Kelsey Darity and Suzanne Pratt

"Giving them the Opportunity to Create"

Planning for Critical Media Literacy in a STEM+C Context

Abstract. The importance of Critical Media Literacy (CML) has been established, yet teachers, particularly those in science, technology, engineering, mathematics, and computer science (STEM+C) fields, remain unsure of how to implement these tenets in their classroom practice. In this article, we examine the ways that one group of STEM+C teachers in an experimental space grappled with taking on and implementing a CML lens and practices in curriculum development for a summer program. Our findings show that this space was vital as it allowed teachers to integrate their other spaces and work with CML practices to create something new. Critical Media Literacy does belong in the STEM+C classroom, and the space these teachers were granted allowed them the opportunity to figure out how to do it authentically. The importance of Critical Media Literacy (CML) has been established, yet teachers, particularly those in science, technology, engineering, mathematics, and computer science (STEM+C) fields, remain unsure of how to implement these tenets in their classroom practice. In this article, we examine the ways that one group of STEM+C teachers in an experimental space grappled with taking on and implementing a CML lens and practices in curriculum development for a summer program. Our findings show that this space was vital as it allowed teachers to integrate their other spaces and work with CML practices to create something new. Critical Media Literacy does belong in the STEM+C classroom, and the space these teachers were granted allowed them the opportunity to figure out how to do it authentically.

Keywords. Curriculum development, STEM+C, Critical Media Literacy

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“Ihnen die Gelegenheit geben, etwas zu gestalten“

Planungen für „Critical Media Literacy“ in einem MINT-Kontext

Zusammenfassung. Die Bedeutung von Critical Media Literacy (CML) ist bekannt, aber Lehrkräfte, insbesondere in den Bereichen Naturwissenschaften, Technik, Ingenieurwesen, Mathematik und Informatik (MINT), sind nach wie vor unsicher, wie sie diese Grundsätze in ihrer Unterrichtspraxis umsetzen sollen. Der Beitrag untersucht die Art und Weise, wie eine Gruppe von MINT-Lehrkräften in einem experimentellen Raum die CML-Linse und -Praktiken in die Lehrplanentwicklung für ein Sommerprogramm aufgenommen und umgesetzt hat. Unsere Ergebnisse zeigen, dass dieser Raum von entscheidender Bedeutung war, da er es den Lehrkräften ermöglichte, ihre anderen Räume zu integrieren und mit CML-Praktiken zu arbeiten, um etwas Neues zu schaffen. Critical Media Literacy gehört in den MINT -Unterricht, und der Raum, der diesen Lehrkräften eingeräumt wurde, gab ihnen die Möglichkeit, herauszufinden, wie sie dies authentisch umsetzen können.

Schlüsselwörter. Curriculumentwicklung, MINT-Fächer, Critical Media Literacy

1 Purpose

To exist in the modern era is to be inundated with media. Teenagers in the United States engage with media (e. g., films, television, websites, blogs, social media) about nine hours a day (Media Literacies 2022)! Our lives are “increasingly crowded with dynamic digital doings” (Vasquez et al. 2019, p. 300) as we experience a soaring reliance on mass media and digital forms of communication. Because media – and producers of media – shape values, culture, and identity formation (Tebaldi, Nygreen 2022), the importance of CML (CML) has been established. The media serve as an outlet for those in power to shape dominant narrative (Morrell 2008), making vital the ability for students to analyze and create media while also interrogating power structures inherent in and often reproduced by media (Critical Media Project). This is even more true when our students are members of a much maligned and stereotyped segment of the population: youth of color in urban areas (EJI 2021). CML “positions students to assume a sense of agency and activism and desire to be civically engaged with real issues in the world” (Haddix et al. 2016, p. 34) and “allows them to develop a greater sense of self-efficacy and a deeper understanding of their self-worth” (Trope et al. 2021, p. 52). Yet teachers remain unsure of how to implement CML in their curricula.

