# Cultivating Science Cultural Capital among Preservice Teachers in an Online, Synchronous Science Method Course

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**Abstract:** This qualitative study examines production and reproduction of science cultural capital in a fully online science method course taken during the COVID-19 pandemic. Findings revealed preservice teachers (PSTs) with daunting family responsibilities and COVID-19 challenges required extensive faculty mentoring and affirmation of positive science identities. Socio-emotional mentorship and engagement in well-scaffolded, inquiry based scientific activities enabled PSTs to develop positive science identities and participate meaningfully in science pedagogy. With positive science identities came higher confidence levels and development of pedagogically valuable science cultural capital.

The COVID-19 pandemic produced myriad challenges for education and added to the existing inequality and disparity in K-12 science education. The transition from the fully in-person classroom to the virtual classroom was almost overnight. Although there were institution-sponsored virtual workshops about navigation of the virtual classroom, there was no preparation time before transition to virtual modality. The sudden change was very stressful to students and faculty equally. It was vital to create an environment in the classroom in which a smooth transition from one type of learning to another type could take place. Faculty had to explore ways to create an academically productive, emotionally safe, and conversationally comfortable virtual classroom environment for their students.

Jennings & Greenberg (2009) state that teacher behaviors contribute to an optimal social and emotional climate for student learning. More specifically, Jennings & Greenberg stress that when teachers lack physical and emotional resources to effectively manage the social, emotional, and academic challenges of a classroom students show lower levels of achievement. In order to effectively manage and respond to social and emotional challenges and maintain a productive classroom, a prosocial classroom mediational model was adapted as an organizational framework for the class discussed in this paper. The prosocial classroom model hypothesizes that a teacher's social-emotional competency and well-being influences classroom climate and mediates student performance. A teacher's higher level of socio-emotional competency is a very important variable that contributes to the development of a supportive classroom environment and reduces students' negative beliefs and emotions, anxieties and disruptive behaviors as it increases empathy and provides tools for self-control. It also promotes enthusiasm and enjoyment of learning among students.

At the beginning stage of the virtual learning environment discussed in this paper, the emotionally exhausted pre-service teachers (PSTs) were at risk of failing and becoming depressed and demoralized. Many felt they had little to gain from continuing in the course. A number of PSTs dropped out of the teacher education program for the semester. To save PSTs from falling out of the course and to prepare them to be effective and successful in their future classrooms, it was essential to enable them to become socially and emotionally competent teachers. Socially and emotionally competent teachers understand and recognize emotions of others in and outside the classroom and they can navigate conflict and stressful situations (Jennings & Greenberg, 2009). Although PSTs were disturbed by challenging emotional environments outside the class, financial difficulties (many lost their jobs), ill-health, and lack of technology resources (poor or no internet connection, sharing one computer in a family of four or five people, very old computers with no cameras) and extremely stressful familial situations, they managed their coursework throughout the semester with the help of constant scaffolding in the form of counseling through Zoom or phone meetings with the instructor of the class.

This study took place in a School of Education in Brown College (a pseudonym) which is part of an urban, commuter, pre-dominantly Black institution situated in a low-income, urban community on the East Coast of the United States. The PSTs at Brown College include first-generation college-going immigrants many of whom are non-traditional students (age 30 or over). Most have experienced limited professional career development opportunities due to persisting structural barriers. They struggle to achieve academic excellence since they face a myriad of social, familial, and economic problems. The majority of PSTs at Brown College are women preparing to become elementary school teachers.

Although science, technology, engineering, and mathematics (STEM) education has recently been the focal point of a national teacher preparation conversation, comparatively little attention has been paid to STEM education among minoritized teacher candidates who in general have had less exposure to science in their own schooling. Herschbach (2011) and Rinke, et al. (2016), have demonstrated the need for greater attention to development of scientific literacy among these groups. The objective of this study is to provide insights into the process of production/reproduction of stronger levels of science cultural capital and more positive science identities among PSTs from minoritized groups. To address COVID-19-related socio-emotional challenges and long-standing disparities in science education among their students, teacher educators need to prepare effective teachers able to transform science education so that the minority K-6 children they are likely to teach may become successful in science classes and enjoy careers in scientific fields. (Tobin et al., 2005) Three research questions guided the study: 1) How do PSTs produce and reproduce cultural capital? 2) What was the role of pre-college science experiences and science background in acquisition of science cultural capital? 3) How did PSTs' negative science identities shift to positive ones?

