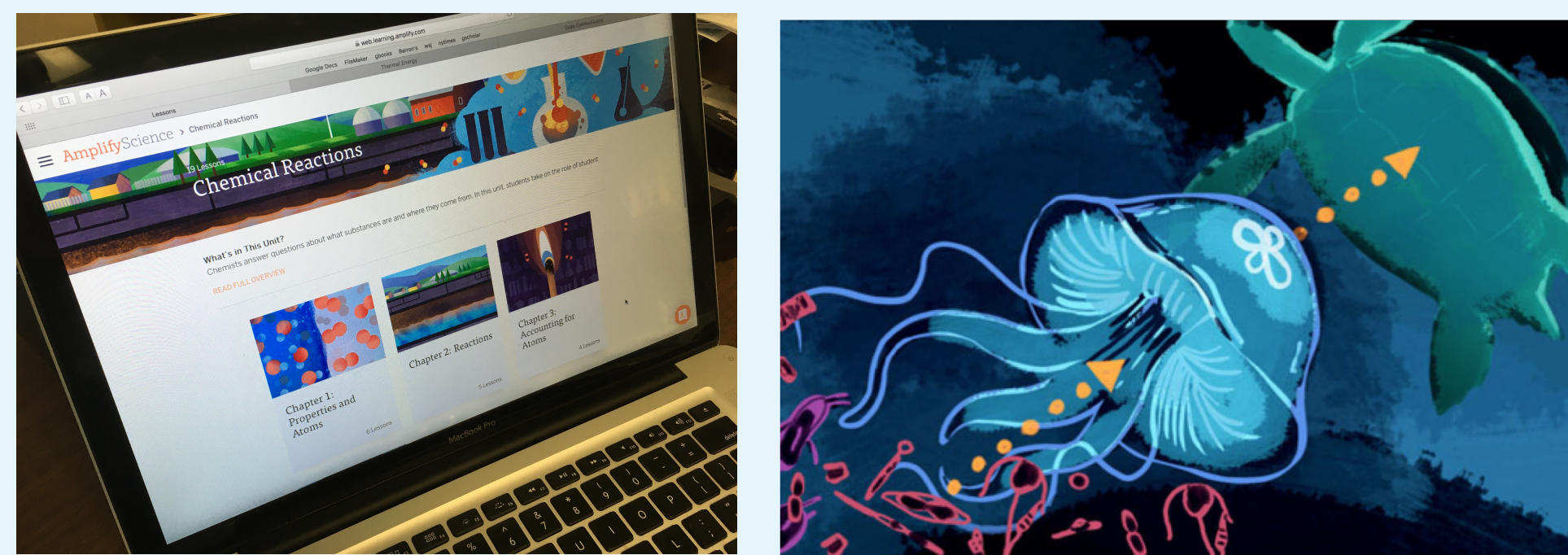


Overview

The Framework for K-12 Science Education (NRC, 2012) and Next Generation Science Standards (NGSS Lead States, 2013) recast science proficiency as not only what students know, but also how they can use and apply what they know to make sense of phenomena and design solutions to problems. New curriculum materials are becoming available to support teachers in providing instructional experiences that will engage their students in this ambitious form of learning. As these NGSS-designed curricula are taken up, it will be important to conduct evidence-based research on their efficacy.

In this study, we examined the efficacy of the widely available Amplify Science Middle School (ASMS) curriculum for improving seventh grade students' learning in relation to NGSS performance expectations in physical science. Designed by the University of California, Berkeley's Lawrence Hall of Science (LHS) in collaboration with Amplify Education Inc., ASMS is LHS's first comprehensive curriculum program that has been designed specifically to meet the vision of the Framework and address the performance expectations of the NGSS.



Design Features of ASMS

The ASMS curriculum materials aim to provide students in grades 6-8 with opportunities to engage with disciplinary core ideas, crosscutting concepts, and science and engineering practices over time to strengthen their science proficiency. The curriculum package includes a digital platform for students and teachers along with physical materials for hands-on activities.