Teachers' dispositions and pedagogical practices are essential to the work of preparing students to engage with texts (including media) critically (Vasquez et al. 2019) as they must understand institutional systems and the ways that power circulates in them while also interrogating texts for these aspects. To teach CML skills, "it is therefore crucial that K12 educators understand the messages that they and their students receive and internalize" (Joanou 2017, p. 41). How can teachers be expected to do this without themselves being equipped with the necessary skills? Supports for this work are minimal (Robertson, Hughes 2011), and "media education in K12 schooling […] has never really been established and developed" (Kellner, Share 2007, p. 4). Even with a growing number of media literacy organizations, teachers continue to be provided mostly with "text-only guidance and resources that remain largely descriptive in nature" (Trope et al. 2021, p. 45). Teachers cannot be expected to teach what they have not been taught, and we argue that teachers need space to play with CML approaches so they can figure out what these look like for them in order to create authentic experiences for their students. In this article, we seek to explore the outcomes of hosting an experimental space for secondary science, technology, engineering, mathematics, and computer science (STEM+C) teachers to develop a CML lens and practices so they can take them up in their own teaching and curriculum development.

2 Theoretical Framework

2.1 Critical Media Literacy

We cannot discuss CML without also tracing its foundations of critical pedagogy and critical literacy. CML is, at heart, informed by critical pedagogy. The Frankfurt School developed critical theory as social critique to bring about change, taking into account the social, historical, and ideological contexts in which we all operate. Those who undertake critical theory can work to understand the ways they, as members of a society with a constructed power hierarchy, exist in that society while also understanding none of this is inherent and can be changed (Yosso 2002). Freire (1970) took up critical theory as he taught reading the world alongside reading the word such that we can make "visible and examin[e] relations of power in order to change and dismantle inequitable ways of being" (Vasquez et al. 2019, p. 301).

From Freire's use of critical pedagogy comes seminal ideas of critical literacy, or "a way of being through which to participate in the world in and outside of school" (ibid., p. 300). Through a focus on the ways language, images, and other

semiotic systems are used to create meaning, the critically literate are able to more deeply understand how power structures are developed and maintained through discursive practices (Vasquez et al. 2019), particularly in representations of class, gender, race, sexuality, and other forms of identity used to justify inequities and oppression.

Though there is no single correct way to 'do' critical literacy, there are several key tenets. Critical literacy is a lens through which to view multimodal texts, draws on students' funds of knowledge, assumes the importance of real-world relevance, rests on the foundational assumption that texts are constructed and are therefore never neutral, asserts the ways we read text are not neutral but instead informed by our life experiences, views the world as socially constructed and readable, allows us to both understand and question the sociopolitical systems in which we exist, and makes transformation possible through creation of new texts (ibid.).

In this article, we expand upon Kellner and Share's (2007) early definition of CML as critical analysis of media sources by adding the Critical Media Project's (Media Literacies 2022) conception of CML skills: "the ability to access, analyze, evaluate, and create media in a variety of forms" while also interrogating the power structures inherent in media. Here, the focus is on not just analysis of media but also emphasizes the importance of production (reconstruction) and distribution (social action) in ways that push students' thinking (Trope et al. 2021). In this way, students are positioned as knowers and agents of change rather than just critical consumers; they are able to "produce texts that matter to them in different formats and for different audiences and purposes" (Janks 2010, p. 156), to see themselves as people whose ideas, and therefore identities, matter, while also "better understand[ing] the process of media construction" (Mason 2016, p. 83).

2.2 Space

A dedicated experimental space is necessary for teachers to collaborate, play, and take ownership of a pedagogical lens such as CML. Space holds a 'becoming' or changing and unfolding nature such that multiple and interrelated narratives of and in that space are possible. In this "emergent, incomplete, and unpredictable" (Talburt 2000, p. 19) space, participants, or co-producers of the space, are simultaneously impacted by the other spaces in which they exist (e.g., home, community). At the same time, they are inherently able to alter the spaces in which they participate, and are actively working to create the new shared space. Through this lens, an open and democratic space is a space of a vast array of

future possibilities, of potential for change to be enacted. For STEM+C teachers who bring a great deal of other spaces (e.g., content knowledge, skills) to create a new curriculum-making space, a spatial lens allows us to honor the ways these past experiences and areas of expertise have impacted teachers' ideas about the ways they could enact CML in their pedagogies.