## Theoretical Framework

*Cultural Capital*: Using the theoretical frameworks of cultural capital (Bourdieu and Passeron, 1990; Bourdieu & Wacquant, 1992; Bourdieu, 1986), and science identity (Carlone & Johnson, 2007; Estrada et al., 2011; Farkas, 2017) this study explores how cultural capital earned in the science method course enabled pre-service students to develop positive science identities that afforded them stronger levels of science cultural capital. The concept of "capital" is vital to Bourdieu's theory of social reproduction. Bourdieu (1986) conceptualizes capital as the pool of resources in a society that can generate forms of social privileges within specific fields such as education. Bourdieu defined four types of capital — economic, social, cultural, and symbolic — that individuals earn via interpersonal interactions. Cultural capital is expressed as habitus, a set of dispositions which guides specific actions and behaviors within various social contexts. Cultural capital refers to qualifications, dispositions, and cultural resources. While economic capital refers to money and financial resources, social capital refers to social networks and relations, including symbolic capital (prestige, recognition, and legitimation) which may be very powerful in earning social advantage. Bourdieu (1986) depicts economic capital as the original ground for cultural and social capital. His theory of social reproduction is grounded in the idea that an individual's actions are determined by factors external to persons (Rogosic & Baranovic, 2016). Economic and cultural capital do not operate in isolation, but interact to determine a person's position within their life world (Archer et al., 2015).

*Science-Related Social Capital*: Thompson et al. (2018) state that in science education research cultural capital has been used as a lens for understanding disparities in science education outcomes (Aikenhead, 1995; Brickhouse, 2001; Adamuti-Trache & Andres, 2008; Archer et al., 2015; Claussen & Osborne, 2013; Gazley et al., 2014; Thompson et al., 2016). Cultural capital can powerfully affect the degree to which students consider futures in science for themselves as "thinkable" (Archer et al., 2014). Thompson et al. (2012, p. 2) found that families who value science and embed science into day-to-day life, "whether as a result of family members' own interests and careers in science or through 'concerted cultivation' of science in the household, more effectively foster and support scientific aspirations among their children" (Archer et al., 2012 and Lareau, 2003).

Coleman (1990) discusses the influence of social capital on an individual's educational achievements, schooling experiences, and future options (Parcel & Dufur, 2001; Pishghadam & Zabihi, 2011; Portes, 1998; Pusztai, 2014; White & Glick, 2000). Differences in educational success can be attributed to different levels of existing social capital produced in the networks and connections of families and communities that a school serves. For example, knowing someone who works in a science field is a form of science-related social capital. Social capital supports educational success in the form of appropriate behavior in classroom and school environments and in the values that motivate students to achieve academically (Acar, 2011). The social capital stance views cultural capital as that set of resources resident in social relations. According to Lin (1999, 2001) the notion of social capital plays out in a person's life as expected benefits from investment in social relationships. In this study, all but two PSTs lacked science social capital. Not only were most of the study subjects unfamiliar with science know-how, they also had a strong fear of science.

*Science-Related Social Capital and Science Identity*: Archer et al. (2015, p. 922) have proposed the term "science capital" to refer collectively to "science-related forms of cultural and social capital." Science capital largely aligns with measures to operationalize *cultural capital* in science and science education: scientific literacy (knowledge and ability to apply it), scientific-related dispositions and practices (recognizing the value of science in society and having a positive attitude toward science), and recognition of the value of scientific know-how and credentials in the labor market (Thompson et al., 2016 and Huang & Liang, 2016). Anyon (1981) and Tobin (2016) note that cultural capital helps explain academic achievement gaps between minoritized and majoritized students; but that means improvement among minority students in science-related social capital is key to overcoming the achievement gap. As PSTs become confident in understanding and application of norms, dispositions, motivations, and identities characteristic of scientific work, they will overcome their own science-related cultural capital deficits and be able to help their students overcome similar deficits. In the context of science method courses, science cultural capital leads to a deeply embodied (and often unspoken) understanding of the "rules of the game" of science (Bourdieu &Wacquant, 1992), contributing to a desire to be active in science teaching and learning, developing confidence to enact effective science teaching strategies, earning recognition by others as a good science teacher, and achieving social mobility in the educational job market.

