
Tailoring STEM Instruction for Diverse Learners: What Matters Most?

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Abstract

This presentation focused on defining a three-tiered transformative approach to differentiating instruction for diverse learners, which includes changing the organization of classrooms, improving the quality of learning activities, and creating a culture of recognition that respects all learners. Using supporting evidence from instructional coaching studies, this paper identifies challenges facing STEM teachers at each tier of differentiation. While coached elementary and secondary teachers make significant gains in implementing this approach to differentiation, STEM teachers, in particular, make significantly less growth and less consistent growth. Implications for increasing STEM teachers' knowledge and skills for differentiating instruction for diverse learners are addressed.

Keywords

Differentiation; Urban schools; Critical Pedagogy; Sociocultural theory; Teacher improvement

INTRODUCTION

Differentiating instruction for culturally, linguistically, economically, and learning diverse students is easier to conceptualize than to implement. Urban teachers, in particular, are challenged on a daily basis to reach a wide range of learners in the regular classroom. Economic disparities, high student mobility rates, inadequate resources, and high variability in teacher quality define urban settings (Bartolomé, 2007; Cobbold, 2010; Hollins & Guzman, 2005). Even when students are pulled out of the regular classroom for special services with English as a Second Language or Special Education specialists, these same learners spend the majority of their school day with core academic teachers who may, or may not, be prepared to make appropriate choices for differentiating instruction.

Research has also shown that minority students' participation in the areas of science, technology, engineering, and mathematics (STEM) are poor, pointing to a need to re-conceptualize STEM instruction to be more inclusive of and responsive to minority student populations (e.g., Crisp & Nora, 2012; Horn,

2012). Teachers' instructional decisions are one important factor influencing minority students' interest in STEM. In professional development studies using one-on-one instructional coaching, researchers found urban secondary STEM teachers the least able to innovate in instruction in comparison to both urban elementary (Teemant, 2013b) and secondary humanities teachers (Teemant, Cen, and Wilson, 2013). These studies found STEM instruction to be predominately whole-class, lecture-dominated, and worksheet-driven, with all students progressing in lock-step fashion through PowerPoint slides and worksheets. Baglieri, Bejoian, Broderick, Connor, and Valle (2011) observed that:

Many teachers proclaim, "I can't get to them all, so I just teach to the middle...." Such disparate comments all circle around an unexamined normative center, a center built on the desirability (and therefore expectation) of all students being taught at the same time, in the same way, learning at the same rate, and demonstrating their knowledge and skills in the same way, presumably on the same examinations (pp. 2137-38).

The purpose of this paper is to describe necessary conditions for creating a more equitable learning environment for the full range of learners in STEM classrooms. These necessary conditions are captured by a three-tiered approach to differentiation, which build on critical (Freire, 1994) and sociocultural perspectives (Vygotsky, 1978). Challenges at each tier are identified for STEM educators using quantitative and qualitative research outcomes from four instructional coaching studies (i.e., Teemant, 2013a; 2013b; Teemant, Cen, & Wilson, 2013; Teemant, Leland, & Berghoff, 2013). These studies were conducted under the auspice of a U.S. Department of Education National Professional Development Grant (T195N070233). Following a brief discussion of the theoretical foundations for differentiation, each tier of transformative differentiation is discussed with a STEM challenge identified and implications presented.

THEORETICAL ORIENTATION

The preparation of teachers for diverse student

populations in urban settings remains inadequately researched (Knight & Wiseman, 2005; Wei, Darling-Hammond, & Adamson, 2010). Nevertheless, models of culturally responsive teaching (e.g., Gay, 2000; Howard, 2006; Tharp, Estrada, Dalton, & Yamachi, 2000; Villegas & Lucas, 2007) are theoretically built upon sociocultural (Vygotsky, 1978) and critical perspectives (Freire, 1994). Sociocultural theory presents learning as an outcome of the teacher-student relationship, which is an active, dialogic, social, and culturally shaped space filled with rich assistance in the learning process from a more knowledgeable other (Vygotsky, 1978; 1997). From a critical perspective, McLaren (2007, p. 69) argues education captures “asymmetries of power and privilege” among minority students, majority teachers, and society steeped in culture, politics, and history. Building on Freire’s (1994) critical pedagogy, Lewison, Flint, and Van Sluys (2002) identify four dimensions for teaching from a critical perspective: They call for a pedagogical approach that (a) disrupts the commonplace, (b) interrogates multiple viewpoints, (c) focuses on socio-political issues, and (d) takes action to promote social justice.

Lewis, Enciso, and Moje (2007) argue that when critical and sociocultural perspectives are taken together, the exploration of teacher and learner identity, power, and agency in the learning process is made possible. When differentiation is considered from this perspective of identity, power, and agency, it expands differentiation beyond typical notions of providing alternative content, products, processes, or environments for learning. Differentiation can become transformative with the goal of collaboratively and reflectively educating for change (Ettling, 2012). Ideally, differentiation should be the antithesis of one size fits all teaching: It should strive to be responsive, pluralistic, and democratic.