Designed to enable students to:

- Engage with anchor phenomena through multiple modalities
- Interact within a digital workspace with access to custom-written science articles, science simulations, and design tools

Provides teachers with:

- Instructional sequence meant to build proficiencies with performance expectations over time
- Explicit support for literacy development
- Online monitoring and reporting tools

Research Questions

1. **Student Learning:** What is the impact of the ASMS curriculum on learning outcomes in culturally and linguistically diverse school settings? How does the impact of the ASMS curriculum vary by student background characteristics?
2. **Curriculum Implementation:** What is the nature of teachers' implementation of the ASMS curriculum? How does ASMS curriculum support teachers in implementing NGSS instruction?

Study Design

We conducted a randomized experiment in seventh grade science classrooms across 18 schools in three school districts to test the impact of the curriculum materials. Schools within each district were paired based on their demographic characteristics and student prior performance on state math and ELA tests and then randomly assigned to a treatment or control condition. All seventh-grade teachers in a given school had the same assignment – they either implemented the ASMS materials or their “business as usual” materials during the 2019-2020 school year. Teachers in both groups were asked to implement curricular units on the same topics in physical science and follow their district science sequence and pacing guide.

Setting and Participants

The school districts where we conducted the study are in two states whose science standards were informed by the Framework and NGSS. Importantly, their middle grade standards took the form of NGSS performance expectations (PEs). The 3 districts are of varying size (i.e., large, mid-size and small) and serve diverse student populations including multiple racial and ethnic groups, English Learners, and students who qualify for free or reduced-price lunch. Most schools in the sample were Title I schools.

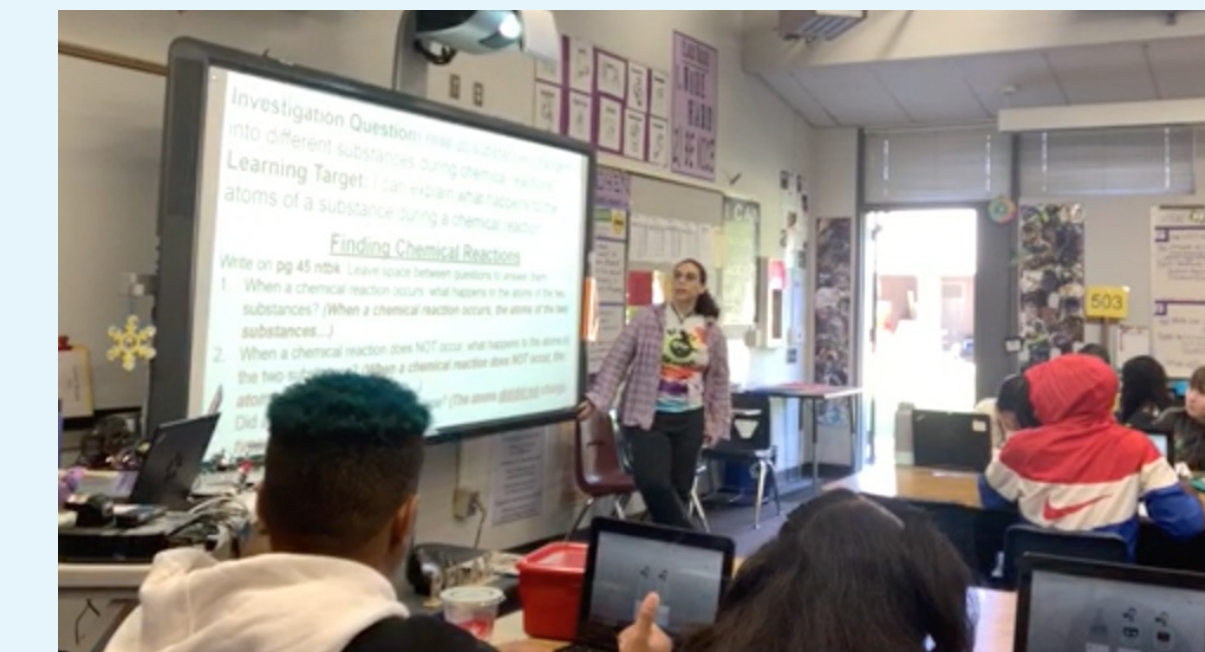
Analytic Sample			
Condition	Schools	Teachers	Students
Treatment	10	19	913
Control	8	14	1,040
Total	18	33	1,953

Curricular Contexts

Intervention Condition

Treatment teachers received the full-year curriculum package plus professional development provided by the LHS developers. The workshops were held at three time points during the school year for a total of 24 hours. Content included navigation of the online teaching resources, overview of the Amplify Science approach, and information about teaching the units.