Beyond the science classroom, Bourdieu (2005, p. 55) notes that science-related social capital "can be converted into other kinds of capital, economic capital in particular." Archer et al.

(2015) fleshed out and broadened Bourdieu's point by observing that science-related resources in the form of science capital possess high symbolic value. Science disciplines have a high social and cultural status. Claussen & Osborne (2013) argue science qualifications command a strategic value in educational and labor markets. Furthermore, what Archer et al. (2015) call the scientifically literate ''science citizen'' is better placed to play an active role in modern society. Knowledge and understanding of scientific concepts, processes, and ''how science works'' enable individuals to interpret and apply the scientific knowledge that they cultivate in their everyday lives to make better informed choices (e.g., around personal health) and enable them to access, understand, respond to and even contribute to shaping scientific developments in society.

Science identity is 1) an internal sense of oneself as a "science person" who knows science and is able to do science, and 2) the personal recognition and development of one's science-self in social contexts of science teaching and learning (Gee, 2000; Carlone et al., 2011; Hurtado et al., 2009; Hazari et al., 2013; Trujillo & Tanner, 2014). Science identities are fluid and can shift directions over time (Brickhouse et al., 2000; Carlone et al., 2014; Gazley et al., 2014; Roth & Tobin, 2007). A student's science identity is a good predictor of whether a student opts or does not opt for a STEM career (Chang et al., 2011; Hazari et al., 2013). Science cultural capital affects development and cultivation of science identity among teachers (Varelas 2012.) Adams & Gupta (2013, p. 4) define teacher science identity as "the ways in which a teacher represents herself through her views, orientations, attitudes, emotions, understandings, and knowledge and beliefs about science teaching and learning." Stetsenko (2008) explains teacher professional identity development as an ongoing process of learning to teach guided by relations to others in specific educational contexts. Becoming a science teacher means learning and practicing how to navigate the continuous flow of the social practices of teaching and learning; "identities are the part of self that are defined by the different positions we hold in society" (Varelas, 2012, p. 3).

Science belief and science identity develop symbiotically in a continuous progression of learning to teach science. Identity construction is affected by contexts or fields in which one learns to teach and in which one teaches. Science belief is one's agency or a sense of empowerment that the self is capable of making the right instructional decisions, apply useful science resources in teaching, and confidence about constructing and maintaining an effective science learning environment. For science teachers, it also means confidence in content knowledge and ability to motivate and sustain science learning in students. In this study, although the COVID-19 pandemic negatively influenced PSTs' cultivation of science identity and they struggled early in the course, by the end of the semester PSTs in the study were successful in cultivating positive science identity and overcoming their negative beliefs about science. They realized that if they could do science in virtual environments, they would be successful in teaching science in in-person situations, as well.

*Constructivism*: The constructivist developmental psychological theory of Vygotsky is highly relevant to this study. The socio-cultural constructivism of Vygotsky sees cognitive development as largely dependent on social interaction and communication of learners with more knowledgeable others. Vygotsky (1978) stresses that the culture we live in provides us with a number of different types of cognitive tools with which we construct meaningful knowledge about our life world (Meletiou-Mavrotheris et al., 2009; Willis, 1998). Since there is relative homogeneity of intellectual practices among groups of experts within a single community, more knowledgeable others guide learners through investigative activities that are relevant not only personally but also to the social contexts in which instructive interaction occurs (Tobin &

Tippings, 1993). The fact that an individual's experiential world is socially mediated and exists as a constant negotiation between individual and social knowledge suggests the success of instructional interactions depends on the learner's internalization of the social context in which instruction takes place. Therefore, a constructivist environment, a 'classroom community', has to be built in order to provide learners the opportunities to construct knowledge (Meletiou-Mavrotheris et al.2009). The classroom environment must provide an information-rich context within which meaning of concepts and ways of understanding can be negotiated successfully by learners (Hannafin, et al., 1997). Rich environments like 'communities of practice' (Goos, 1997) are appropriate for optimal classroom learning.