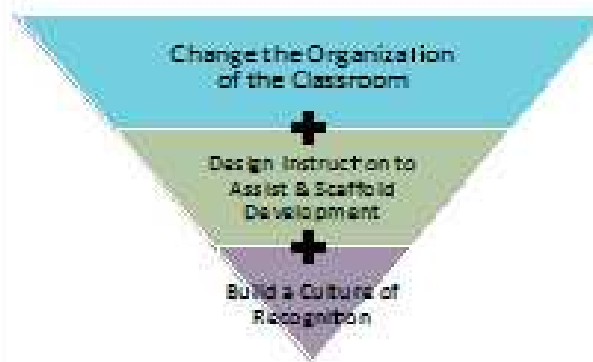
THREE-TIER APPROACH TO DIFFERENTIATION

To realize a transformative approach to differentiation, teachers need to consider three pivotal changes. Figure 1 presents the three-tiered approach to differentiation informed by findings from three instructional coaching studies (i.e., Teemant, 2013a; 2013b; & Teemant et al., 2013).

Change Classroom Organization

Realizing the potential of critical sociocultural prac

Figure 1. A three-tiered approach to differentiation



tices requires teachers to move away from teacher-dominated, whole-class presentations of content and individual mastery assignments. A shift to small group configurations increases student talk, engagement, negotiation, the co-construction of meaning, and opportunities for peer or teacher assistance in the process of learning. A study by Teemant and Hausman (2013) demonstrated that teacher use of collaborative small group activities promoted significantly more student achievement among both native and non-native speakers of English. The verbal interactions that result from well-designed small group activities make academic concepts and language more accessible as students and/or the teacher question, construct, and demonstrate learning collaboratively. Vygotsky (1978) would describe such interactions as assisting students to move from being other-assisted to being increasingly self-regulated. In actuality, differentiation is only made possible when a teacher employs various types of small group for various purposes.

The challenge for teachers, especially STEM teachers, at this tier is classroom management. Teaching, modeling, and reinforcing routines, procedures, behaviors, and expectations are essential for making small group work productive. When instructional coaching urban teachers, Teemant (2013b) and Teemant et al. (2013) found that 100% of elementary teachers, 89% of secondary humanities teachers, but only 25% of secondary STEM teachers were able to use and consistently manage small group activity centers by the end of seven coaching sessions. In focus group discussions, STEM teachers shared that they lacked the experience, skills, and confidence to manage students work-

ing in multiple small groups. This suggests STEM teachers would benefit from more explicit discussion and concrete techniques and routines for phasing in use of small group activities. Without this fundamental shift to use of small group configurations, students are left passive and receptive in whole class settings rather than active, engaged, and discovery-oriented.

Design Activities to Promote Learning

The next tier asks teachers to reflect on the design of learning activities. Tharp, Estrada, Dalton, and Yamauchi (2000) and Teemant, Leland, and Berghoff (2013) have identified six enduring principles of learning—or Six Standards—as pivotal for increasing achievement among culturally, linguistically, and economically diverse learners (Teemant & Hausman, 2013). Figure 2 defines each of the Six Standards for Effective Pedagogy.

Collaboration is the underlying principle of learning for Joint Productive Activity. While small group collaboration among students promotes learning, Joint Productive Activity is even more powerful when a teacher is a full participant with students in the co-construction of understanding. As a teacher intentionally asks questions, elicits more student talk than teacher talk, and presses students to provide rationales for their thinking, the teacher engages in an Instructional Conversation. Such interaction focuses on sustained use of academic language, literacy, and concepts to learn, which concurrently addresses Language and Literacy Development. When the activity requires higher order thinking and provides students with (a) quality expectations, (b) assistance, and (c) formative feedback, the goal of Challenging Activities is achieved. Contextualization is a principle of learning that asks teachers to build on what students already know or have experienced from home, school, or community. Finally, Critical Stance invites teachers to design activities that encourage the application of school learning to real-world contexts, problems, or injustices. Teachers consciously engaging students in naming experiences, reflecting upon them, and taking action within their sphere of influence as Freire (1994) advocates in critical pedagogy.

