2020

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RIGOROUS AND MEANINGFUL SCIENCE FOR ENGLISH LEARNERS: URBAN ECOLOGY AND TRANSDISCIPLINARY INSTRUCTION




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The implementation of the Next Generation Science Standards (NGSS) continues to present opportunities and challenges to "create a rich language-learning and practice-oriented science classroom environment, provided teachers ensure that English Learners (ELs) are supported to participate" (Quinn, Lee, and Valdés 2012). The recent NASEM report, *English Learners in STEM Subjects (2018)*, issues a call to action to create contexts for systems- and classroom-level supports that recognize the assets ELs contribute to classroom learning and to increase rigorous science instruction by providing ELs access to adequate program models, curriculum, and instruction. Paramount among the recommendations proposed are high-quality curricular materials coupled with equipping teachers with the preparation and tools needed for effective instruction for ELs.

Attending to these recommendations is critical if we are to reverse trends in National Assessment of Educational Progress (NAEP) data that show only 19% of eighth-grade ELs scored at or above the basic level in science, as compared to nearly four times that number (71%) of English Only students (US DOE 2015). To address these challenges and call to action, two centers at Loyola Marymount University—the Center for Equity for English Learners (CEEL) and the Center for Urban Resilience (CURes) collaborated with five districts to implement the Urban Ecology for English Learners Projects with funding from U.S. Department of Education National Professional Development (NPD) and National Science Foundation (NSF) grants. Over the course of seven years (2012–2019), this effort resulted in the creation of curricular resources, professional learning models, and tools to increase the quantity and quality of science instruction for ELs in fourth to eighth grades who were Long-Term English Learners (LTELs), or at risk of becoming LTELs. The projects' primary goals were to (1) increase teachers' knowledge and skills in delivering STEM education for ELs; (2) increase ELs' science achievement and engagement in Urban Ecology; and (3) bolster ELs' scientific disciplinary academic language skills and access to inquiry-based science.

This article presents project highlights, professional learning approaches, elements of the interdisciplinary, standards-based Urban Ecology curricular modules, and project evaluation results about ELs' outcomes and teachers' knowledge and skills in delivering high-quality STEM education for this population.

TRANSDISCIPLINARY INSTRUCTION: INTEGRATING SCIENCE, LITERACY, AND LANGUAGE DEVELOPMENT FOR TEACHERS OF ENGLISH LEARNERS

Effective science instruction for ELs provides access to content and simultaneously builds literacy skills (reading, writing, speaking, listening, viewing, and representing). Thus, our projects engaged cross-disciplinary teams of fourth- to eighth-grade teachers of ELs. We utilized a transdisciplinary approach (Kaufman, Moss, & Osborn 2003) using Urban Ecology (UE) as a branch of environmental science that focuses on the sustainability and interdependence of cities and nature (Bravo et al., 2007). The use of Urban Ecology through a transdisciplinary approach was developed by creating multiply-aligned cross-disciplinary relationships among the Next Generation Science Standards (2012), the Common Core State Standards-English Language Arts (2010), and the California English Language Development Standards (2012) to respond to the increased demands for effective teaching of ELs envisioned in the curricular reforms of these standards. These demands require that teachers integrate science, language, and literacy seamlessly, and that ELs should… "[engage] in …practices [that] require classroom science discourse, which demands both receptive and productive language skills…[to] present their ideas and engage in reasoned argumentation with others to refine them and reach shared conclusions" (Quinn, Lee, & Valdés 2012).

Framing the professional development (PD) model was Guskey's Professional Development Design Theory (2005) consisting of five levels: (1) Reactions; (2) Learning; (3) Organizational Supports and Changes; (4) Use of Knowledge and Skills; and (5) Student Learning Outcomes. PD was designed to be responsive to the needs of teachers of ELs seeking to improve and increase access to quality science instruction.

Professional learning sessions included annual three-day summer institutes coupled with a series of three-hour follow-up sessions throughout the year. Collaborative learning agendas included delivery of simultaneous science, language,

literacy, and inquiry-based content focused on research-based practices for teaching, learning, and assessment for ELs. Lead teachers and on-site coaches provided support and feedback based on classroom observational data. Ongoing PD sessions allowed for cross-disciplinary collaboration and discussion of approaches to assist teachers in maximizing opportunities to increase instructional time in science and to support students' scientific research.

