

RESEARCH ARTICLE



WILEY

Under pressure: How do science teachers use capital to achieve agency during turbulent times?

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Abstract

Disruptions to education systems (e.g., the COVID-19 pandemic) evoke a range of responses from teachers. Teachers are required to learn new skills, attend to students' social emotional needs, modify their instructional approaches, and discover innovative ways to engage their students in science, technology, and engineering courses, all while managing their own professional and personal needs. Although teachers of all disciplines adjust their instructional and curricular approaches in response to disruptions, the impetus for this study was to explore the unique challenges of science teachers during the COVID-19 pandemic that affected their sense of agency (sense of control). To understand how science teachers acquired, used, and invested in capital (i.e., available resources with the potential to meet identified challenges) to achieve professional agency, we studied 113 science teachers in 2020–2021 when they experienced disruptions associated with the pandemic. An analysis of open-ended responses from 60 teachers indicates that teachers who achieved agency shared four attributes. They (i) demonstrated an awareness of needed capital, (ii) acquired capital, (iii) used capital, and (iv) dedicated effort toward capital-building for future use. Our findings inform science teacher educators and schools that are committed to

mitigating science teacher attrition by understanding how teachers respond to personal and professional stresses.

KEYWORDS

agency, capital, professional disruption, science teachers

1 | INTRODUCTION

Teachers around the world regularly overcome significant challenges to meet the needs of their students whose lives are disrupted due to extreme weather events, violence and conflict, or crises (Kawasaki et al., 2020; Sherif et al., 2020). Thus, there is a need to understand how to best support teachers during crises or other disruptions that impact schooling. Consequences of the COVID-19 pandemic involved extensive disruptions for stakeholders within global K-12 educational systems, evoking a range of responses by teachers and administrators (Huck & Zhang, 2021). While mitigating public health concerns dominated the decisions of politicians and community members, educators grappled with additional issues. In spring 2020, school administrators and communities prioritized decisions to ensure that students continued to receive support services (e.g., free/reduced breakfast and lunch, special education, other academic support) as they simultaneously worked to maintain academic continuity for students (Wright et al., 2023). Although the overnight disruption to the K-12 system affected teachers of all disciplines, we were interested in examining whether science educators described and navigated challenges unique to the teaching of their discipline. Specifically, we anticipated that to maintain engaging inquiry-based and hands-on instruction, science teachers may feel additional stressors, affecting the types of support they sought.

For the past couple of decades, science teachers have been learning (through teacher education and professional development programs) that by making science content relevant, engaging, meaningful, and authentic (e.g., Braund & Reiss, 2006), they can diversify scientific disciplines (Tilghman et al., 2021), prepare students for success in postsecondary science studies (e.g., Goode, 2007; Sadler & Tai, 2001; Tai et al., 2005), and transform student lives by engaging them in thinking critically about the role of science in society and how scientific knowledge can either perpetuate or mitigate social inequities (e.g., Calabrese Barton, 2003; Morales-Doyle, 2017). Hence, science teachers are under pressure to ensure that they use pedagogies that support student agency and empowerment (Morales-Doyle, 2017) and address content that integrates disciplinary practices with knowledge acquisition. These expectations require them to develop students' understanding of collaborative knowledge-building practices based in inquiry and problem solving (National Research Council, 2012), while shifting their own instructional delivery strategies.

In the first academic year of the pandemic, schools and districts in the United States focused on instructional continuity for students and relied on teachers to help with these efforts (DeCoito & Estaiteyeh, 2022; Fackler & Sexton, 2020). Some science teachers found these challenges overwhelming (e.g., Wisanti et al., 2021), while others found opportunities for creativity (e.g., Landicho, 2021) or leadership (e.g., Wieselmann & Crotty, 2022). At the same time, schools explored various technologies that their teachers and students could effectively use (Balgopal et al., 2022) to maintain instruction across science disciplines. Teachers were asked to learn new skills (e.g., using technology for remote teaching; Gudmundsdottir & Hathaway, 2020; Kang & Seo, 2021), assume expanded responsibilities (e.g., assessing students' social-emotional learning needs; Minkos & Gelbar, 2021), and reimagine their role as teachers (e.g., communicating public health information; Rogayan & Dantic, 2021). In addition, science teachers needed to devise classroom management strategies for new, but engaging, instructional modalities (e.g., remote, hybrid) as they emerged (Wright et al., 2023).

The abrupt change in expectations was exhausting for some educators, and anxiety about teaching in these new modalities was a significant contributor to teacher burnout during the pandemic (Pressley, 2021). Teachers

described feeling ill-prepared to change their instructional delivery overnight (Ehren et al., 2021; Whalen, 2021). Furthermore, teachers were also expected to provide continued support for their students' socio-emotional learning as everyone returned to classrooms (Minkos & Gelbar, 2021). Challenges that arise when teachers feel unsupported, unprepared, or unhappy with the profession are a concern for the retention of all teachers. However, concern about the exacerbation of science teacher burnout, attrition, and continued shortages has been escalating over the past several years (Aragon, 2016; Rumschlag, 2017; Sebald et al., 2022; Skaalvik & Skaalvik, 2011; Wright et al., 2019). Subsequently, while the pandemic has had a negative impact on teacher retention in all subject areas, Schmitt and deCourcy (2022), who analyzed data collected from the National Center for Education Statistics, found that life, physical, and computer sciences are fields particularly at risk of failing to attract and retain teachers. For example, they reported that 10% of U.S. schools had vacancies for physical science educators in 2022.

To prevent early science teacher attrition, teacher educators must understand factors that influence their decision to leave the profession. In doing so, we can better support (1) early-career teachers, as they develop their own sense of professional agency and (2) mid- and advanced-career teachers, as they reflect on their professional agency (Wright et al., 2023). "Professional agency" refers to individuals' beliefs that they have control over their actions both now and in the future (Bandura, 2001). When teachers have professional control over what, when, and how they teach curricula, they may feel agentic. Achieving agency requires access to "capital," or available resources with the potential to meet identified challenges (Ehren et al., 2021). By better understanding what capitals that agentic science teachers believe they need to maintain professional control, teacher educators and administrators can offer more effective support. In our study, we collected open-response survey data from 60 secondary science teachers in the U.S. in the first year of the COVID-19 pandemic to understand how they maintained or lost their sense of agency amid this professional disruption.