3 Methods

3.1. Context

We focus on an experimental space, Global Citizens (GC), created for teacher learning, which is hosted by an institution of higher learning (IHE). It grew from a new-teacher induction program supporting newly graduated teachers working in high-need schools in New York City that runs in association with a residency-model teacher preparation program. Graduates often continue to collaborate with the IHE in various ways for years beyond the formal residency and induction programs including mentoring pre-service teachers, leading/participating in professional development workshops, and joining a range of extended collaborative learning spaces.

GC is a collaborative space that grew from graduates' interest in enhancing their practice through experimentation with theoretical pedagogical ideas they aspired to enact in their classrooms. From this, teachers and teacher educators created a 'sandbox' for experimenting with teaching practices. They worked to make an autonomous interdisciplinary space where they felt safe to be vulnerable while innovating around ambitious pedagogical ideas. Teachers who participate in the space have a range of teaching experience and move in and out of the space depending on their band-width and current professional goals. Some teachers are graduates from the IHE residency program, and others have worked as mentor teachers or are affiliates of the IHE collaborating in other ways. In 2022, the team consisted of 15 members (characteristics of the group illustrated in Figure 1). The cycle of planning typically follows the layout in Figure 2.

There are no limits to the kind of curriculum the team can create but to date the group has divided into two clusters, both of which are focused on creating and implementing STEM+C curriculum:

> Citizen Scientist (CS): Centers on developing knowledges, skills and mindsets related to scientific inquiry with emphasis placed on field-based and data collection experiences as modes of better understanding the root of a

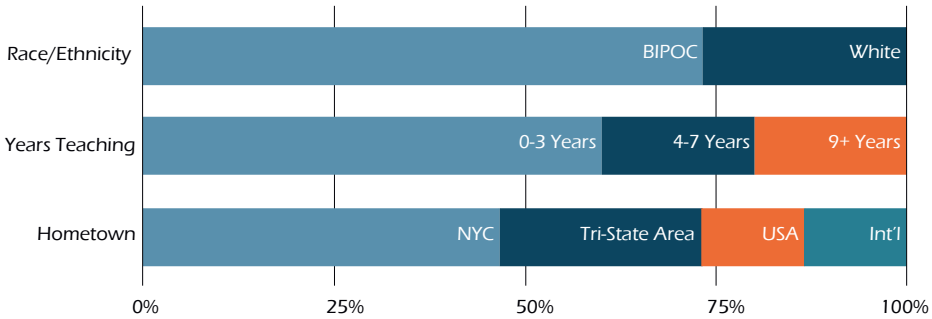

Figure 1: Participant Characteristics

Figure 2: Gloabel Citizens Timeline

problem. In its fifth iteration of design, the curriculum has typically focused on the health of local water bodies in collaboration with environmental science partners in the city.

Digital Citizens (DC): Focuses on using computer science, engineering and design-thinking knowledges, skills and mindsets to understand and address a problem in the local community. In its third iteration of design, emphasis is placed on building, iterating and aligning ideas with voiced concerns of community members.

2022 represented a shift in curriculum as both groups were connected to new local partners affiliated with Morningside Park (i.e., the NYC Parks Dept and a volunteer association), who were looking for people to help address an issue with a Harmful Algal Bloom in the park's pond. The park is historically a site of racial and class contention; in 1968 the majority white IHE attempted to build a university gym on the city-owned land that would offer only limited access, through a separate door, to largely minoritized members of the community. This led to protests from both community members and IHE students, and the project was disbanded, leaving a partially dug foundation in the middle of the park (Collins 2015). Twenty years later, the community worked to transform the hole into a pond for park-goers to enjoy; now the pond is in a state of disrepair, hence the new partnership.