WHY AN URBAN ECOLOGY CURRICULUM FOR ENGLISH LEARNERS?

The science of Urban Ecology (UE) provides an emerging set of tools to enhance the sustainability and resilience of urban communities. This affords an opportunity to re-envision social challenges (Lord, Strauss, & Toffler 2003) by integrating natural and social sciences to understand urban communities as systems and to manage human effects on ecosystems (Alberti & Marzluff 2004, DeStefano & DeGraaf 2003, Pickett, Cadenasso, Grove, Nilon, Pouyat, Zipperer, & Costanza 2001). As Tate (2010) concludes, science education for diverse urban students is the new civil rights agenda.

Our projects were designed to explicitly engage students in experiences where they are learning science content through investigations of their local schoolyards and neighborhoods. Student interest in science is stimulated and retained using these curricula since the majority of ELs' families live in urban-centric areas (DeBay et al., 2012, Barnett et al., 2011, McNeill et al., 2011). Subsequently, motivation and engagement are increased for minority students and ELs when science is "connected to real-world problems in the school community" (Bouillon and Gomez 2001).

Three upper-elementary / middle-school Urban Ecology for English Learners curriculum modules were designed to bolster English language and literacy learning by providing access to standards-based, rigorous STEM content. Project teachers and site-level coordinators were an integral part of developing these transdisciplinary curriculum modules, providing feedback on their content, sequence, and standards alignment. The curriculum emphasizes locally relevant field studies and is multiply-aligned with science, literacy, and language standards. Each module *(See Figure 1 at the end of this online version.)* includes six instructional units with over 22 lessons that develop inquiry-based integrated English language and science emphasizing expository / informational writing and oral language development. Academic writing in science for ELs (Quinn, Lee, & Valdés 2012; Minicucci 1996) is particularly essential given the focus of the National Common Core Standards. The modules culminate with an action-oriented project consisting of an interrelated science and literacy product. Pre- and post-module assessments are used to measure acquisition of scientific concepts, vocabulary, and informational text-writing skills.

IMPLEMENTATION STRATEGY AND PROJECT EVALUATION METHODOLOGY

The strategy for implementing the Urban Ecology for ELs projects consisted of several components: (1) system and site-level leadership technical assistance and collaboration; (2) identification and development of teacher leaders across designated school sites to support implementation; (3) sustained, recurring professional development focused on integrated science and language teaching; and (4) classroom observation and peer coaching.

Two research questions guided project evaluation inquiry: 1) How does a transdisciplinary model for professional development in Urban Ecology for ELs support teacher learning of both content and pedagogy?; and 2) What are the effects on student outcomes as measured by a pre- and post-student writing assessment and state-level language and academic assessments?

Participants

Our projects engaged 126 educators, including district and site-level leaders in 5 school districts and 13 school sites in an urban area of Southern California over the course of 7 years. During the project's second phase, a subset (n=14) of the 126 teachers from one of our partner districts engaged in continued collaboration. Students enrolled in project teachers' classrooms received instruction in the project curriculum for at least one year.

Data Collection and Analysis

Mixed methods analyses of multiple data sources were conducted on teacher data collected. Matched data were examined for 29 teacher participants who remained in the project for two or more years. Quantitative (Likert scale) and qualitative data were collected through PD evaluations, classroom observations, a teacher survey, and pedagogic artifacts such as a Project Journey Showcase.

The second phase of the project allowed us to better examine the effect of the professional development at Guskey's fifth level of implementation, Student Learning Outcomes, by collecting pre- and post-measures of language and academic growth for the California English Language Development Test (CELDT), the Smarter Balanced Assessment Consortium ELA Test, and the Urban Ecology for ELs Writing Assessment. Based on available student data, reclassification rates and growth in English-language proficiency were examined across three years for student participants. Matched pre- and post-writing scores based on the Urban Ecology for ELs Writing Rubric were analyzed to determine if there were statistically significant differences between the pre- and post-assessment of each subgroup for each domain.