2 | THEORETICAL FRAMEWORK

Our study draws on and integrates agency and capital theories. Teachers work within nested systems: what happens at the district levels affects schools, school level responses affect departments, and departmental-level responses affect individual teachers and their respective classes (Keshavarz et al., 2010). It is important to remember that this professional environment is complex, where each micro-system is dependent on the next macro-level system in which it operates. As a result, teachers' sense of agency and their professional decisions are shaped by a multitude of variables, such as administrators, peers, students, students' families, social community, and policies about teaching and assessment (Diamond, 2012). Therefore, it is essential to understand how the system impacts teachers' agencies in making professional choices.

2.1 | Agency theory

Agency, which Bandura (2001, p.1) described as "the capacity to exercise control over the nature and quality of one's life," may help explain teachers' professional resilience. Individuals within organizations must have attributes that allow them to "weather the storm" as well as believe that they have the capacity to do so (Ehren et al., 2021). Believing that one has control to shape one's own life and then acting on such beliefs requires effort. For this reason, Biesta and Tedder (2007) argued that one *achieves*, rather than just *has*, agency. Achieving agency occurs when an individual (1) reflects on past events, (2) responds to current events, and (3) plans for future events (Emirbayer & Mische, 1998). As teachers examine their professional practices (e.g., reflecting on past professional practices, recalling current experiences, and how these inform intentions for future professional practices), all three elements of agency are relevant. Moreover, the decisions teachers make as they reflect, respond, and plan are dependent on the capitals they perceive as available to them. Their professional decisions may be influenced by

intrinsic or extrinsic capitals (Balgopal, 2020). For example, teachers may draw on their peer group to support them during challenging times, and as such, demonstrate collective agency (Ehren et al., 2021). They may engage in collaborative learning and observation of master teachers before implementing the skills in their classroom (Sullivan et al., 2012). They may share resources and strategies with peers in professional learning communities, where they find both professional and personal support (Vangrieken et al., 2015).

People's capacity to manage their environments and how they function within them is affected by their perception of the challenges they face and the capitals available to help address these challenges (Balgopal, 2020; Balgopal et al., 2022; Wright et al., 2023). Therefore, we assume that science teachers who have achieved agency, demonstrating a "mindset and disposition to respond to changing conditions" of schools during the pandemic (Ehren et al., 2021, p. 62), are likely to have done so by drawing on a range of capitals, both intrinsic (e.g., psychological) and extrinsic (e.g., professional learning community). Investment in certain types of capital likely occurs if people expect positive outcomes (e.g., Wiswall & Zafar, 2021). By assessing their resources, teachers may choose to either take on new professional roles within or outside of their current school district or maintain their current roles (Wright et al., 2019). For example, they may stay within the same district in roles like curriculum developers or administrators or leave the district altogether. Since school districts invest in supporting new teachers through various resources—such as mentoring programs, on-site training, and professional development workshops—teacher attrition becomes costly (Sample McMeeking et al., 2012).

2.2 | Capital theory

Liou and Canrinus (2020) referred to resources that teachers can use as capitals and classified these as *human* (knowledge, skills, and experience), *social* (trust, expectations, and obligations that form through relationships with others), and *emotional* (anticipated outcomes of the investment in interpersonal relationships). The concept of capital is intricately linked to that of professional agency. Teachers draw on these capitals through their own expertise, experience, and professional activities (Hargreaves & Fullan, 2013). Therefore, acquiring and investing in human and social capital can bolster a teacher's emotional capital, which in turn likely influences their ability to achieve agency. The sense of agency plays a critical role in a teacher's decision to stay in or leave the profession. Teachers who recognize they have access to human and social capital are better equipped to persist under challenging conditions (Chan et al., 2021). The ability to persist, especially in the science teaching profession, is a hallmark of professional resilience. Resilient educators, whether they serve as classroom teachers, administrators, or support instructors/curriculum designers, can navigate various challenges and opportunities in their work environment. By drawing on available capitals, these resilient educators are better prepared to adapt and respond to adversity (see Balgopal et al., 2022; Wright et al., 2023).

As teachers gain experience in their profession, their ways of responding to challenges evolve (Yariv, 2013). This experience allows them to invest more time in their social and professional communities, thereby accumulating capital on which to draw during professional turbulence. As a result, the levels of professional experience presumably affect teachers' awareness of capitals, how to access them, and how to use them to support their professional resilience. For example, Doney (2013) found that novice science teachers demonstrated professional resilience when they had support in their roles and when they used capitals (i.e., human, social, and emotional) to respond to professional demands. However, the experience of novice teachers is not uniform. Some may have fresh energy and innovative mindset typical of those new to the profession, which can contribute to higher resilience. They may know what efforts are required to ensure that they have access to capital in the future; that is, they invest in capital (Astone et al., 1999). Others may not yet have identified supportive capitals that can help them feel resilient. Such variability means that novice teachers likely fall on a continuum of high and low resilience that may be influenced by their sense of agency or control over their professional decisions. These factors, in turn, may impact their decisions to remain in or leave teaching (Balgopal et al., 2022).

Building on the foundations of teacher agency theory (Biesta & Tedder, 2007) and capital theory (Liou & Canrinus, 2020), this study aims to explore the intertwined roles of agency and capital in the context of science teachers during the pandemic. We argue that agency and capital theories are intrinsically linked, especially for science teachers, because science education often involves complex pedagogical demands (e.g., preparing and teaching inquiry-based laboratories) and a rapidly evolving knowledge base (e.g., helping students learn a scientific vocabulary; Figure 1). To better predict how teacher agency informs decisions to remain or leave teaching, we emphasize the importance of understanding how agency is achieved through the awareness, acquisition, use, and investment in social and human capital, thereby achieving or sustaining agency in the face of disruptions. While the model of achieving agency through capital is not unique to science teachers, it can inform science teacher researchers to identify and explain how and why some science teachers achieve professional agency.

While some teachers build and apply new capital to meet their professional goals, not all experiences are identical. Teachers may experience difficulties as they identify, use, and devote time to their own capital-building at any point in this process, whether it is in awareness, acquisition, application, or investment in capital. For example, a science teacher might attend professional development workshops on how to integrate quantitative reasoning into their curricula but fail to integrate the new knowledge (Weinberg & Sample McMeeking, 2017), possibly due to a lack of awareness or access to required capital in their specific educational setting.

