

LEGO® Education Science Case Study

Cultivating 21st Century Skills Through Hands-On Science Instruction

Picture the science classroom that fosters 21st-century skills—students puzzling over real-world phenomena, critically analyzing evidence, and creatively problem-solving together to address scientific challenges. Now picture the typical science classroom. How big is the gap?

Today, many teachers tell us it feels wider than ever, especially when it comes to getting students to communicate, collaborate, problem-solve, and create together. So, what is the challenge, and why does the gap exist?

Students are not experiencing hands-on, inquiry-based learning often enough. Our recent three-grade case study of LEGO® Education Science shows how accessible, well-designed, hands-on materials help teachers deliver these experiences consistently, closing the gap between science education's potential and classroom reality.

K–8 science teachers worldwide believe that science education plays a significant role in building transferrable skills:¹

- 82% of teachers believe science education develops critical thinking.
- 77% of teachers believe it develops curiosity.
- 65% of teachers believe it develops creativity.

The skills used in scientific thinking are instrumental to excelling in all facets of life, from



working with others to academic success. Growing up in a world with rapidly advancing technology, students will find that creativity is an essential future-ready skill. While 65% of teachers believe science instruction helps develop creativity, 100% of teachers using LEGO Education Science felt student creativity was enhanced by the experience.

Supporting students as they build the capability to thrive in these areas demands an increased focus on the development of 21st century skills.² After testing LEGO Education Science in nine K–8 classrooms across the U.S., we have data indicating strong associations between these joyful, hands-on learning experiences and the development of 21st century skills (full Case Study description on page 4).

Key Results: LEGO® Education Science Fostered 21st Century Skill Building

- **Enhanced collaboration:** 100% of teachers reported that students were more engaged and more collaborative during LEGO Education Science lessons compared to regular science instruction.
- **Observable critical thinking:** In 80% of taught lessons, teachers frequently observed students demonstrating critical thinking. By the end of the study, 8 out of 9 teachers reported that students were more likely to show critical thinking in LEGO Education Science lessons compared to regular science instruction.
- **Sustained behavioral engagement:** 78% of students across grade levels self-reported staying on task during lessons, a key indicator of sustained behavioral engagement.
- **Breakout creativity:** 100% of teachers reported that students were more likely to show creativity in LEGO Education Science lessons than in regular science instruction.



Testing Our Approach: 21st Century Skill Building with Collaborative, Hands-on Learning

Hands-on, collaborative science experiences help build essential 21st century skills, but these lessons do not happen frequently enough in most K-8 classrooms. Accessible, well-designed materials can change this pattern, giving teachers practical tools to make collaborative, hands-on science learning a regular part of instruction rather than an occasional event.

The structured approach of LEGO Education Science integrates joyful, hands-on learning into over 120 lessons that align with local state standards as well as Next Generation Science Standards (NGSS). Teachers are also supported by an online teacher portal with ready-to-use teaching resources and hands-on materials including LEGO® bricks and wireless hardware.

The LEGO Education Science program builds communication, collaboration, critical thinking, and creativity into every lesson through intentional design choices that ensure all students have a role in the learning process. Each kit includes four

colorful LEGO® minifigures that help students understand their assigned roles to ensure full participation and engagement during group work. This simple visual system removes ambiguity about participation and creates clear expectations for contribution.

LEGO Education Science includes teaching resources for time-strapped teachers and administrators seeking flexible, hands-on tools. The curriculum offers student-led, inquiry-based science lessons that were developed using the following evidence-based principles.

Research-backed design principles of LEGO Education Science	Learning Through Play: The five characteristics of learning through play posit that the learning process should be joyful, meaningful, actively engaging, iterative, and socially interactive. ⁸	Constructivism and Constructionism: Knowledge is constructed through hands-on activities and meaningful creation of physical models with peer interaction and teacher guidance. ^{9,10}
	Guided inquiry with the 5Es Model: Scientific phenomena investigations follow the Engage, Explore, Explain, Elaborate, and Evaluate instructional model to build understanding gradually. ¹¹	Universal Design for Learning: Lessons are created to include multiple modes of representation, engagement, and expression that support accessibility and flexibility for all students. ¹²

