Climate Change Education Teacher Professional Development in MADE CLEAR: A Research Brief

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Executive Summary. Guided by state, national, and environmental organizations, there is emerging consensus on the scientific content and impacts of climate change K-12 students should understand. However, implementation of professional development for teachers in varied educational settings presents a challenge to implementation and replication, especially for sensitive topics such as climate change. Three constructs, *instructional vision*, *sanctioned private practice*, and *lack of progress*, are presented and discussed in relation to K-12 climate change education. An example of an effective professional development process based on work by City and colleagues (2009) is presented with descriptions of how it relates to the context of the MADE CLEAR project.

In MADE CLEAR, due to our project's commitment to align with state and national policy in science education (e.g., Next Generation Science Standards) and professional associations' recommendations for environmental literacy principles (e.g. Essential Principles for Climate Literacy), we have consensus on both science content and pedagogy of climate change education in Delaware and Maryland. However, we need to consider carefully how we will conduct our climate change teacher professional development activities, so that our intervention is effective in assisting our participating teachers to present climate change education successfully to their learners (i.e., a deep and scientifically informed understanding of its causes and impacts, locally and globally). Findings from contemporary literature on teacher professional development offer assistance.

Usually, school improvement efforts in USA science education seek to increase student achievement by raising standards and expectations, adopting new curricula clarifying content at the grade levels, reorganizing administrative control, requiring and monitoring improvement plans, providing professional development, and engaging the service of outside experts. While these efforts are necessary, research suggests that they are not sufficient because of three fundamental challenges (City, Elmore, Fairman, & Teitel, 2009).

The first challenge is the *lack of a common instructional vision*. Although much is known about how students learn, this knowledge is not consistently articulated in an instructional vision that can be applied to daily instructional practice. Moreover, lead teachers, principals, and system-level administrators frequently attempt to direct improvement efforts without an agreed-upon vision of high-quality instruction.

The second challenge is *sanctioned private practice*. City and colleagues (2009) found that "most people in schools work in siloed cultures characterized by independence and autonomy" (p. 62). When teachers are not encouraged to collaborate, their instructional practice is not subject to critiques that can lead to instructional improvements.

The third challenge is *lack of process*, meaning that educators do not have an organized process for translating new knowledge into practice. Often teachers must determine how to apply the information and skills they acquire through professional development. Because few school improvement efforts address these challenges explicitly, classroom practice remains unchanged.

Research on teacher engagement in climate and environmental literacy efforts underscores the relevance of these challenges for MADE CLEAR. Wise's (2010) survey of science teachers suggested a *lack of common instructional vision* for climate change education at system and institutional levels, leading many interested teachers to address climate change only informally in the classroom. Related to the *sanctioned private practice* challenge, teachers participating in climate change education focus groups have reported rarely engaging in such interactions with school-based colleagues (Gayford, 2002). And in describing lessons learned from a climate change professional development program for middle and high school teachers, Johnson et al. (2008) highlighted the need for participants to gain deep familiarity and experience using instructional approaches to climate change education during professional development in order to facilitate transfer of knowledge and skills to the school context. Without such opportunities, professional development efforts risk perpetuating the *lack of process* challenge.

Therefore, of primary importance to the success of an educational innovation is the effectiveness of its implementation (Wallace, Blase, Fixsen, & Naoom, 2008), and of primary importance to the replication and scale-up of an innovation is examination of strategies specific to varied educational settings, including the science classroom (Lynch, Pyke, & Grafton, 2012; McDonald, Keesler, Kauffman, & Schneider, 2006; Penuel, Fishman, Cheng, & Sabelli, 2011).

MADE CLEAR should also take into account the status of climate change as a controversial or "sensitive" topic in science education. Research suggests that science teachers might avoid topics that are most relevant for students, because they are perceived as too controversial (McGinnis & Simmons, 1999). Additionally, teaching sensitive science topics, such as climate change, may induce tension between beliefs and practices (Jones & Carter, 2007). However, as Hart (2007) has pointed out, many educators have developed professional strategies to resolve this tension. He also suggested that teachers should promote active student engagement in decision-making about controversial issues.

One way for MADE CLEAR to address the challenges described above is to follow a process in a PD experience with teachers as suggested by City et al. (2009). As we

consider how to provide teachers with effective and relevant professional development such a process can offer guidance in the activities and experiences offered to teachers during the MADE CLEAR Climate Change Summer Academy and during the school year. The table highlights a professional development process and describes how it relates to climate change teacher professional development.

To conclude, the impact of MADE CLEAR is linked directly to the success of the participating teachers in their teaching of climate change to learners located across Maryland and Delaware. Therefore, we should think very deeply about how we will design and conduct professional development in the project that is research-based.

Table 1: Professional Development Process for Teachers in MADE CLEAR

PD Process	**Description**
Lesson Examination	*Teachers* select a lesson topic in climate change that aligns with the NGSS and local science standards, examine instructional materials, review prior evidence from the literature of students' anticipated conceptions of the topic, and difficulties with the core science concept, and collaboratively consider strategies to teach the topic.
Science Content Study	*Teachers* consult with science and pedagogy experts to improve their science content knowledge and pedagogical knowledge informed by learning progressions and sociocultural research for a sensitive topic. They then develop statements that clearly identify the core science concepts their students need to understand to learn the topic and how they align with science standards.
Lesson Refinement	*Teachers* collaboratively design a lesson (or series of lessons) by integrating instructional strategies that support student learning of core science concept (e.g., craft questions to move students' thinking to higher levels of cognitive demand, emphasize argumentation based on evidence, diversify lesson for all learners that includes consideration of salient sociocultural factors).
Lesson Delivery and Observation	*One teacher* volunteers to teach the lesson to students according to the collaboratively developed plan. *Remaining teachers* observe the lesson implementation (live or recorded), focusing on the students (rather than on the volunteer teacher) and examining data evidence of students' learning.
Individual Reflection	*Individual teachers* reflect on the lesson observation with questions such as "What happened?" "How did it play out?" and "Why did learning occur in the observed way?"
Debrief and Generalization to Practice	*Teachers* identify (a) connections between student learning and successful aspects of the lesson design, (b) connections between the instructional strategies employed and student learning, and (c) generalizations about how effective strategies can be applied to future instructional practice.

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