The unprecedented strains of the pandemic on educational systems around the world provided an opportunity to delve deeper into the dynamics of science teacher agencies. In this context, we explored how science teachers sought, accessed, applied, and devoted effort to building capital to maintain their professional goals and sense of control. Rather than construct new theory, we apply existing theoretical frameworks to understand the unique challenges and strategies employed by science teachers during this crisis. The central research question guiding this study is: *How did science teachers achieve agency by acquiring, using, and investing in capital while teaching during the first year of the COVID-19 pandemic?*



FIGURE 1 Science teachers are positioned to achieve agency when they are aware of (recognize needs), acquire (obtain resources), use (apply resources), and invest in (plan for and ensure access to future use of) social and human capital to meet their challenges.

3 | METHODS

Our open-response survey study aimed to describe how science teachers navigated professional challenges by leveraging various forms of capital. Using an integrated model of agency, we sought to identify the types of capital teachers recognized as valuable and used during a significant professional disruption or intended to use in the future.

4 | PARTICIPANTS

Participants were all recipients of National Science Foundation (NSF) scholarships through the NSF Noyce Program in the U.S. Noyce Scholars (still enrolled in an undergraduate teacher licensure program while earning degrees in science, technology, engineering, or mathematics) and Teachers (Scholars who were teaching as full-time classroom secondary teachers) commit to teaching in high needs (based on students' socioeconomic status, rates of teacher turnover, and percentage of teachers teaching outside their endorsement area) secondary classrooms in U.S. school districts upon graduation from a licensure program. Scholars are determined to be high achieving by their college or university's local Noyce program based on academic merit, experience, and professional goals.

Using the NSF website and our professional networks, we identified Principal Investigators (PIs) of other NSF Noyce programs across six states. Thirteen PIs responded and agreed to share our email recruitment letters with their Scholars. Of a potential pool of 252 Scholars, 155 responded to our invitation and consented to participate. Among these, 113 identified as secondary science teachers who taught science, technology and/or engineering classes. Sixty of these science teachers responded to all three surveys and comprise the sample for this study. The study was approved by Colorado State University institutional review board. Due to the indirect method of recruitment (we asked our fellow Noyce PIs to send email recruitment letters to Scholars who graduated from their respective programs), we do not have any demographic information for nonrespondents.

The teacher participants were employed in 13 states (Figure 2). Of the participants ($n = 60$), 62% ($n = 37$) identified as women, 37% ($n = 21$) as men, and 3% were gender nonconforming ($n = 1$) or preferred not to respond ($n = 1$). Most participants identified as white ($n = 52$), and one preferred not to share their race and/or ethnicity. Of those who identified as Teachers of Color (TOC; 12%), participants described themselves as Asian ($n = 1$), Black ($n = 2$), Latine ($n = 3$), or more than one race/ethnicity ($n = 1$). Some participants cared for dependents ($n = 19$; e.g., children, partners, parents, grandparents) while most ($n = 41$) did not. Teachers with one to three years of experience were categorized as *novice* teachers ($n = 33$, 55%), those with four to five years of experience were categorized as *early career* teachers ($n = 16$, 27%), and those with six or more years of experience were categorized as *master* teachers ($n = 11$, 18%), following Wright et al., 2023).

5 | DATA COLLECTION

We designed a series of three Qualtrics questionnaires that were administered at three points during the pandemic: (1) in spring 2020 as the impact of the pandemic prompted changes in instructional delivery, (2) in early fall 2020 as teachers returned to teaching, and (3) in late fall 2020 as teachers were wrapping up their semesters. The open-response questions prompted respondents to describe their perceptions about their teaching environment and expectations during the pandemic (Supporting Information S1: Appendix). Here, we focus only on the qualitative responses (which took around 20 min for participants to complete), while quantitative responses are summarized in other papers (Balgopal et al., 2022; Wright et al., 2023).

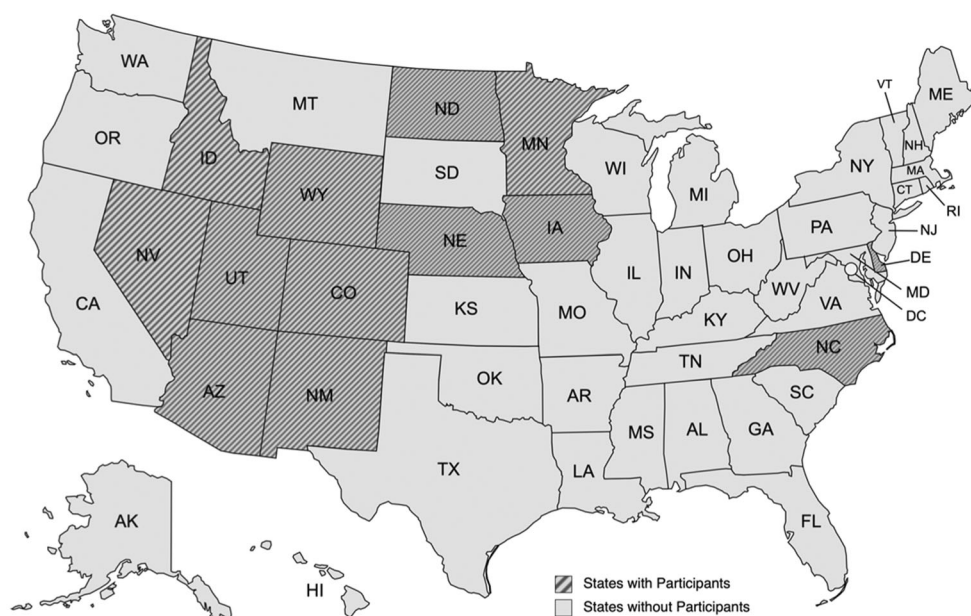


FIGURE 2 Where participants taught in 2020. States in which participants taught or were completing teacher licensure programs in 2020, when data were collected, are identified with hashed lines. The states that are colored gray and without hashed lines indicate those from which no participants were teaching. This map was created using <http://www.mapchart.net>, which is licensed for public use under a Creative Commons Attribution-ShareAlike 4.0 International License.