The curriculum team was excited about this opportunity as they discussed how the park's history represented "an example of communities addressing a problem" while also allowing students to participate in addressing a new problem in intersecting ways – CS focusing on data collection and understanding the scientific aspects contributing to the problem; DC emphasizing developing potential ways to address the varied aspects of the problem.

3.2 Study Design

This year, a GC focus was considering how to align both curricula with CML tenets. Members of the curriculum team spent time considering CML principles and practices to plan what it might look like for students to engage in learning through this lens.

This case study investigates the complexities and "abstract aspect(s) of human experience" (Dyson, Genishi 2005, p. 3) that encompass the learning and experimentation of teachers engaged in the development of GC curricula while also

making sense of old and new pedagogical practices. We were particularly interested in better understanding how ideas, meanings, and creative considerations centered around CML principles aligned with their work in this context.

Data were collected in the spring and summer of 2022 as the team prepared for implementation of their curriculum in July. Data collection methods included participant observation by both authors, audio recordings of working sessions, and collection of artifacts developed by the team (e.g., curriculum documents, primary source materials).

3.3 Data Analysis

Though team members experimented with the application of a range of pedagogical approaches, our analysis centered around teachers' grappling and planning in connection to CML principles. Data were initially analyzed inductively using a coding system of deconstruct/reconstruct/social action (Jones 2006) to provide an initial foundation for making sense of how planning in the space was (or was not) aligned with tenets of critical literacy, of which CML is one particular application. By *deconstruct* we refer to the aspect, "that promises to keep us aware that all texts are constructed and therefore can be deconstructed, taken apart bit-by-bit to unveil power, perspective, and positioning" (Jones 2006, p. 75). *Reconstruct* refers to the act of creating new information, objects, and written texts and "also encompasses the overt reconstruction of identities" (ibid., p. 76). *Social action* is connected to the act of communicating and connecting and "comes in all shapes and sizes from short-term campaigns in classrooms […] to long-term inquiry and action projects around a particular social issue" (ibid, p. 78). After this process, we looked deductively for patterns within the data to identify general themes that emerged.

4 Findings

Here we interpret how participants in this study made sense of and took up components of CML in their practice by developing curricula for students. The process of doing CML is not linear; deconstruction, reconstruction, and social action do not always appear in that order nor are they discrete stages, which may be due to the disciplinary context. Teachers designed opportunities for students to construct, rather than reconstruct, media as they would be creating something new rather than redesigning extant media or texts. Therefore, we refer to the act of reconstruction as (re)construction throughout our findings and discussion;

this stage took the form of an iterative process of perspective-taking and mastering tools to take on this work.

4.1 A Nonlinear Process

As participants collaborated to build curriculum, we learned that CML practices need not occur in a linear format. Though deconstruction and critical analysis of (multimedia) text may seem as if it should precede (re)construction and social action, this is not always the case. Teachers participated in deconstruction of text before designing opportunities for students to practice skills and gain mastery of the tools needed to produce their own knowledge base and share this with relevant parties (e. g., NYC Parks Dept).

Data collection for (re)construction was frontloaded for students; in this way, they were not only positioned as knowers but were also able to talk about the process of collecting data from a firsthand perspective. This experience led to students understanding data production methods such that in later deconstructions (and subsequent reconstructions), they know what kinds of questions to ask. During the creation of these curricula, teachers prioritized student opportunities to build a toolkit of ways knowledge can be constructed so that students can practice these before moving to another phase.

4.1.1 Teacher Work

Teachers facilitated the CML process by first working to choose relevant problems for students to engage with. Students were able to select their own focal micro-problem, but teachers pre-selected the larger problem of the pond in Morningside Park based on its relevance to NYC rather than something more general, such as oil spills. A teacher reflected on this specificity by saying,

> [n]ow we can look at the actual New York City problem and the power of that, we were saying is, sometimes you have these problems; you never know what happens to it, it seems removed, even if I bought into it. But when's the last time they've been in the bottom of the ocean? So, the difference, like, they see this overridden with algae park in the middle of New York City […] [and can] now think of it as, oh, I can enact change.