*Community of practice*: Community of practice is a construct grounded in an anthropological perspective that examines how adults learn through social practices (Gray, 2004). A community of practice consists of a group of individuals with a shared domain of expertise, who engage in a process of collective learning about practices that matter to them (Wenger, 1998). In Wenger, McDermott & Snyder's (2002, p. 4) words, "communities of practice are groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis." Learning is an interpersonal social process. This stance envisions the relationship between instructor and students as a social process of learning in which participants don't necessarily work together every day, and their life worlds may vary from each other's, but they meet regularly to work on shared goals and find value in their interactions. According to Crawford (2004), in a community of practice there is a perceived need to rebalance the learning experience more positively towards collective experience by focusing on collaboration, communication, co-learning, and co-inventing. A community of practice approach to classroom learning requires a shift away from an individualistic perspective on learning to a social systems approach to schooling (Stahl, 2006; Vygotsky, 1978; Engeström, 2001; Wenger, 1998).

The theoretical construct of communities of practice is a useful analytic tool in outlining the theoretical underpinnings of the science method course discussed in this paper. In this course, teaching and learning took place in a virtual social context among groups of interested individuals who have the collective goal of learning how to teach science. PSTs enrolled in the class spent time together in synchronous virtual classrooms where they shared their past experiences with science and helped each other solve problems about science learning. They discussed their personal situations, their aspirations and their academic and social-emotional needs in class with their peers and the instructor. PSTs deliberated common issues and complexities of COVID-19, explored ideas and strategies of science teaching, and acted as sounding boards for one another. They created tools, artifacts, science standards, science fair designs, lesson plans, and other documents, and developed a shared understanding of science pedagogies. Participating PSTs formed a sense of community, interpersonal support, and personal satisfaction in knowing colleagues who understood each other's struggles and perspectives, bonded by the sense of accomplishment and reward that they found in learning together (Wenger, McDermott & Snyder, 2002). They also developed a common sense of science identity as they formed a community of practice.

The concept of communities of practice is also especially relevant to this research because the research is about the process of facilitating *virtual* communities of practice. Internet encounters focused on establishing rapport and sharing experiences between participating PSTs and the educator. As Wenger et al. (2002) state, communities of practice do not reduce knowledge — they make it an integral part of activities and interactions. Since the course was offered virtually it included space for discussions, breakout rooms, and application sharing between PSTs and instructor in online meetings. Participating in the out of the ordinary, online classroom environment involved a shift from individual activity to artifact-mediated, collaborative participation during class sessions (Lunds, 2008).

## Research Design and Methodology

The study uses a Design-Based-Research (DBR) framework in which an educator-researcher seeks to improve impact, transfer, and application of education research into contexts of practice (Anderson & Shattuck, 2012; Brown, 1992). DBR is about an effective intervention that can migrate from experimental classrooms to instructional classrooms. In this study interventions are a form of positive feedback, Zoom meetings outside class time, and sharing family situations and discussing ways to deal with problems were applied constantly to fulfill PSTs' social, emotional, and academic needs.

*Context of the study*: EDUC 317, Teaching Science in Elementary School, is an undergraduate science method course for pre-service urban teachers offered at a commuter college in a poverty-stricken area of the northeastern United States. In mid-March 2020, six weeks after the class had begun, the course had to be suddenly transitioned to fully online synchronous mode from a face-to-face modality. In the synchronous modality, after participating in a 3-day emergency institute to facilitate transition to online instruction, the professor followed a set class time and met with students enrolled in the class on Zoom, a platform for digital instruction. There were thirteen students enrolled in the class. The demographic profile of the class was:

| **Sex** | **N** |
|---|---|
| Female | 11 |
| Male | 2 |
| **Race** | |
| Black | 11 |
| Latina | 1 |
| Asian | 1 |
| **Citizenship Status** | |
| Immigrant to US | 9 |
| US Citizen | 4 |
| **Family College Experience** | |
| 1st-Generation College Student | 9 |
| 2nd-Generation College Student | 4 |