6 | DATA ANALYSIS

Informed by agency and capital theories, we conducted a reflexive thematic analysis of responses, recognizing the inherent subjectivity in the coding process (Braun & Clarke, 2021; Kiger & Varpio, 2020). We began by familiarizing ourselves with the entire data set, which we uploaded into Dedoose (ver. 9.0.17; 2021) for collaborative review. Throughout the process, we refined our codes, sometimes re-coding previously past narrative data, to develop our final codebook (Table 1). While codes are well-defined segments of the data set that fit within a large coding framework (Boyatzis, 1998), themes are a “patterned response or meaning” that may be semantic (explicit) or latent (inferred) text (Braun & Clarke, 2006, p. 82). As we reviewed our codes, we further organized codes into themes considering our theoretical frameworks, research questions, and individual positionalities. For context, three members of our research team are former classroom teachers and current teacher educators, two have worked peripherally with schools to support teachers, families, and/or administrators, and all seven are science education researchers who have experience with a range of participants in formal and informal educative settings.

Using our theoretical framing (i.e., the previously described agency and capital theories) as guides for our analysis, we identified several challenges the teachers described in their environments and the capitals they felt they could or could not draw on to address these challenges. Agentic teachers believe they have the control and accessible capital to meet their professional challenges. Our initial themes aimed to understand participants' perceptions concerning key challenges, such as instructional planning, peer collaboration, public health management, and financial stability.

TABLE 1 Codebook describing how STEM teachers navigated challenges during the COVID-19 pandemic by being aware of, acquiring, using, and investing in social and human capitals.

Themes		Collapsed codes	Initial codes
Awareness of, acquiring, using, and investing in capital to address challenges	Challenges	Professional (self)	Time
		<i>Low wages and too high of expectations set by admin/district with no support. Having a degree in chemistry and a master's degree, I know I would make significantly more in another career and have less work hours. This year has been exhausting and I don't feel adequately compensated or respected.</i>	Curriculum (format or teaching outside of content expertize)
		— Participant #44	Technology (for instructional delivery and assessment)
			Workload expectations
			Uncertainty of future (professionally)
			Feelings of success
			Financial stability
			Collegial support/mentors
		Professional (student)	Student engagement
		<i>Kids are just not learning nearly at the same rates as they would have—this is going to be detrimental to our kids right now in school and even more to our students that are behind. We are going to have to work very hard and try and make the biggest gains we can in learning when we are in back in person. It is hard to teach and learn chemistry in a environment where I am not with my kids, no labs, as well as not the typical opportunities to process and work through a lot of the learning that would take place in person!</i>	Student performance
		— Participant #27	Interacting with students
			Inquiry-based teaching
			Meeting students' needs in equitable and sufficient ways
			Student access to technology/technology literacy
			Insufficient parental support
			Student physical and emotional wellbeing
		Personal	Dependent care
		<i>Continued lack of support from people in the public sector. As teachers we are overworked, worried about our health, and often put our students before our families. If our teachers are not supported better, I would consider leaving the profession.</i>	Physical and emotional wellbeing
		— Participant #32	Political discourse (with community members)
Human capital		Pedagogical Content Knowledge	Technology skills and tools
		<i>This year I am trying to get more labs, and hands on things done early, in case we do have to go remote again, but at the same time practice social distancing so that we hopefully do not have to go remote. It definitely makes me think outside the box for lesson plans, and a</i>	Content knowledge
			Professional development
			Curriculum format and instructional delivery

(Continues)



TABLE 1 (Continued)

Themes	Collapsed codes	Initial codes
	<i>lot of what we do this year is spontaneous and student led.</i> — Participant #2	
	Professional Disposition <i>Take it one day and one task at a time. I know that sounds simplistic, but I have found myself getting overwhelmed when I look at all the tasks that I need to complete at once. Breaking things down into smaller task has been key for me managing these challenges.</i> — Participant #37	Patience Prioritization of professional tasks Time management Work/life balance Physical and mental health support
Social capital	Relationships <i>I definitely rely on the other teachers to see if they're encountering the same issues and how they're handling it. Modifying science curriculum in a creative and interesting way has been a team effort so we have had many late-night PLC meetings to do so! —Participant #23</i>	Administrative and district support Family and student support Collegial support Professional mentor support Social support (friends and family)
	Professional Acknowledgment <i>Additionally, there is very little oversight at my school, and I am free to plan and implement what projects I want, as long as it is PBL based. Although my school is dysfunctional in other ways, such as with Admin, I enjoy this freedom.</i> — Participant #49	Respect Professional autonomy

Meeting these challenges requires that people are aware of, can acquire, choose to use, and invest in various types of capital. Therefore, we then identified when and how participants *described capitals to address their challenges*. We coded types of capitals that participants identified as being necessary (awareness), accessible (meaning they had acquired them), and in use (Figure 1). We also separately coded when participants identified that a capital was available; accessible or usable (capital presence) versus unavailable; or inaccessible versus unusable (capital absence). We also noted when participants discussed investing in or building capital to maintain a sense of professional control in the future (Figure 1). Informed by Liou and Canrinus (2020), types of capital were categorized as social (which included collegial networks, mentors, students/families, administrators, family/community) and human (which included curriculum, teaching tools, technology tools, time, mental health management, and work-life balance). We coded for anticipated outcomes of investment in interpersonal relationships (which Liou and Canrinus (2020) coined as emotional capital) by determining when participants did or did not feel in control of their professional state. We coded participants as agentic based on the relationship between the identification of challenges, associated capitals, and the description of working toward or having achieved control. Conversely, we coded participants as nonagentic under two conditions: (1) they were unable to identify either challenges or any available capitals, or they only spoke of the capitals; or (2) they identified a challenge, but did not describe awareness, nor did they acquire or use any form of capital to address it.

7 | TRUSTWORTHINESS

We engaged in several strategies to establish trustworthiness. First, the codebook was collaboratively developed and revised during weekly debriefing sessions throughout the analytic process. Second, inter-rater reliability was determined as team members separately coded and met to reconcile coding. A third coder who was not part of the codebook development was trained and helped re-code all the data. The inter-rater reliability was over 90%, and the discrepancies were discussed until there was full agreement among the three coders. Throughout, findings were triangulated by drawing on multiple responses from each participant to ensure clarity of determining codes for an individual. Through final debriefing among the entire team, who ensured that the theoretical frameworks were guiding the analysis, we finalized the themes and proposition.