This teacher is identifying a problem for students to work on and defending its relevance. Another teacher also spoke of the necessity of "an authentic invitation or an authentic call to action that kind of sets up the stage for everything"

to "move accountability and motivation," whether from a community leader or member of the NYC Parks Department.

To provide more context for students before they set out to (re)construct a text about the pond, these STEM+C teachers engaged in their own deep dive (deconstruction) of the sociohistorical context of the pond. Though they did not plan to have students replicate this work, students did still benefit from a critical analysis, as one teacher suggested,

> [w]hy don't we talk about the advocacy that happened in Morningside Park where Columbia tried to make this gym but wanted people to go in the back entrance in the community, and how people stood up and basically said, no, we don't want that and instead made the pond.

Here, it is evident teachers have asked their own questions about the pond. Where did it come from? Who created it? Why? In answer to these questions, they were able to learn of racial and class tensions between (largely white and higher SES) university faculty and administrators and (largely BIPOC and lower SES) members of the West Harlem and Morningside Heights community. Therefore, teachers planned to have students interrogate the research they had already undertaken in order to gain context on the pond.

4.1.2 Student Work

Because of teacher efforts to identify a multi-faceted, relevant problem and their efforts at deconstructing the social, historical, and political aspects of that problem, the teachers were able to design a curriculum where students could build skills and knowledge to address the part of the problem they saw as most pressing. This resulted in a STEM+C curriculum intended to teach students the tools of (re)construction such that they can then effectively deconstruct future texts. Teachers spoke of the importance of "recognizing there's different tools [students] could use to communicate there's a problem. So I think providing opportunities and showing students that one tool is not more effective than another, but it's just a pathway you can choose to communicate." This teacher speaks to the importance of students' ability to decide which media to use in their creations (Marsh 2016) because the type of media selected for (re)construction impacts what can be communicated to an audience. Another teacher agreed, saying,

> One of the things we're doing is giving them the opportunity to create […] using that media. So we're going to use algorithms to create a solution so that the critical part is them having the ownership of what they're creating,

> because right now, the structure, the power, the way it is […] doesn't really tell them that they are allowed to create.

Both of these teachers highlight the importance of students beginning with a phase of (re)construction rather than through deconstruction of text. By prioritizing media production, these teachers equip students with essential knowledge and skills such that they can question and critically analyze future texts.

Another teacher built on this concept by discussing the ways students are able to "use [a digital media algorithm] for our advantage" by gaining "a better understanding of how code works, so that when [they]'re looking at a program, they have that experience, and they can interpret it differently." He explained that by empowering students with knowledge of an algorithmic function, they won't be left "wondering why you just said something that's showing up on TikTok," and can instead "understand that it's not magic. There's something happening with this device that's creating the feed to that gate here, right, so that creates a better understanding of the world." This knowledge demystifies the ways media and texts find their way to students so they can, in the future, ask questions of and manipulate algorithms that work to maintain balances of power. In this way, students are able to "extend their range of semiotic resources" (Janks 2010, p. 156) to more effectively deconstruct media messages.

These teachers, in the building of a curriculum focused on (re)construction of media, never lose sight of the greater purpose for learning these skills. One teacher concretely envisions students applying their knowledge production skills to critical reading of media when he says, "they hear something, like, the Hudson River is disgusting and dirty. What does that actually mean? How dirty is it? They'll be able to ask those questions and then know the tools they can use to actually measure that." When students lack the disciplinary skills to understand how a message can or should be formed, the curriculum must focus first on building that foundation. Otherwise, students cannot know what questions they should be asking to discern the implied messages of the media. When students are able to collect their own data, decide if they need more data and if so, what kind, and then consciously and intentionally decide "what story can we tell based off what we just saw here," they better understand and can engage in the process of wondering what story someone else is trying to tell.