## Instructional Focus and Curriculum

The science method course focused on four key dimensions: technology-enhanced science learning with social-emotional mentorship, science pedagogy and production of science cultural capital, developing a positive attitude toward science, and cultivating positive science identity. Assignments included writing an ongoing science journal, teaching one virtual science lesson to a group of elementary-aged students, designing and demonstrating science experiments, and developing a science fair project which the PSTs enacted online for a group of K-6 students, an event organized with the help of Community of Volunteer Educators (COVE). Science teaching videos were used as a pedagogical resource for modeling science teaching strategies. The course sought to develop communities of science learners that reflect the intellectual rigor of scientific inquiry and the attitudes and social values conducive to science learning.

PSTs wrote in their journal about their science experiences and their likes and dislikes of science that originated in their elementary, high school, and college introductory science courses, or during the pandemic. Topics included their experiences, perceptions, ideas, beliefs/mindsets, motivations, or attitudes toward science; their understanding, ease, and comfort with problem solving procedures and inquiry learning; their knowledge of science concepts; their confidence level to learn and teach science; and readiness to apply in the field recently acquired pedagogical knowledge about teaching science. Of particular importance to establishing a baseline scientific identity for each PST, in the first week of the class participants wrote a Walking Down Memory Lane reflection about their prior science experience. The assignment consisted of three sections: 1) elementary and high school science experience, 2) past science experiences gained from family science background and access/exposure to science activities outside of school, 3) science identity and self-efficacy/confidence level to teach science in elementary grades. The reflective journal provided a framework for the course instructor to guide day-to-day discourses of science instruction. Many PSTs came to the course with negative beliefs, fear of science, and very weak science cultural capital. However, success stories predominated among the PSTs by the end of the semester as the following accounts attest:

**AH**, a Caribbean, first-generation college student with initially weak science cultural capital, wrote in a late-semester entry to the reflective journal, "I was very skeptical of taking this course because I did not like science and I was intimidated by the idea of teaching science… but I am not scared of science now. If I can teach science to students in virtual classrooms and do Science Fair experiments for children and parents I can teach science in elementary grades."

**KB**, an African American PST with medium science cultural capital, described himself as a first-generation college student, coming from a family with no science background. He began to develop interest in science in the first year of college, when he took two biology courses with a professor who provided guidance and made science accessible to him. In the beginning of EDUC 317, he was very much interested in the course but after the first month he had to deal with his mother's COVID-19 illness and a death in his family. As a result, he became disoriented and was ready to drop the course. He needed constant mentoring and emotional support from the professor. He participated in phone calls and Zoom meetings with the professor almost every day for three weeks. Towards the end of the semester, he gained his confidence and completed missing assignments. After taking the science method course, **KB** developed confidence in his ability to teach science in elementary school. He described in his reflective journal how he was assertive in the science fair project; in planning, developing, and writing a unit plan; in teaching science lessons; and demonstrating science experiments for faculty and peers. He felt confident and proud of his science teaching abilities by participating in COVE activities.

**GM**, a mother of two children, was having serious emotional problems with one of her children due to COVID-19 which, along with her initially weak science cultural capital, complicated her participation in the class. In the beginning of the class, she explained her personal crisis to the professor and requested more time for all assignments. She had limited science exposure before the science method course. Throughout the semester she struggled to finish all work and needed faculty assurance and affirmation. However, all her work was well researched and of exceptional quality. At the end of the course, after the science fair presentation, **GM** was very happy she could finish the course successfully. She came to the course with very limited science cultural capital but a high level of interest in science and achieved her goal to be a good, elementary-grades science teacher.