8 | FINDINGS

Science teachers who were agentic were aware of, acquired, used, and invested in capital to maintain professional control and meet their goals during the COVID-19 pandemic. More specifically, agentic teachers described managing demands by prioritizing what to address and acquired various relevant capitals. If these teachers did not have access to capital, they described capital that they needed and had a plan to acquire these. Throughout 2020, 63% of participants ($n = 38$) consistently demonstrated feeling agentic, 28% ($n = 17$) demonstrated feeling agentic at some points but feeling nonagentic at others, and 8% ($n = 5$) consistently felt nonagentic. Moreover, individuals who maintained some level of control in one professional aspect but not in others described how capital affected these perceptions. That is, participants who were considered nonagentic at some point during the study, relative to those who were coded as always agentic, did not describe using and investing in capital to increase their feelings of control during the professional disruption.

9 | CONCERNS LIKE THOSE OF NONSCIENCE TEACHERS

We found that science teachers in our sample described many of the same concerns reported by teachers across disciplines (Huck & Zhang, 2021; Pressley, 2021; Reich et al., 2020; Whalen, 2021). One of the most frequent capitals teachers described needing was time to engage in instructional planning, particularly in redesigning their curricula and instructional delivery for modified courses (online, hybrid, or socially distanced in-person). As illustrated by the following examples, teachers expressed intentions to engage in instructional planning (professional challenge) and were aware that they needed more time (human capital):

- "I've spent a year making lessons for in-person, and now I'm spending a lot of time making remote lessons, and soon I'll have to spend a lot of time making hybrid lessons." (Participant #33)
- "I am struggling with teaching my courses both online and in person. I have been putting in a lot of extra time developing content for my online learners." (Participant #51)

These accounts highlight the critical role of time as a form of human capital in adapting to diverse instructional settings.

Teachers were aware of their need for social capital and often mentioned the importance of their relationships with students and colleagues in meeting their professional challenges. For example, Participant #51 mentioned the difficulty of developing collaboration: "[It] is more difficult to foster in students and between colleagues. I'm used to going down the hall and checking in with my fellow teachers, but now I'm stuck at home so I can't do those check-ins." Many teachers expressed concern about student engagement in online science instruction, particularly the



challenges in building relationships with students remotely. Participant #33, for instance, noted, “Kids at home can’t be engaged and often refuse to do any work. And without in-person support they have no idea what they need to do to get caught up or what assignments to prioritize.” Another teacher shared their challenges in supporting students requiring additional guidance: “...connecting with students. It is so hard to know how best to support my exceptional learners without being in person and being able to offer the support I usually do” (Participant #44). These narratives collectively highlight that teachers are aware of their need for both forms of human capital (i.e., time, curriculum format, and technology) and social capital (i.e., collaboration and relationship-building) to navigate their professional challenges effectively.

10 | CONCERNS UNIQUE TO SCIENCE TEACHERS

In addition to general teaching concerns, science teachers in our study expressed disciplinary challenges. They were particularly focused on maintaining inquiry-based instructional approaches relevant to academic science standards (DeCoito & Estaiteyeh, 2022; Landicho, 2021; McPherson & Pearce, 2022). These concerns were exacerbated when teachers grappled with inequities across their student populations and felt that their pedagogical values were tested. Some teachers navigated new challenges by using capitals that enabled them to feel agentic, while others did not. In the following subsections, we delve into the experiences of agentic teachers, identifying how they navigated challenges through their (1) awareness of, (2) acquisition of, (3) use of, and/or (4) investment in various types of capital (Figure 1). A separate subsection discusses the challenges faced by nonagentic teachers.

10.1 | Awareness of capital

Agentic science teachers identified multiple forms of human and social capital as essential to managing the increased professional demands placed on them during the pandemic. With respect to **human** capital, time emerged as a critical element, with teachers expressing the need for more hours to plan, redesign curricula, and set up materials for students to use remotely. Alongside a lack of time, many teachers felt obliged to develop new curricular materials and instructional approaches that would allow them to continue to meet science academic standards, while balancing shifting expectations of instructional delivery. Technological support for inquiry-based instruction was another area of concern as exemplified by Participant #58 who voiced a need for “high investment in online tools that cost money. Science labs, interactive tools, etc.”

Social capitals were also identified as important for addressing challenges. As illustrated by the narratives in the previous section, teachers felt that community understanding, and cooperation were vital. Collaboration among colleagues was also highlighted as a valuable form of social capital. One teacher even suggested that societal solutions like less politicization of the pandemic could contribute to a more supportive educational environment, stating, “[the solution is] less politicization of the pandemic so kids and their parents actually take it seriously instead of pulling their kids from the school and cussing out admin for overstepping” (Participant #12).

10.2 | Acquiring capital

While the act of acquiring is closely related to its use, the two are not always synonymous. Some science teachers reported acquiring valuable resources, but they were not always able to use them during our study. In these cases, the resources were cited as insufficient or misaligned with the teachers’ unique teaching contexts. For example, some teachers described participating in professional development on virtual and remote teaching, but they did not know how to adapt their new skills to specifically teach remote laboratory activities. For example, Participant #4

shared that “If there are opportunities to take advantage of, I am too anxious and stressed to pursue them.” Here, the teacher felt that they could not acquire professional capital because of the absence of mental health capital. Misalignment of resources was most often cited in relation to maintaining student equity (i.e., ensuring that curricular materials and assessments were aligned with student needs). This was particularly salient for teachers who were expected to juggle different instructional modalities, even when they had acquired tools for teaching remotely: “I am struggling with teaching my course both online and in person. I have been putting in a lot of extra time developing [science] content for my online learners” (Participant #51). This teacher also expressed concerns about equity: “I still don’t know how to approach equitable [science] assessment between the two groups” (Participant #51).

Science teachers sought science-specific capital. For example, some science teachers perceived their existing curricula as a form of capital that would allow them to address their objectives of increasing scientific literacy during a public health crisis. For example, one participant explained,

It has forced me to re-examine my curriculum and assessment strategies. Many of my assignments have been altered or completely reworked to accommodate digital based learning. There have also been more opportunities to discuss the nature of science in relation to the pandemic, infectious diseases, and vaccine development (Participant #46)

This teacher saw the pandemic as an opportunity to increase students’ understanding of how science knowledge is generated, evaluated, disseminated, and used. Other teachers also saw their curricula as a type of capital that could help them teach how scientific studies are conducted.