Though much of the curriculum developed by these teachers is focused on (re) construction, skill-building, and demystification of the ways in which knowledge is produced, their end goal, which connects to the authenticity of the project and requires a targeted audience, is social action. The teachers proposed a com-

munity event for students to present their findings to interested stakeholders through, "[a] time series of Morningside, some kind of public service announcement about what's going on, or a proposal to the Parks Department. Obviously, there can be more than that, as long as all these things include evidence and data." By engaging in this activity, students are positioned as people whose knowledge matters and are able to advise community members as to "how they could contribute to helping the health of the pond." However, teachers were all too aware that affecting any substantive social action in the short time frame was not possible and was therefore not prioritized.

4.2 (Re-)Construction: Teachers Create Opportunities for Text Production

Curriculum team members considered potential approaches for student experiences of (re)construction while reflecting on the role of data transparency in directing a broad narrative that informs how we consume and make sense of information. As one teacher put it,

> [m]any times media outlets will take the data, not share what they're collecting and then use it as a way to manipulate […] a dominant perspective. We talk a lot about how algorithms are used to actually push inequity rather than finding equity. I feel like […] we're being transparent about what data we're collecting and how we're using [it] to support our community […] [it] is a component that's weaved in both our programs.

Teachers wanted students to have a firsthand understanding of the process of data collection, analysis and synthesis, and worked to build entry points that would prepare students to ask questions about, "Where did [the data] come from? […] What was the purpose of getting that data?" while also considering the reliability of sources. In one conversation, teachers considered, "explicitly building around identifying when given reliable data but reliable sources are using the data in a biased way […] it's happening so often and I feel like it's key […] and it's not enough […] to say we should understand data better." As teachers negotiated these challenges, they developed learning experiences that offered iterative opportunities for students to visit data collection and problem solving skills while focusing on a central problem. These cycles were designed to build understanding through science and engineering lenses while also having students evaluate where data comes from and how it is reported.

4.2.1 Citizen Scientist

CS teachers built the curriculum to utilize data collection methods focused on looking at water bodies from biological, chemical, and physical perspectives. "There's also the qualitative aspects and quantitative aspects of the data that they're collecting that I feel like creates various access points," one teacher stated as the group worked to consider how to build the curriculum in ways that offered opportunities to delve deeply into the discipline.

Students collect data using the three methods while moving between four sites that offer points of comparison to their central location. This intentional aspect of iteration is both educative and scientific; it offers various opportunities to practice data collection skills and consistently review scientific concepts introduced at each instance of data collection. Teachers designed this process so,

> […] we similarly have an end product in which students have to think about ways in which they communicate their knowledge they've been gaining through all the […] data analysis they've been doing, and how they can communicate that to communities to make sure that we're involving everybody.

This mixture of (re)construction and social action provides space for students to collect and work with data to a point where they are able to "communicate their knowledge" to others. This requires students to move beyond a general knowledge of scientific concepts toward a more nuanced understanding of the data and its impact. Students must be able to make decisions about how to discuss their findings to peers and community members to help them understand the implications, potential solutions and possible impacts on the surrounding ecosystem. In this way, students are considering multiple perspectives and their audience as they (re)construct text to share with others.

Teachers were also thinking about this process as a way to introduce students to better understanding, "the relationship between who's collecting or doing the science and who the science is on, or about, or supposed to help […] there's often a disconnect between those two." This relationship takes on new meaning when students have firsthand experience of the data collection cycle. Teachers worked to enhance this connection by designing opportunities for students to meet scientists who worked in and were from the local community and developed ways for student data to be added to larger scientific data sets. By seeing scientists who share their demographics, students are able to envision themselves as pro-

ducers of knowledge that impacts their daily lives rather than subject to someone else making decisions that perpetuate a dominant narrative for them.

