associate professor
B	Statistics	Male	Professor
B	Mathematics	Male	Professor

A third-party service transcribed interview recordings in preparation for coding by the researchers for system narratives and family roles or identities. System narratives (Roselle et al. 2014) describe how the world is understood to be structured and how it functions according to the individual interviewee (e.g., we coded the quote from participant B-09, "My father was adamant about hard work and no excuses. You either do it or you don't . . ." as alluding to the system narrative, "Hard work is the route to success"). The researchers began coding using a list of narratives documented in the literature (e.g., Habermas et al. 2000) but also allowed for new system narratives to emerge throughout the process. The researchers coded roles when a participant attributed a set of actions or responsibilities to themselves (e.g., problem-solver, chief nutritional officer). The team coded identities when participants used non-action-oriented language to describe themselves (e.g., a perfectionist, an outsider). Roles and identities existed in the individuals' self-descriptions both while growing up and as adults, though we hypothesized that those internalized as children were likely more influential (Nisbett and Ross 1980).

All three researchers independently coded three transcripts (initial and follow-up interviews combined) for system narratives, family roles, and identities, and met to discuss and resolve discrepancies. Subsequently, two researchers coded each transcript and met to discuss and agree upon codes, resulting in the addition of several new system narratives to our initial list. During this coding pass, the researchers also identified all quotes that described the faculty participant's teaching practice and compiled them into a single document.

After the research team coded all 15 transcripts, two members identified prevailing system narratives, roles, and identities for each participant as well as illustrative quotes to represent those conceptions. We selected these elements specifically from passages where a participant discussed their personal experience or family life, not from their descriptions of their teaching practice. This

allowed us then to examine the correspondence between these personal or family narratives, roles, and identities and the ways each individual described their teaching practice.

Guided by individual themes identified in the personal or family related passages of the interview, one reviewer re-reviewed the document of quotes describing the participant's teaching practices. They identified areas of congruence between the individual's prevailing narratives, family roles, and identities and how they approached their teaching. A second researcher who coded the transcript in the first-pass coding process checked the representative quotes illustrating that congruence and descriptions of how that congruence took shape to ensure reliability.

RESULTS

Each participant espoused an array of unique roles, identities, and system narratives in describing their personal and family lives, not all of which explicitly tied into their self-described teaching practices. However, for every participant, we observed significant correspondence between at least one system narrative, at least one family role or identity characteristic, and how they described their teaching. In nearly every case, a systematic network emerged with a few dominant system narratives, role(s), and identity characteristic(s) working together in a cohesive way to inform how they approached classroom instruction. Below, we describe two participant case studies in-depth in order to illustrate our approach and findings. Subsequently, we outline overarching findings based on our analysis of all 15 transcripts.

Case study A-01

Participant A-01 is a male-identified assistant professor of statistics who completed a certificate program in research-based teaching as a graduate student. This participant describes his role within his family as "getting pieces to glue together or to stay together, and connecting some of the pieces," "where pieces are individuals in conflict or with disparate personalities." His dominant identity characteristic is "perfectionist": "I was certainly aware that I was more of a perfectionist, that I needed to get straight A's . . . I always put pressure on myself to, you know, get 100. The expectation was to get 100 percent on everything."

Two overarching system narratives recur within A-01's stories. The first is the universe is magical and mysterious (i.e., good things happen randomly and sometimes unexpectedly). For this faculty member, this takes the form of the universe of providing unique opportunities for him to experience incredible things:

> I think probably the relative rarity of . . . who's even able to see them, and the fact that I was able to . . . be part of those research projects and expeditions to kinda go and actually look at them, when comparably few people even get an opportunity or even know that they exist to some level. And to be able to actually go and do meaningful work there . . . I think that's kind of the main thing, is just how rare of an experience that would be. And then, somehow I was able to be part of that.

A downside of the capriciousness of the world, the system narrative life is unfair also recurs in A-01's stories and shapes his worldview. For example, in describing the arc of his graduate school experience, he notes:

> all of sudden, it just kinda dropped out from under me . . . I had to kind of switch directions there. But then, even some of the research I was doing in my PhD work, that kind of came back to bite me again.

In describing his teaching practices, A-01's identity as a perfectionist comes through repeatedly in the transcript. He describes various ways he strives toward a set of ideals learned through experience and teaching PD. For example:

> I think switching some of the grading practices has helped, but I don't think—it's certainly not maximized by any stretch of the imagination . . . I still have a very instructor-centered or lecture-centered classroom, where I go through notes, and I think that's helpful at times. Especially learning a new subject like statistics, for students, but I think it would be a lot more helpful if they were just getting more hands-on, a little bit more active learning, like going through some data, actually applying the skills, and then, maybe they—like, flipping the classroom, I think, would be another big step for me . . .