The lesson design within the LEGO Education Science program is based on 5E instructional design grounded in learning sciences,⁸ and scaffolds collaboration, from structured to authentic. This provides students with intentional opportunities for rich discussion and authentic collaboration:

- **Engage:** Pique student curiosity by discussing a big question.
- **Explore:** Assign roles to help students collaborate and solve problems through their first model build.
- **Explain:** Students discuss their observations and initial models.
- **Elaborate:** Students collaborate and iterate to develop solutions using their science knowledge.
- **Evaluate:** Students use critical thinking to evaluate and explain which solution is best and why.



The Case Study

LEGO® Education research partners conducted a case study to examine how LEGO Education Science performs in diverse, real-world classroom settings.⁹ Teachers across three states implemented the program as researchers gathered data and insights about critical thinking, creativity, collaboration, and communication skill development while students learned with LEGO Education Science in their science class. The embedded case study design allowed researchers to observe authentic classroom experiences as teachers and students worked through five LEGO Education Science lessons.

Case Study Snapshot

- **Timeframe:** Spring 2025 (2.5 months)
- **Districts:**
 - Compton Unified School District, CA
 - Irving Independent School District, TX
 - Northeastern School District, PA
- **School profiles:** Title 1 schools with large populations of multilingual learners, students receiving special education services,¹⁰ and those eligible for free or reduced-price lunch
- **Participants:**
 - 9 teachers with varied experience
 - » 5 generalists; 4 science specialists
 - » 3–31 years of science teaching experience
 - 201 students
 - » 64 in grades 1–2,
 - » 64 in grades 3–4, and
 - » 73 in grades 6–7
- **Data collection methods:**
 - After each lesson:
 - » Teacher post-lesson evaluations
 - » Student post-lesson surveys
 - At the end of the study:
 - » Teacher survey.
 - » Teacher interviews.
 - » Student focus group.





Research Findings:

Marked gains in critical thinking, collaboration, and problem-solving skill development

LEGO Education champions research-backed, hands-on learning through play pedagogy.⁶ LEGO Education Science incorporates this through the physicality of building, narrative framing of problems, and visible cause and effect feedback. Students reported it made science feel active and purposeful: “Because every lesson we do, we learn more” (Grade 1 student, CA).

When students experience learning through joyful, hands-on, interactive experiences, they strengthen academic knowledge, critical thinking, communication, collaboration, and creativity skills that help them grow and thrive.³

Development of 21st Century Skills Across All Grades

In interviews with teachers across grades and states, they reported that collaboration became increasingly student led. Students worked in structured, small-group collaboration as they proposed hypotheses, tested solutions, and interpreted evidence.

Teachers also reported that students were learning-by-making as they were building with interactive components such as motors and sensors and modeling with physical mechanisms. True to the research-backed idea of constructionism, students experienced unexpected outcomes, sparking curiosity, and exploration while building scientific knowledge.¹¹

In interviews, teachers reported that student agency grew visibly as engagement and collaboration evolved developmentally:

- In grades 1–2, students engaged through hands-on exploration and structured roles.
- In grades 3–4, they showed more creative ownership and student-driven teamwork.
- By grades 6–7, students demonstrated greater autonomy and collaborated to apply scientific concepts in more complex, purposeful ways.



By middle school, students negotiated between following instructions and inventing. The desire for autonomy reflects a shift from playful participation to strategic ownership. The positive tension between meeting an objective and problem solving is a catalyst for creativity, another key 21st century skill. When students create, they take ownership and see new possibilities for themselves. In post-study surveys, teachers identified creativity as a standout outcome, with 100% of teachers reporting that students were more likely to show creativity in LEGO Education Science lessons than in regular science instruction.

LEGO Education used the evidence-based 5E structure to incorporate two building experiences within each lesson for students to explore and elaborate on their understanding of a scientific concept.¹² In the Explore phase, students practice collaborating with assigned roles and clear building instructions as scaffolding to support them as they practice. During the Elaborate phase, students collaborate to build a solution to an open-ended problem, communicating and creatively problem-solving together in their small groups. Teachers' observations were corroborated by students' experiences: "It's more fun because you can build stuff and create things" (Grade 4 student, TX).