4.2.2 Digital Citizens

Iteration was central to the development of the DC curriculum as it was built using the design thinking framework (in this case, discover, define, design, develop, deliver). A framework commonly used in engineering and other creative problem-solving industries, design thinking is iterative by nature. One teacher described the approach of this cycle:

> Each week, they'll go through the cycle […] how am I collecting data about the issue? [...] write them down and com[e] up with a question. They're going through the cycle, so they will have opportunities at first to collect data […] from the [CS], try prototyping a solution, getting feedback from each other and also from engineers […] revisiting the problems they are saying that they have to kind of iterate on their solution.

Within the program, teachers aim to support students in "getting really good at iteration" and "incorporating new […] things we're talking about […] especially sciences" into the way they are thinking about understanding a problem and approaching solving it. Here, the problem is concrete and provides a tangible illustration of something they are working to solve. Being able to see it, touch it and talk with people in the area about it, provides students an opportunity to access multiple perspectives including some that are not often considered (e.g., BIPOC community members who use the park) as they develop potential solutions.

Teachers are also using this experience as an opportunity to introduce students to concepts such as computational and algorithmic thinking and connecting those to considerations of "communities, […] relationships and how we build relationships and how narratives inform how we build relationships." Teachers are developing curriculum meant for students to spend time working with the literal nuts and bolts of technology while enhancing a lens through which to consider the role of technology in addressing the park problem and also beyond. In this way, through (re)construction, students are simultaneously learning the skills of the discipline.

4.3 CML in STEM+C

As the GC team created curricula, they represented two scenarios that lent themselves to non-sequential, almost haphazard applications of the deconstruct/(re)construct/social action framework. Curriculum planning in general included a recognition of many unknowns. One teacher stated, "I don't know exactly what's gonna play out. And I think the beauty of that, when we first got introduced to the pond, it's a complex problem." At the same time, the contextual and situational nature of the problem created opportunities to develop learning experiences designed to approximate processes used by professionals working in relevant STEM+C fields. These were layered in ways where CML principles were present but not predictably sequenced. This allowed teachers to consider how students might critically engage in the discourse of science and engineering through a CML lens while also making space to situate the disciplinary fluency students were developing in a local context. This meant teachers needed to grapple with the realities of work in these fields, as they came to recognize that data collection and problem solving in science and engineering do not fit neatly into the three-week timeline of a summer program.

4.3.1 "Science is Slow"

Teachers' focus on data collection and analysis methods in the CS curriculum offered space for students to develop insight into where data comes from. Data collected by students would be shared with community partners who would incorporate it into more extensive data sets. At the same time, this process also meant introducing students to the reality that, "science is actually really slow, it takes a really long time to do." Teachers considered how to "mitigate the instant gratification dilemma" of students (and teachers) wanting to see their own impact by witnessing some sort of social change from their actions.

By situating the curriculum in a way that centered data collection, teachers introduced aspects of research rarely discussed when data is presented in a published form. The slow timeline, dilemmas of understanding the nuanced research process, and frustration with the unknown are rarely topics of conversation once research is finalized. Introducing these elements into the students' experience required teachers to consider how to remove an expectation of "figur[ing] out the whole problem" in a short period and develop a new understanding of the complexity of the relationship between "data collection, problem solving, it takes time." Teachers had to consider the implications for CML in a STEM+C context due to this extended timeline of doing science.

4.3.2 "I Don't Have an Answer"

DC teachers had to acclimate themselves to being OK with instructional spaces where, "I don't have the answer, you don't have the answer." This meant there were significant levels of ambiguity within the curriculum as the aim was to, "push the students so we're not solving the problem for them, that's what they're learning to do, think about different ways to solve the problem." Because students would be contributing to the work of a real problem with NYC Parks Department collaborators (e. g., engineers and scientists), there would be no solution that teachers could 'give' students at the end of the program. Instead, their aims would be to help students understand the parallel processes that community collaborators were going through to contribute to addressing an issue that extended beyond the walls of a classroom and to emphasize the cyclical nature of the problem. One teacher said, "[t]hat kind of ties into the whole process of always thinking of new innovative ways to address a problem […] just because it's a solution now doesn't mean it's gonna be a sustainable one forever."