Beyond simply aiming to make his pedagogy more aligned with STEM education research, two system narrative drive A-01: On the one hand, he seeks to inspire students' curiosity and wonder about this magical and mysterious universe ("I think that's what I kind of define as my major role, is to try to stimulate thinking and curiosity and to really ask good questions about what's going on in the world"), while on the other he seeks to counter what he sees as the inherent unfairness of the world through experimenting with alternative grading practices: "I was frustrated with the way traditional course structures were and my exams, and students being punished for . . . structural things with the class instead of really their learning." As a result, "what I'm trying to do now is more define success as internal growth and understanding about it, and less focused on the grades and to another extent, getting it right. Like, the process is more important than the results."

Together, his identity as a perfectionist and belief in the system narratives of "life is unfair" and "the universe is magical and mysterious" form a cohesive system shaping how A-01 approaches his teaching. His role as the interpersonal "glue," which he mentions multiple times with respect to his family, is not explicitly tied to his approach to teaching, nor are the additional non-dominant identity characteristics ("hardworking") or system narratives that occur sparsely in his life stories (things always work out the way they should; tragedy often turns to triumph if you don't give up). However, those identity characteristics, roles, and narratives are congruent with those more explicitly connected to A-01's teaching; they make sense as part of a cohesive worldview and sense of self.

Case study B-05

Participant B-05 is a male-identified professor of biochemistry. This participant describes his role within his family as a problem-solver, and he defines emotions as barriers to solving problems: "emotions don't solve any problems, but, rather, create them." His dominant identity characteristics include being "knowledgeable" and "stoic": "I don't let things fluster me, but I don't get too excited about things either. I'm just always sort of calm." Coupled with these, a dominant system narrative in B-05's stories is that knowledge and experience have inherent value in life. In his words, "I've gotten the chance to experience a lot of things, especially through traveling, and [that] started out when I was pretty young. . . . and that's something that I've continued my whole life. I think that's been pretty influential in forming who I am."

As a professor, his self-identity as a knowledgeable problem-solver is evident in his approach for deciding what content to teach: "I'm a problem solver, and that's a problem to solve. . . . How do you take this material and make it accessible? And then, I look at it from that perspective, which is not necessarily that of a biochemist." Moreover, he emphasizes to his students that his goal is not for them to memorize; rather, he wants them to be able to apply the ideas. He reflected, "what they should be able to do is look at any reaction mechanism, even one they've never seen before, and understand what's going on." His stories about teaching also include multiple accounts of him getting "side-tracked" and sharing ideas that draw on his extensive fund of knowledge beyond the scope of course content. While he reports some students respond positively to these diversions, he recounts that the common refrain from students, "is this gonna be on the test?"

His description of his approach to teaching also aligns with his systems narrative and his identity as stoic. For example, in response to students' concerns about their performance on an individual quiz or exam, he will challenge them by reflecting on his own history: "Do you know what grade I got on my first biochem test? . . . And I say, I have no idea, no one else on the planet knows, and . . . no one in the world cares." He argues further that students are too focused on the short-term:

> They are worried about today's test and professors have the advantage of having a more long-term perspective, and so I try to communicate that in saying, the things you're worried about are not as important as you think they are, and hopefully [. . .] they can come to maybe appreciate that a little bit.

Embedded within this observation of students' reactions is his identity as stoic. Emotional reactions to short-term grades are not consistent with a sense-of-self that is not easily upset. Indeed, his stoicism supports his system narrative that knowledge and experience have inherent value in life. His response is an attempt to express this view that the learning of the course should be more important than a grade.

Overarching themes from the dataset

Each participant articulated different system narratives, some of which multiple interviewees echoed (e.g., "hard work is the key to success," participants A-02, A-03, B-05, B-07, B-08, B-09, B-11). Others were entirely idiosyncratic (e.g., participant B-06, "it's me against the world"). Similarly, each individual described their role and identity in unique ways with little commonality in what traits they foregrounded to explain themselves, though each individual's roles, identities, and narratives held some degree of internal coherence. Nonetheless, we identified a clear set of overarching themes as we analyzed the full dataset for commonalities regarding system narratives, roles and identities, and STEM faculty teaching practices.