10.3 | Using capital

While teachers may acquire capital in the form of knowledge or resources, the practical application often determines its influence on professional agency. In this study, this distinction was particularly salient in the content of technology as both human and social capital. For instance, Participant #27 exclaimed, “I have become a Schoology wizard.” Another teacher demonstrated agency by using technology to manage their classroom: “I make it very clear when screens are needed and when they are not...My district has a software that allows for me to view and/or remote-control student computers...I like to use it during quizzes/tests to hold students accountable” (Participant #46).

Interestingly, technology emerged as not only human capital to support science teaching but as social capital, helping science teachers navigate the multiple demands placed on them. While some science teachers felt the distance from their students was stressful, other teachers saw this as an opportunity to balance both professional and personal demands. Participant #28, for example, explained that “working from home has dissipated almost all of my stress, and I’ve been able to return my health to normal.” Some teachers explained that technology allowed them to feel connected to their students and colleagues in ways that alleviated pressure.

Although the need to learn how to use available technology to teach in new modalities was not unique to science teachers, the need for disciplinary curricular materials related to science and teaching in socially just ways was important. For instance, Participant #29 noted that “having an online curriculum like Amplify Science has been a blessing in disguise. I hate teaching from a script, but I never have to worry about equitable content or experiences for my students.” Yet, this teacher was also frustrated that their school administrators were not supportive of science teachers acquiring and using capital that could be shared laterally with other colleagues, and this negatively impacted student engagement: “However, our school leaders have strongly discouraged labs or sharing of any materials. The biggest challenge this year, as with last year, is student engagement.” Some teachers acknowledged their acquisition and use of social capital as they described the support they received from their



schools and districts. One respondent explained, "I continue to find new resources and new ways for students to connect with science and show what they know and can do--but it is extremely challenging!" (Participant #6).

Science teachers also referenced mentors as a form of human capital, although we noted it was used as a social capital too. The recognition, acquisition, and use of mentors was described frequently by science teachers, as the following quotes demonstrate. Some teachers found comradery in co-mentors to help them cope with challenges:

- I don't have a mentor, but my colleagues across disciplines are all co-mentoring and working together to share tech resources, platform training, cool ideas they stumbled across, ways to support students this year, etc. It's awesome and I'm incredibly grateful for the people I work with. (Participant #59)
- I definitely rely on the other teachers to see if they're encountering the same issues and how they're handling it. Modifying science curriculum in a creative and interesting way has been a team effort so we have had many late-night PLC meetings to do so! (Participant #23)
- We have a group chat between science teachers where we are being supportive of one another. I have some common planning sessions where teachers are working together, but we are all overwhelmed trying to move an inquiry-based curriculum to fully online. (Participant #60)

These science teachers saw colleagues across and within content departments as both human and social capital. Indeed, some teachers lamented not having access to this capital because they were not in school and could not network in person with their peers.

10.4 | Investing in capital-building

In an ever-changing educational landscape, achieving agency is not just about the present but also applies to the ability to plan for future events and exert control over their professional decisions leveraging various available forms of capital. Teachers who exhibited agency showed a proactive approach to maintaining control over their professional decisions and creatively planning for supporting students in the long-term. For instance, Participant #11 noted an abundance of "...professional development (specifically webinars and Zoom classes) available. There is an overwhelming amount of resources to support student learning." This comment reflects not just the acquisition and present use of technology but also its future application to continue teaching in the "digital world." Another agentic perspective came from Participant #37 who emphasized the dual responsibility of continuously addressing academic and social-emotional needs. "...now more than ever, our students and learners need us to show us to show up for them and support not only their academic growth but also their social emotional learning."

While these experiences are broadly relevant to all teachers, science educators faced distinct challenges, especially as they related to inquiry and lab-based lessons. The next example highlights how science teachers, specifically, were thinking creatively about using capital to support inquiry-based teaching. Participant #2 spoke about changing the timing of independent and collaborative projects to mitigate the potential to shift to remote teaching.

Last year we had to more independent projects, learn to Zoom and figure out ways to teach remotely. This year I am trying to get more labs, and hands on things done early, in case we do have to go remote again, but at the same time practice social distancing so that we hopefully do not have to go remote. It definitely makes me think outside the box for lesson plans, and a lot of what we do this year is spontaneous and student led.

Similarly, Participant #33 discussed the need for adaptability in planning for the future, specifically in terms of quickly adjusting inquiry-based activities to suit different teaching modalities:

I have been spending most of my summer reworking my curriculum to include in person and remote lessons and have spent a considerable amount of time trying to figure out how to safely conduct labs, communicate effectively while wearing a mask, and how to implement class management during remote learning.

These narratives exemplify agency by illustrating the importance of acquiring and strategically implementing different forms of capital to address their students' or their own immediate needs while planning for future contingencies. As illustrated previously, this approach often involves remaining involved in or seeking access to a supportive community of practice. In summary, the narratives from participants illustrate that they drew on both *social and human capital* to support their professional practices. Furthermore, those who acquired, used, and invested in both types of capital were the ones we identified as having achieved agency (being in control during a major professional disruption).

10.5 | Nonagentic teachers

In contrast to the preceding subsections that explored awareness, acquisition, use, and future planning related to different forms of capital contributed to their agency, here we describe the experiences of those who were coded as nonagentic. The term is used to describe teachers who, unlike their agentic counterparts, found it challenging to leverage any form of capital to address the challenges they identified.