During the COVID-19 pandemic, PSTs put the needs of their family ahead of their individual academic needs. Although the close-knit family ties provided strong emotional and social support for PSTs' success in college, family responsibilities and needs posed immense constraints on them and pulled them away from their studies. That seemed like a lack of commitment to science and the coursework. This is consistent with the way **SM** framed her time away from college. She had to take care of her father and grandmother after her mother passed away during the first wave of COVID. Her family responsibilities were her priority and were competing with school work. Though **SM** did not show any resentment towards her academic responsibilities, an artifact of her initially strong science cultural capital, her family obligations contributed negatively to her science identity, her scientific dispositions, and to realization of expectations that earned recognition from the instructor. However, *recognition of arduous family responsibilities* from the professor provided a sense of relief and lessened **SM's** anxieties about completing coursework, lead to opportunities to develop science-related cultural capital, and, ultimately, to a positive science identity. When the professor demonstrated a *flexible attitude* and shifted expectations to accommodate students' family responsibilities, and provided supportive dialogue, PSTs in this study demonstrated their commitment to science curriculum and made attempts to complete course assignments. Specifically, focusing on the science fair while she juggled family responsibilities, enabled **SM** to develop and improve the key science fair assignment and enabled her to hone her science identity.

In the same vein as **SM**, **SS**, who had strong science cultural capital coming into the course but doubted her ability to teach science to elementary school children, shared in her reflective journal that "The science fair was a very good experience… I never thought I could do this… I mean doing a science experiment for children and parents, I can teach science… I am not afraid of science anymore." Proving beyond any doubt her newfound confidence as a science teacher, in Fall 2021 **SS** taught virtual science lessons for a whole 5th grade class as part of her student-teaching requirements. Based on her excellent performance, she was hired as a full-time science teacher by the principal of the school in which she served as a student teacher prior to her completion of the teacher education program at Brown College.

## Building Science Cultural Capital through Socio-Emotional Mentorship

The professor's *expanded scope of recognition and encouragement* helped students develop science cultural capital. The instructor's words of appreciation boosted students' morale and motivated them to demonstrate their potential to develop scientific cultural capital. The broad scope of recognition supported PSTs with growing self-recognition and confidence. PSTs' narratives demonstrate that, when the professor looked beyond students' initial dispositions and expectations and recognized students' personal and academic hardships, work for the class affirmed students' potential as blossoming science teachers. *The open-door socio-emotional mentorship policy* proved to be the key dimension in keeping PSTs from dropping out of the course. The PSTs had the option to meet with the professor online seven days a week from early morning to nine at night to get not only the emotional support but also to discuss their developing identities as confident science teachers.

In terms of method classes, it is especially important for elementary school teachers not to experience science as a difficult and complex discipline, as this would inhibit their developing positive attitudes towards the subject. Just as some students do not feel a sense of membership in science, some elementary school teachers hold anti-science attitudes (Eshach 2003). These attitudes need to be addressed by ensuring new teachers begin to identify themselves as members of a science-centered community (Bellocchi et al., 2013). Contexts of teaching and learning shape learners' identities and their socio-emotional well-being. (Beauchamp & Thomas, 2011). Stetsenko (2008) stresses that the quality of interactions with others is an important part of a learning context as our identities are shaped by our positioning in relation to others in a given context. This agrees with Adams & Gupta's (2015) notion of flow, where a teacher candidate engages in activity that is suitably challenging in a way that allows complete focus and immersion in teaching.

PSTs' experiences in EDUC 317 suggests a few strategies faculty can use to help strengthen science cultural capital. The suggested strategies are:

> Begin the science method course with the assumption that PSTs may not have adequate content knowledge. Start by teaching students "rules of the game" of science.
>
> Constantly provide academic *and* socio-emotional mentorship to help PSTs' realize their aspirations for teaching.
>
> Accommodate PSTs with a flexible attitude towards due dates for assignments, especially women and minoritized students, who likely come to college with competing family responsibilities.

Urban elementary school science education is a highly challenging field where effective science teachers are needed to teach science to minoritized children and narrow the achievement gap in science. Teacher educators have to encourage PSTs to develop science capital to teach science to a range of diverse learners in digital and in-person environments. Before COVID-19, virtual modes of teaching and learning were considered the yet to be realized future of education; but post-pandemic, virtual modes of learning have become a way of pedagogical life. Therefore, PSTs need to use virtual tools and opportunities for their own learning to expand their science cultural capital and become more confident and effective as science teachers.

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