Theme #1: All interviewees' teaching practices reflected their personal system narratives and family roles and identities in clearly observable ways

All interviewees espoused multiple system narratives, family roles, and identity characteristics when describing their personal lives. In many cases, as with A-01, several of those narratives, roles, and identities created a logical system through which decisions about teaching (course design, assessment, facilitation, etc.) might be understood or explained. Yet, those expressed narratives, identities, and roles reflected dramatically different worldviews from one participant to the next, therefore leading to dramatically different classroom norms and teaching practices. For example, A-02's family role as a caregiver, her identity as someone who practices kindness, and her system

narrative that life is a struggle leads her to try to create a classroom that maximizes student support and flexibility:

> I made a conscious decision when I started this time that . . . I wanna teach with kindness. 'Cause I know it's hard for students, especially—our university is a residential college, so most of the students are away from home for the first time . . . And I remember making this transition in my brain, like, I'm not gonna be tough anymore. There's no need for that. I can be an effective teacher and be kind . . . I have suggested due dates for when people should get things done. And I always re-enforce, telling people you need to get this done by this date in order to be successful for this assessment, or that sort of thing. But I'm not strict on any of these due dates . . .

By comparison, B-09's faith is central to how he sees himself and the world: "I'm a member of the Church . . . there's a bigger purpose to things rather than just this life you know, and that's just been kind of the guiding principle for me, and it always has been." Drawing upon this biblical view of life, B-09 demands much of his students in order to prepare them for a world in which life is unfair and hard work is the route to success. Yet he also prides himself on kindness:

> I'm hard, [students] consider me one of the tougher [professors] out there. Most people characterize me as being very nice, but they all complain that my tests are too hard, that I expect too much. And I look at [it] as, I don't expect enough, and they don't understand what they really should know . . .

A-02 and B-09 provide just two more examples of the diversity of ways in which all our interviewees' system narratives inform and shape their teaching approach.

Each individual also described themself as having additional family roles or identity characteristics or told stories that held underlying system narratives that did not explicitly connect to how they described their teaching. In most cases, as with A-01, additional non-dominant narratives and roles were congruent with those that more directly shaped their teaching—or at least they were not in conflict. For example, B-09 also describes himself as a jack-of-all-trades, an identity that led him to invoke a diversity of topical examples, but did not show up in other ways; A-02 describes herself as a leader who gets things done, yet never explicitly discusses teaching in such terms, though the identity of a leader could easily align with the role of a teacher.

Theme #2: Some interviewees espoused competing or vastly different system narratives or roles/identities for themselves

A number of interviewees espoused multiple system narratives or roles/identities that were not consistent with one another. We observed these differences within categories, such as within system narratives, as well as across categories, such as between roles and identities. For example, B-06 expressed potentially conflicting system narratives of life as a series of ups and downs and life as a battle between the interviewee and the world. The former narrative emphasizes an ebb and flow or balance to life over time, while the latter understands the world as dangerous, in which individuals must always be on guard. This particular person spent more time speaking to pedagogy that linked to the world as a battle. For example:

> . . . Unfortunately our intro level . . . courses are very highly regulated. I actually have very little autonomy deciding what the content area of the course is. I participate in committees that make those decisions, but once the . . . department . . . makes a decision about what has to be in the introductory . . . course, I can't alter that.

Several additional quotes described how challenging it can be to teach when there is significant oversight of syllabi from above and when student resistance occurs within the classroom.

Another example of potentially conflicting roles and identities is when B-10 described themself as both "loosey-goosey" and also logical, quick-thinking, and organized. At home this person allows a partner to be concerned with organizing finances, for example and they describe their classrooms at the university as open and playful, yet they plan what particular subjects to cover in the classroom carefully:

> I pull out the syllabus of record to see what we said we were gonna have as our student learning objectives. Then I maybe modify those on my own a little bit, because sometimes the syllabus record's a little bit old, [or] hasn't been updated for a while. But so, then I think to myself, okay, these are the things that I want students to be able to do at the end of the semester. And then I kind of backward design a little bit . . .

In some cases, respondents' comments indicate some self-awareness of how their own narratives contrast or even clash, and in other cases do not. These internal inconsistencies are not necessarily surprising: individuals can hold different ideas or identities simultaneously. The multiplicity of self-conceptions, though, raises interesting opportunities for pedagogy, which we will address in the discussion section.