The ASMS units we studied were focused on the physical science topics of structure and properties of matter (i.e., phase change, energy and matter) and chemical reactions. Each unit engages students in investigating and explaining an anchor phenomenon in the context of a compelling real-world problem. For instance, in one unit, students investigate the anchor phenomenon of an unknown substance discovered in a neighborhood's well.



Business-As-Usual Condition

Teachers were asked to implement their regular curricular units on physical science topics relating to structure and properties of matter and chemical reactions. They participated in the same professional development as they would in a typical school year.

The range of enacted curriculum materials varied across schools, but all were focused on NGSS instruction. Teachers in one district used a redesigned curriculum for the NGSS, teachers in another used their own district-developed curriculum to address the NGSS PEs, and teachers in the third district mostly used a district-adopted textbook while some used an open-source project-based NGSS curriculum.

Measures

Student Learning: Three-dimensional Assessment

We developed an assessment to elicit performance with aspects of NGSS PEs related to MS-PS-1, Matter and its Interactions. The assessment was instructionally sensitive to both conditions (DeBarger et al., 2016) and informed by the design work of the Next Generation Science Assessment Project (Harris et al., 2019):

- 7 constructed-response tasks address aspects of disciplinary core ideas, science and engineering practices, and crosscutting concepts
- Contextualized in scenarios presented in a succinct story format
- Tasks include prompts for integrated responses

Curriculum Implementation: Instructional Logs and End-of-year Survey

We employed a weekly online instructional log and an end-of-year survey to investigate teachers' curriculum enactment and instruction in both conditions:

- Enactment questions focused on self-report of lessons and activities enacted each week, modifications made (and reasons why), and successes and challenges encountered with the materials
- Instruction questions focused on frequency and depth of engaging students with the NGSS dimensions, instructional strategies employed, and instructional successes and challenges

Analysis Approach

Assessment tasks were randomized and assigned to scorers who received extensive training on the rubrics. Scorers were blinded to students' identities and the research condition. For most tasks, there was at least 90% agreement between scorers.

For the learning outcome analysis, we compared posttest scores of students in treatment schools with posttests of students in control schools by fitting 2-level hierarchical linear models (students nested within schools) to the data and controlling for school-level and student-level characteristics and students' prior achievement on their sixth-grade state tests.

Student Outcomes

Analysis showed that implementing ASMS had a significant positive impact on student learning. Seventh grade students who participated in the Amplify Science curricular units in physical science outperformed students in the control classrooms on the outcome measure that was aligned to the NGSS PEs. The difference was statistically significant ($p < 0.001$), with an estimated effect size of +0.40. No statistically significant effects were found across student demographic characteristics (i.e., gender or ethnicity) ($p > 0.05$).

Implementation Outcomes

The analysis of instructional logs is ongoing. Preliminary survey findings indicate that most treatment teachers (>80%) agreed that they and their students benefited from using ASMS. 88% of treatment teachers reported that ASMS supported them in engaging students in science discourse, 73% planned to continue using ASMS after the study ended, and 54% reported that using ASMS changed the way they taught science.

Discussion and Implications

Curriculum materials designed for the NGSS are becoming widely available and as they go to scale it will be important to measure their impact on teaching and

learning. This study is among the first to investigate the efficacy of NGSS-designed curriculum materials. It focused on the impact of the comprehensive ASMS curriculum on seventh grade students' learning in relation to NGSS PEs in physical science.

Students in ASMS classrooms outperformed students in the control condition on an assessment aligned with the NGSS PEs. Our analysis is ongoing and aims to better understand the features of ASMS that may differentiate it from other curricula that are also intended to support NGSS instruction.