In designing high quality learning activities, teachers are encouraged to use at least three of the Six Standards in each activity to promote deeper learning. Numerous studies have demonstrated that use of the Six Standards increases student achievement for

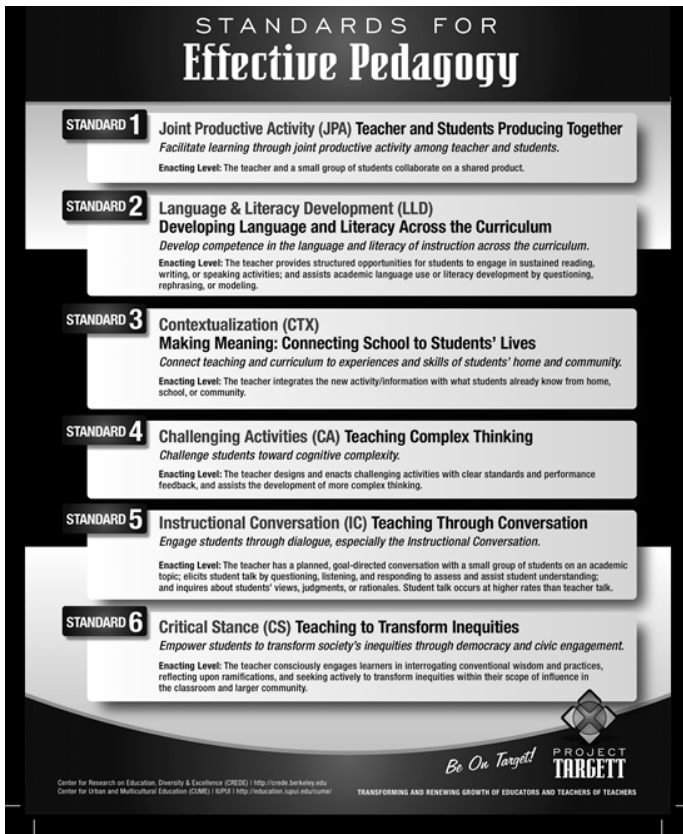
both native and non-native speakers of English (e.g., Doherty & Hilberg, 2007; Doherty, Hilberg, Pinal, & Tharp, 2003; Estrada & Imhoff, 1999; Saunders & Goldenberg, 1999; Teemant & Hausman, 2013).

While Teemant, Cen, and Wilson (2013) found that secondary teachers, in general, were able to significantly increase their use of each of the Six Standards with instructional coaching support, they uncovered unique challenges for STEM educators. For example, STEM teachers implemented each of the Six Standards at a lower level than their elementary or other secondary colleagues. They struggled to contextualize their lessons thereby failing to build on students' previous knowledge and experiences with academic concepts. STEM teachers were also less likely to engage their students in unplanned or planned conversations about their learning. Therefore, they provided their students less assistance and feedback in the process of learning. These coaching findings suggest that STEM teachers would benefit from more in-depth consideration and prolonged support to radically re-conceptualize their role as active participants with students in the learning process. The Common Core States Standards Initiative (2012) and the Next Generation Science Standards (2013) are pressing STEM teachers to teach students to discuss, solve problems, and communicate findings (Johnson, 2010). Yet, STEM educators themselves are not positioned to easily take up these new instructional demands. Professional development targeting STEM educators needs to explicitly focus on the historical inadequacy of teaching as telling while simultaneously modeling use of the Six Standards in activity design.

Create a Classroom Culture of Recognition

To be transformative, differentiation should explicitly build a culture of recognition within the classroom that knows, honors, and affirms students' identities as learners and people. Rodriguez (2012) describes five ways educators can affirm students in the teaching-learning process. Rodriguez calls for teachers to first build meaningful relationships with their students. Second, a culture of recognition includes tailoring the curriculum to reflect students' experiences and knowledge. Third, teachers should use the students' local community context to contextualize learning, including the social, political, historical, cultural, and economic issues. Fourth, teachers' pedagogy should invite student voice and allow for choice. Finally, teachers are transformative by inviting student civic

Figure 2. The six standards for effective pedagogy



CONCLUSION

Common Core (2012) and Next Generation (2012) standards are placing new demands on STEM educators at the same time there is mounting pressure to become more inclusive and responsive to historically marginalized students (Horn, 2012). The three-tiered critical sociocultural approach to differentiation presented in this paper calls for STEM educators to increase use of small group configurations, design high quality learning activities, and create a classroom culture of recognition that is pluralistic, responsive, and democratic. Instructional coaching findings suggest, however, that STEM teachers struggle with classroom management, providing meaningful assistance and feedback, and tailoring curriculum to context and learners. Despite positive STEM instructional coaching outcomes, more professional development innovation and research are needed to fundamentally transform and improve STEM teachers' abilities to differentiate for historically marginalized students.

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engagement by applying school learning to the real world outside of school. The Six Standards represent one way of accomplishing Rodriguez's pedagogical and transformative aspects of teaching.

Studies by Teemant (2013a, 2013b), Teemant, Cen, and Wilson (2013), and Teemant, Leland, and Berg-hoff (2013) demonstrate that elementary and secondary teachers as well as STEM and non-STEM teachers alike need more time and instructional coaching to fully realize a culture of recognition in the classroom. In today's era of high stakes accountability, coached teachers reported they felt pressured to follow pacing guides and ignore actual student development. Building relationships, tailoring curriculum, and planning for civic engagement require a multi-year approach to professional development, especially for secondary STEM teachers.

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