Theme #3: All interviewees, regardless of pedagogical practices, cared about teaching

Many of the faculty did not describe using evidence-based pedagogies. Nonetheless, all interviewees described their teaching in ways that conveyed care for students' learning. Interviewees commonly explained their role in teaching by explaining their approach to relationships with students, often viewing themselves as a guide or supporter: "I try to serve as a guide" (A-04); "my role is to be like the guy in the community that's like leading towards knowledge" (A-05). In some instances, their approach centered on care and kindness:

> I know where the roadblocks are going to happen. I mean, every student hits these roadblocks. The question is just when and where. When do you want this to happen? . . . I don't want it to happen when students are by themselves. . . . I want that to happen in a controlled environment where they have friends together. They can access tools and materials. They can access me. And it's a productive struggle at that point rather than just, like, a hopeless struggle. (B-11)

In other instances, their approach focused more on setting clear and high expectations and engaging students in effective learning tasks:

> So, anytime I give an exam, I make sure they know that, first of all, the test is not just an evaluation tool. It's primarily a teaching tool. And that they are all going to get questions

> wrong. . . . you learn from your mistakes. If you don't make any mistakes, you're not learning anything, and that would be irresponsible of me as a teacher. (B-05)

Interviewees also frequently expressed care about teaching through the system narrative "hard work is the key to success": "I do think that all of my students can be successful in my class. However, having said that, they have to put in the work to be successful" (B-08).

Coupled with this attention to relationships, interviewees acknowledged their awareness of the challenges that students face in learning and in life. As instructors, some seek to encourage persistence, especially when facing mistakes:

> I think that making mistakes or learning from your mistakes was a big part of my life and just in general of learning, and I want students to know that it's okay to make mistakes and that's an opportunity just to kind of re-adjust what our thought process is and update it, or maybe make the thing that we're trying to do work. . . . It just takes perseverance to make it work, and it failed just because we didn't try hard enough. Or it failed because it was a good thing that it failed, and we need to stop doing that. . . . So that freedom . . . to explore what I was interested in, I think, has definitely shaped my mind in terms of who I am as a person in all aspects of life, but definitely as an educator. (B04)

This quote shows how instructors can make the connection between the personal domain, by reflecting on one's own life lessons, and the domain of practice, by supporting students' learning through care and acceptance of mistakes.

LIMITATIONS

Faculty from STEM disciplines at two primarily undergraduate universities in the United States participated in this study. While the existing literature suggests these findings are likely generalizable to faculty (or other teachers) in other disciplines and contexts, further study is needed.

The interviews used in this study limit our analysis to self-reported information about individuals' roles, identities, and teaching behaviors. Classroom observations or analysis of teaching artifacts (syllabi, assignments, feedback, etc.) might reveal different teaching practices than those the interviewees described. Similarly, the limited duration of the interviews and the self-concept of the interviewees meant that we were not always able to elicit relevant responses. For example, a few participants focused so much on their academic identities that we were unable to elicit much information about their personal and family lives, making correspondences more difficult to uncover.

Finally, interviews occurred in summer 2022 when COVID and the challenges of online or hybrid teaching remained fresh in the minds of several participants. For participants earlier in their career, COVID impacted a much greater percentage of their time teaching than for older participants, but we did not seek to account for these impacts.

DISCUSSION

Recentering and extending the personal domain in STEM education

As affirmed by the Interconnected Model of Professional Growth (IMPG; Clarke et al. 2002) and related frameworks (e.g., Herbst et al. 2011), STEM faculty are rational actors who are responding to a complex set of personal and contextual factors (personal domain, domain of practice, external domain, domain of consequence) when making choices on how to teach. True to the STEM cultural

assertion that our personal identities and lives should be left outside the workplace, prior research has focused on how our beliefs about teaching and professional identities might impact our teaching practices (e.g., Brownell et al. 2012; Kane et al. 2002). However, as documented by the field of interdisciplinary narrative research, we all view the world through the lens of the stories that we have internalized throughout our lives—stories about how the world works (system narratives) and stories about who we are within it (roles and identities) (McLean 2016). These and other long-established and extensively reinforced beliefs tend to be most deeply entrenched in our mindsets (Nisbett et al. 1980). Together, these facts indicate that the influence of the personal domain of the IMPG (Clarke et al. 2002) on our teaching extends much deeper, to include the stories we internalize from our families and lived experience of the world. Our study illustrates that STEM faculty's practices in the classroom are informed by a broad set of internalized logics or "system narratives" about the world around them and the roles and identities faculty associate with themselves. These findings suggest a series of foci for future SoTL and educational development research at the individual, department, university, and disciplinary or multi-institutional levels (Friberg 2016).