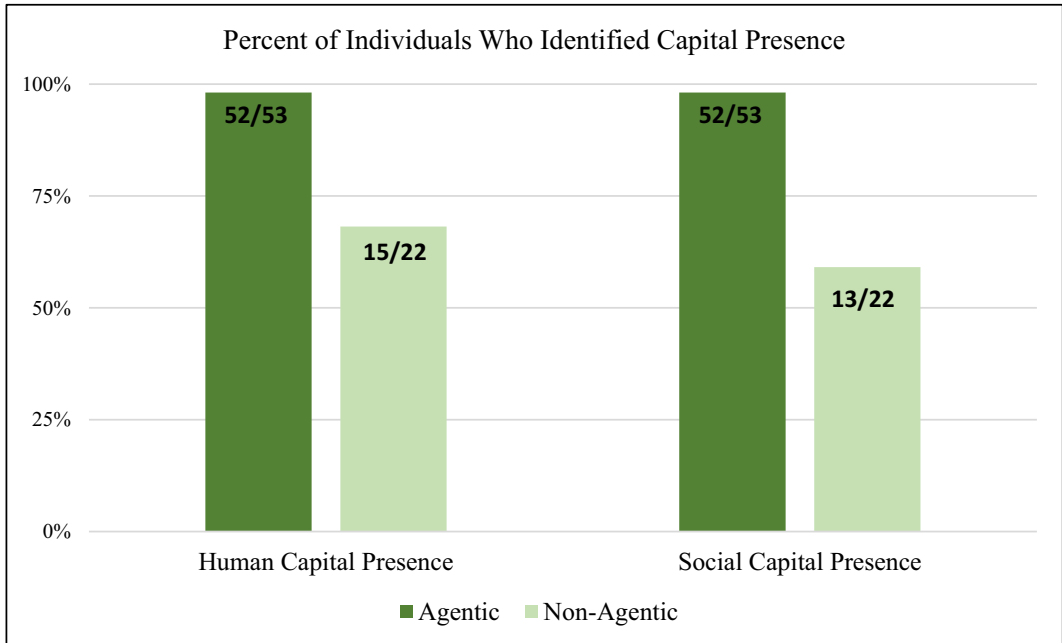
These teachers often spoke about their own stress in managing their professional, social, and personal roles and expectations. This was evident in the shifting focus of survey responses from students' mental health (Survey 1) to their own socio-emotional struggles (Survey 3). For example, Participant #51 expressed that teaching during the pandemic "...often [left] me tired, unmotivated, and makes me much less patient with students." Others described more than exhaustion, referencing their mental health: "I am far worse off now than I have ever been. If there are opportunities to take advantage of, I am too anxious and stressed to pursue them" (Participant #29). Some teachers specified additional stress from practical, real-life concerns, such as "...childcare, added stress of health and safety concerns" (Participant #10). Adding another layer of complexity, Participant #34 noted stress from ideological conflicts with their community: "I am a Democrat teaching in a highly conservative community with students who are largely Republican. Mask wearing became largely political in my school and this has been a battle fought each day."

While these experiences could be universal across teaching disciplines, some comments stood out as unique to science teachers. Participant #44, for example, noted the alternative career opportunities available due to having a science degree, stating:

Low wages and too high of expectations set by admin/district with no support. Having a degree in chemistry and a Masters degree, I know I would make significantly more in another career and have less work hours. This year has been exhausting and I don't feel adequately compensated or respected. (Participant #44)

While it was challenging to definitively classify teachers as agentic or nonagentic—given that agency is neither stagnant nor dichotomous—we identified recurring themes among participants. These themes illustrate how agency relates to the awareness, acquisition, use, and investment in various forms of future capital. However, it was evident that some teachers struggled to navigate these aspects successfully. This is reflected in Figure 3, which illustrates the complex relationship between levels of agency and the associated challenges and capitals that were mentioned in each group.

(a)



(b)

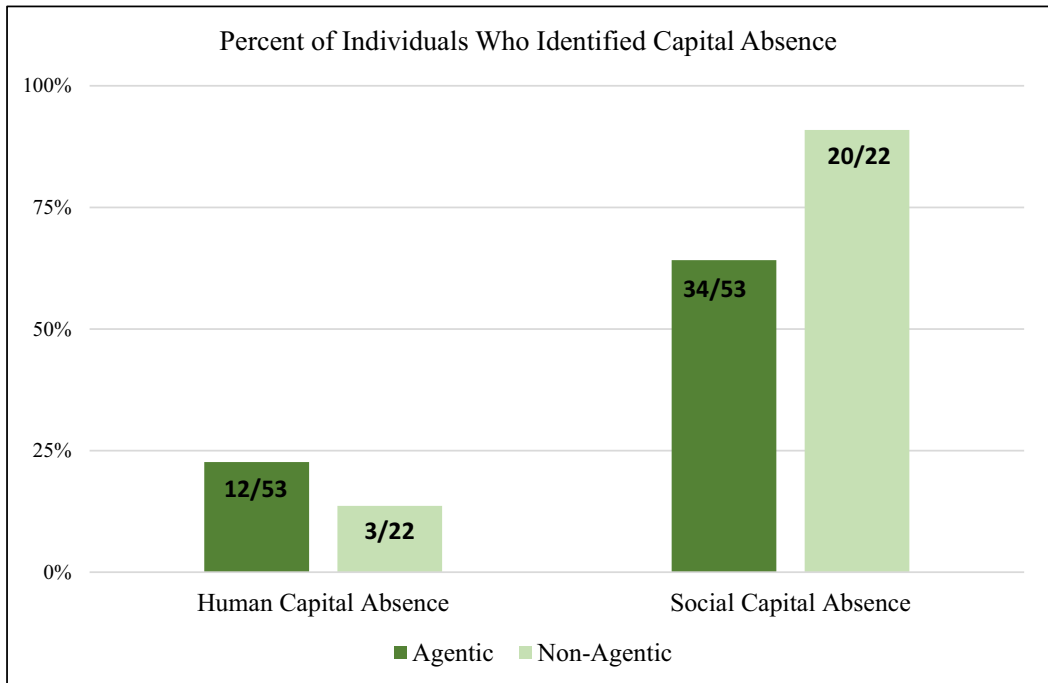


FIGURE 3 Percent of Agentic and Nonagentic individuals who identified each type of capital absence and presence. (a) Percent of Agentic and Nonagentic individuals who identified presence (i.e., capital awareness, acquisition, use of, and/or invested in) of human and social capitals. Agentic teachers identified more of both types of capital. (b) Percent of Agentic and Nonagentic individuals who identified an absence (i.e., unavailable, inaccessible, or unusable) of human and social capital. Nonagentic teachers identified more capital absences.

11 | DISCUSSION AND IMPLICATIONS

We recognize that working during the recent pandemic has created challenges for many people worldwide. We began this study to understand how science teachers navigated their professional landscapes during the pandemic recognizing that science teachers likely faced unique challenges providing high-quality science learning experiences during this time. All teachers were expected to wear multiple hats as the pandemic started (e.g., ensuring students' mental and physical health, communicating changing instructional delivery plans with students' families, maintaining their own families' health, learning new technology). However, here we report on the specific additional concerns of science teachers to continue providing meaningful, standards-based, equitable, inquiry-based science instruction.