RESULTS

Research question 1: How does a transdisciplinary model for professional development in Urban Ecology for ELs support teacher learning of both content and pedagogy?

Professional learning support for EL science teaching and learning

Project teachers found the Urban Ecology for ELs modules' content and resources to be useful, pertinent, and exemplary of interdisciplinary instruction. Results from the Teacher Survey, Journey Showcase artifacts, and teacher reflections also indicated growth in teacher practices in using Urban Ecology Scientific Inquiry processes in tandem with EL research-based practices through a transdisciplinary framework. Overall, this project affirmed the efficacy of an integrated PD model focused on STEM literacies for LTELs. The following representative quotes capture teachers' perceptions:

> *"I loved seeing how excited and proud my English Learner students felt as they were able to study Urban Ecology and understand challenging science content and vocabulary."*
>
> *— Middle school teacher*

> *"This program has a positive impact on my students because I'm using many of the strategies while teaching the Urban Ecology for English Learners curriculum and also in other content areas."*
>
> *— Fourth/fifth-grade teacher*

By the end of the project, teachers' overall mean rating was 4.1 on a 5-point scale ("High") on knowledge, skills, and practices in developing science content, language, and literacy learning for ELs. Teacher survey results showed evidence of confidence and implementation of the interdisciplinary practices and most project strategies. See Figures 2 and 3 (located in the online version of this article) for examples of teacher documentation of application and use of research-based strategies.

Research question 2: What are the effects on student outcomes as measured by a pre- and post-assessment of student writing and state-level language and academic assessments?

EFFECTS ON STUDENT LEARNING OUTCOMES

Reclassification. Of the EL students for whom data were available (n=103), end-of-project results indicated that 73% (n=75) were reclassified as Reclassified Fluent English Proficient (RFEP); 27% (n=28) remained ELs, with 46% (n=13) of these receiving special education services.

CELDT. Of the ELs for whom there were CELDT scores for pre- and post-project data (n=37), the number in the Early Intermediate proficiency level decreased by 48%. Conversely, the numbers at the Intermediate and Early Advanced/Advanced increased by 13% and 35% respectively.

Academic Achievement. EL students' progress on ELA state-level academic achievement assessments indicates that from pre- to post-project, the number of students in the EL/RFEP group who scored at the "Standard Not Met" Performance Level decreased by 25%. Those who scored at the "Standard Nearly Met" level increased by 21% and those who scored at the "Standard Met/Exceeded" Performance Levels increased by 4%.

Writing Assessment. Project writing assessments showed statistically significant differences in scores ($p \leq 0.05$) related to development of informational text structure, academic discourse, spelling/grammar, and metacognition/metalinguistic awareness.

CONCLUSIONS

Overall, project findings are consistent with PD research that suggests the need for more ongoing teacher support to translate research to practice. Results also corroborate the importance of providing teachers with detailed, responsive, and structured PD focused on an interdisciplinary framework and research-based practices for ELs. This approach increases content knowledge pedagogy and accelerates content knowledge among students. Additionally, teachers' exposure to interdisciplinary science during PD sessions translated into increased student exposure to scientific concepts and science as a way of knowing.

The positive results achieved by participating ELs indicate that the teacher PD enhanced instructional skills to deliver Urban Ecology scientific content knowledge effectively and utilize effective practices for ELs to develop the academic language of the discipline. Several implications serve to advance scholarship and practice:

- **Increasing teachers' implementation of research-based practices requires a framework for and flexibility in PD delivery.**
- **Transdisciplinary approaches to PD involving the integration of science content and pedagogy are effectively modeled when university collaborators demonstrate it themselves through curricular innovation that incorporates learning outcomes for oral and written language and literacy of ELs.**
- **The PD model influences depth of teacher learning and confidence, with additional implications for guided feedback to support transdisciplinary pedagogic shifts.**

Projects such as this also contribute to systemic efforts to model, influence, and study how members of transdisciplinary communities engage in and benefit from the development and implementation of resources, models, and tools that have the potential to positively affect educational outcomes for English Learners.

References are available in the online version: https://www.gocabe.org/index.php/communications/multilingual-educator/