While efforts for institutional change and disciplinary teaching reform typically foreground teaching practices and intended student outcomes, our work calls for both SoTL investigations and educational development to recenter the individual faculty and the personal domain of the IMPG, especially beliefs about how the world works and who we are within it. Each faculty member in our study articulated a unique set of system narratives and a unique sense of their roles and identities within the system, which corresponded in unique ways to their teaching. If our interview participants had participated as a cohort in a single PD program, each would likely have taken away different key ideas and enacted what they learned (or declined to do so), in ways that aligned with their uniquely personal stories. Future SoTL investigations should explore patterns and correspondences between these ideas and investment in, or inclination toward, particular teaching approaches; this may then help faculty developers and institutional champions for change focus on individuals likely to easily make sense of and effectively implement specific pedagogical strategies. Future research might also identify specific evidence-based or high-impact practices that align with different system narratives, in effect helping educational developers select a "menu of options" more likely to land with a particular colleague.

Implications for faculty development

Perhaps most importantly, this research suggests a greater emphasis on faculty development practices, such as consultations with individual faculty members and workshops and programs at a cohort level, that help faculty identify their own system narratives and self-concepts and how those beliefs inform their teaching. Many of our participants expressed skepticism about the connection between their personal self and teaching practices or expressed surprise at uncovering these links during the interviews; however, several found that articulating the connections helped them identify specific things they wanted to do more of, or be better at, in their teaching. In a consultation or workshop context, educational developers might facilitate that type of reflection by asking questions such as "What experiences or memories come to mind when you think about why this pedagogy feels aligned/misaligned with your practice or philosophy?," "What do those stories say about how you see the world in your classroom?," "Are there other stories or experiences in your life that support a different perspective? What might you gain by applying that lens?"

Furthermore, when designing interventions aimed at fostering the adoption of evidence-based teaching approaches, educational developers must remember and acknowledge that STEM faculty, like other teachers, interpret PD through the lens of our existing beliefs—not just our beliefs

about the nature of teaching and learning (Pajares1992) but also our beliefs about how the world works and who we are within it. Much like how beliefs that run counter to constructivist learning impede effective adoption of student-centered teaching practices (Hashweh 1996; Yerrick et al. 1997), we are also unlikely to meaningfully implement recommendations that run afoul of our system narratives and sense of self. Legitimizing that resistance and noting its association with narratives articulated by a particular faculty member may help them feel seen and heard in a way that opens them up to re-engaging in the conversation.

Fostering faculty pedagogical choice and agency

Faculty who engage in structured reflection on the correspondence between their system narratives, roles and identities, and teaching practices might gain greater agency in how they navigate institutional culture change initiatives; recognition of the impact of stories about the world and the ways they shape us opens up space for the self-determination to shift our stories in intentional ways. Most interviewees expressed multiple different system narratives and several roles or identities for themselves. Sometimes these narratives and self-concepts were in tension with one another, offering meaningfully different affordances for teaching practices; not all equally impacted their teaching. Intentional efforts to elicit personal stories with system narratives or roles for the faculty actors that might align with evidence-based practices at the outset of a PD intervention might encourage participants to explore the validity of alternative system narratives and ways of viewing themselves, creating fertile ground for PD to land on. As just one example, consider asking a faculty member who is devoted to didactic lecture approaches to recount a time when someone structured a set of practice activities for them and provided immediate expert feedback in a way that helped them master a skill. After reflection, that individual might be open to considering the value of including expert-designed activities during class sessions, then reviewing the solutions, to some degree when they might otherwise resist entirely.

Implications for institutional and disciplinary change

At the institutional and disciplinary levels, research and praxis that acknowledge faculty's full humanity and explore the ways that the personal domain and our broader beliefs about the world (including system narratives and identities) shape teaching practice will provide a much fuller picture of why individuals resist or adopt pedagogical changes aligned with institutional and disciplinary reform efforts. Beyond engagement with the individual, institutional and disciplinary messaging that allows faculty to explore how a particular set of reforms aligns with widely varying system narratives may help enhance overall adoption of pedagogies aimed at enhancing our students' experiences.

CONCLUSIONS

This pilot study demonstrates that STEM faculty's teaching practices correspond in clearly observable ways with their system narratives about how the world works and their roles and identities within their families. Both STEM education research and professional development interventions will benefit from attending more deeply to the impact of the personal domain of frameworks, like the IMPG (Clarke et al. 2002), on teaching practices. Furthermore, understanding the deep well of influences from our personal lives and how they shape our professional practice can help us claim additional agency in shaping our own professional journeys and practices.

ACKNOWLEDGMENTS

The Elon University Turnage Fund and Faculty Research and Development Fund supported this research. The authors are grateful to Beth Campbell for feedback that improved the manuscript.

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ETHICS

The Elon University ethics review board deemed this research exempt.

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