11.1 | Theory integration

Capital and agency theories provided the framework for our investigation. These theories allowed us to identify the types of capitals science teachers described as necessary to feel agentic. The teachers we categorized as agentic described a reflective and proactive approach (Emirbayer & Mische, 1998) to leveraging both human and social capital to handle both immediate and future challenges. This theory integration is particularly relevant for science teacher educators and to school administrators, as it provides insights into both personal and professional attributes that foster a sense of agency that may lead to improved teacher retention and job satisfaction.

11.2 | Implications for practice

It is known that increasing job tasks or the perceptions of mismatched job priorities among employees and employers can cause stress, and even attrition (Adiguzel & Kucukoglu, 2019). Our participants described juggling many professional and personal expectations, as others have reported (Schunk et al., 2018). The pandemic required science teachers to navigate classroom management and manage their own human and social capital needs as they communicated with their students' families and administrators. In addition to this, science teachers still had to attend to academic needs, such as redesigning on short notice their science curricula and instruction to ensure students stayed engaged in remote or in-person learning, while foregrounding the importance of inquiry in science learning. This was often required of teachers with little support from schools and school districts, which created more burdens for teachers. Although the teachers in our study were concerned about their students' socio-emotional and academic outcomes, they also expressed the possibility of leaving the profession altogether (Rumschlag, 2017; Skaalvik & Skaalvik, 2011), this was particularly salient to science teachers who, like Participant #44 noted, have other, less exhausting, career opportunities afforded by their science degrees.

The ability of teachers to identify and use support, whether from administrators or colleagues, was essential for building and maintaining agency and may mitigate challenges that lead to high science teacher attrition. Although most teachers in our study expressed feeling overwhelmed, those who were categorized as agentic also spoke of being hopeful, resourceful, and creative as they found and leveraged capital to maintain quality science instruction for their students (Balgopal et al., 2022). For example, many of the participants in this study saw their colleagues as capital and found support in helping one another by sharing science curricula to help navigate the challenges of the pandemic. Educator communities as human and social capitals has also been shown in other studies (e.g., Balgopal, 2020). For example, Fackler and Sexton (2020) similarly found that resilient teachers tended to leverage community support. Given these findings, school

administrators and science teacher educators should emphasize the need to establish and nurture professional learning communities and peer support groups to improve teacher resilience.

The challenges articulated in this study appeared to disproportionately affect faculty members in the early stages of their careers. This aligns with existing research suggesting that while early career teachers enter classrooms with high professional agency regarding pedagogy and content knowledge, they must renegotiate professional agency related to classroom management (e.g., Etelapelto et al., 2015). The pandemic exacerbated this phenomenon by requiring teachers to navigate additional expectations and increased communications with their students' families and administrators while managing personal and professional challenges. While some teachers sought support (social, professional, personal, etc.) to maintain their capacity to address unexpected professional demands, others reported feeling overwhelmed and isolated. The ability of teachers to effectively navigate these complexities holds significant implications for the quality of students' learning experiences. For example, science teachers' abilities and experience with remote teaching and engaging students through active learning may explain student performance more than demographic variables (e.g., gender, race/ethnicity; Orlov et al., 2021). In this light, we have used our findings to engage our science teacher mentees in conversations about the types of capital they believe they need, can acquire, and will use to bolster their professional agency, and by extension, their students' educational outcomes. We also encourage our colleagues to do the same.

11.3 | Limitations

Our study has several limitations that warrant considerations. First, achieving agency is a dynamic process that likely evolves over time. Our study is constrained by the comments teachers shared with us through three time points. To this point, Silver et al. (2021) concluded that because people interact with others in different contexts in various ways, agency should be thought of as a continuum, as we also advocate (see Figure 4). Therefore, our findings are a snapshot, capturing whether teachers were agentic at specific moments, particularly during a major professional disruption (i.e., the pandemic).

Second, the teachers who participated in our study may not reflect all teachers who navigate professional landscapes experiencing turbulence. Lastly, our analysis is limited to open-response survey results and may lack the depth that interviews with teachers or classroom observations might provide. Despite these limitations, we believe our model offers valuable insights for other researchers of science teacher resilience and attrition.



FIGURE 4 Teacher participants fell along a continuum of nonagentic and agentic, which were determined by their awareness, acquisition, and use of capitals to address their challenges during a professional disruption, such as the COVID-19 pandemic.

12 | CONCLUSIONS

We believe that researchers of science teacher education will find our study to be timely. Teachers of all subjects experience professional challenges; yet because science teachers in the United States are at risk of leaving to find higher-paying jobs, a concern exacerbated during the pandemic, we focused only on science teachers. Our findings can help mitigate further science teacher attrition that may occur because of stresses created during the pandemic or other major disruptions. As Bortolotti (2018) wrote, "...we should encourage the adoption of beliefs that emphasize our resources as agents without denying the reality of the setbacks we might experience, as such beliefs are instrumental to enhancing resilience, building our capacity to engage in agentic behavior at critical times" (p. 531). In other words, it behooves teacher educators and school administrators to understand what capitals matter for science teachers, how they use these capitals to address their perceived challenges, and whether professional colleagues are making capitals accessible to teachers. Moreover, we contend that science teacher educators and school districts should work collaboratively as a community of educators to support teachers in achieving professional agency by providing them with more relevant (what teachers believe they need) human capital, promote social capital, and help them to identify what capitals are accessible and relevant. Ultimately, the onus is on science teachers to achieve agency, since no one can give agency to others (Biesta & Tedder, 2007). If we do not heed the concerns of science teachers now, during global crises that strain our education system, we are sure to witness both an increased teacher exodus as well as a shortage that cannot be filled with new recruits.

ACKNOWLEDGMENTS

The authors appreciate and acknowledge the teachers who took time to participate in this study when they were navigating new challenges and opportunities. We thank the reviewers for their helpful suggestions.

DATA AVAILABILITY STATEMENT

The data supporting the results of the current study can be found in the Mountain Scholar Data Repository (<https://doi.org/10.25675/10217/232378>).

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Diaz-Clark, E. D., Otto, J. L., Wright, D. S., Lin Hunter, D. E., Sample McMeeking, L. B., Weinberg, A. E., & Balgopal, M. M. (2024). Under pressure: How do science teachers use capital to achieve agency during turbulent times? *Science Education*, 108, 680–700.

<https://doi.org/10.1002/sce.21852>