This idea of on-going problem solving as a mindset rather than destination extends to developing a critical eye that looks beyond a situational problem toward the future. In this way, CML presents itself as a cycle; the (re)constructed text will not always be applicable or useful because sociopolitical contexts change, and as these contexts change, the produced text can continue to be deconstructed and reconstructed as needed.

5 Significance

These findings inform our thinking of how teachers can take up CML when provided with an experimental space to do so. Teachers need space to think about how to enact theoretical practices in their classrooms and refine their teaching practice with colleagues who are working toward similar aims.

Because a pedagogical lens can look different in different disciplines, providing teachers a 'sandbox' space to play in, where they are able to bring each of their identities to create a space that can become something new or more, is essential. These teachers were granted time and physical space to engage with new ideas, allowing them to create curricula informed by CML where there previously was none. Professional development often consists of being presented with an array of resources; teachers then return to their classrooms without having had the opportunity to engage with the resources, so their practice remains unchanged (Butler 2019). Instead, when taking on a new approach to teaching content and

skills, teachers need to experience "critically engag[ing] the media and popular culture and connect[ing] these texts to critical theory" to "open the possibility for them to transform their classrooms into sites for social change" (Joanou 2017, p. 41). These spaces are necessary for teachers to discover and plan a sustainable CML connection to their disciplines (Butler 2019).

Too often, teachers believe CML and other literacies belong in humanities classrooms, but we argue it fits naturally into all disciplines though it may take on a different form in STEM+C settings. Science moves slowly and involves a great deal of risk-taking and failure; this means sustainable social change takes time. Therefore, social action in this context may look like contributing to a data set or joining a conversation that is ongoing after students are no longer a part of it, so teachers need to find manageable bits of social action so students remain motivated to see their projects through. In these curricula, teachers defined social action as students sharing their findings with stakeholders so that, though the project is on-going, students are able to complete the program with the sense that what they did mattered. These small acts align with Kuby's (2013) argument that "social action can happen in day-to-day occurrences and relationships as well as large-scale group endeavors" (p. 107). In addition to students walking away with new ways of thinking about and understanding the world around them, teachers also hope students leave the program with an understanding that, though positioned by the media as "other" (EJI 2021), they are people whose words and ideas matter and are worthy of being shared with a wider audience. In this way, change in student identities is the social action.

Implementing CML practices takes time. Our participants found they did not have space to include opportunities for students to authentically deconstruct, reconstruct, and plan for and participate in social action. These findings suggest it cannot be a one-time project or assignment but rather needs room to breathe. When engaging with new content and skills, however, students may benefit from the concrete act of constructing before the more abstract phases of deconstructing and reconstructing media. Yet students also need spaces where they are able to take up the work of deconstructing and taking social action. For our participants, this may take the form of extending this project throughout the school year so students are able to take the skills they have learned to more effectively question, or deconstruct, the texts they encounter in the classroom and beyond. Teachers then need to develop follow-up opportunities for students to engage in reconstruction of these texts.

Teachers need space to continue to reflect and reconsider their pedagogical practices and the ways in which pedagogical theories and practices show up in

their classrooms. The GC space was vital to the work that happened as it acted as a space to figure out how to integrate teachers' other spaces and work to create something new. CML does belong in the STEM+C classroom, and the space these teachers were granted allowed them the opportunity to figure out how to do it authentically.

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Authors

Kelsey Darity, Ed. D. Teachers College, Columbia University. Research focuses: critical literacy, disciplinary literacy, curriculum development
kkd2125@tc.edu

Suzanne Pratt. Co-Directory, Teachers College, Columbia University. Research focuses: teacher education, teacher learning, learning partnerships
sp2801@tc.edu

Correspondence Address:
Suzanne Pratt
Teachers College, Columbia University
525 West 120th Street
New York, NY 10027
USA