Teachers reported that in collaborative groups students felt confident modifying builds with original or personalized features, distinguishing between decorative and functional design choices, and taking more risks during problem solving.

"It helps kids who think they're bad at building feel more confident" (Grade 2 student, TX).

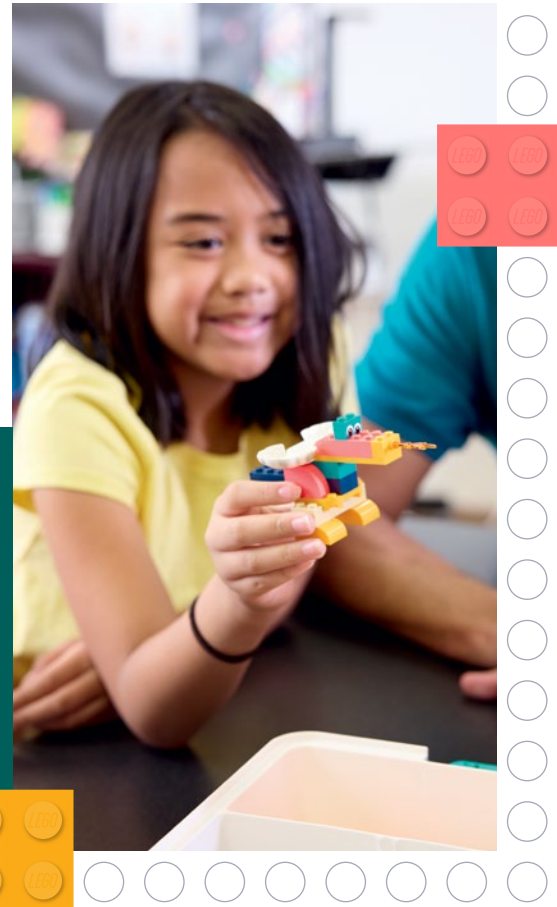
Students relished freedom to design, personalize, and invent. "My favorite [science lesson] was [called Troll] Under the Bridge because you could make whatever kind of bridge you wanted" (Grade 2 student, TX). Like this student, others recalled specific creations not as following instructions but as personalized reflections of their learnings.

High Behavioral Engagement Enables 21st Century Skill Development

Teachers and students also identified behavioral engagement as a key strength of the LEGO Education Science program. Clear routines, including structured tasks and instructions, promoted observable participation such as staying on task, following instructions, and minimizing distractions in a way that empowered teams to collaborate, communicate, and share creative new ideas equitably.

Group work encouraged participation—particularly among multilingual learners and quieter students—who felt more confident contributing in a collaborative setting. LEGO Education Science lessons provided students with multiple modes of communicating their understanding of science concepts:

“I don’t usually raise my hand... with LEGO [Education Science lessons] I could make different things”
(Grade 6 student, TX).



Beyond the multimodal opportunities for communicating understanding, the lessons also enabled students to strengthen agency, teamwork, and leadership skills. For example, students spontaneously regulated peers, asking for focus or suggesting tests rather than relying on teacher intervention. “We all took turns” (Grade 4 student, PA). Students also used conflict resolution skills before intervention was necessary. What did one group do when two possible solutions emerged? “Build both to see which works better” (Grade 6 student, TX).

Through peer accountability, students co-constructed solutions, supported one another in overcoming challenges, and shared ownership of tasks. “We can build and talk to our friends... combine our ideas and help each other” (Grade 7 student, CA). Over time, peer interactions shifted from simple turn-taking to shared decision-making and self-regulation, testing multiple solutions, and resolving disagreements through evidence: “We see who’s right by testing it” (Grade 1 student, CA).

Groups and structured tasks normalized peer teaching and nurtured classroom culture where ability differences become invisible through shared action. In focus groups, students reported that working together lowered anxiety and built confidence, especially for those who feel intimidated by science or working in groups.

Overall, collaboration within LEGO Education Science experiences nurtured both social and cognitive development. Students described teamwork during LEGO Education Science lessons as faster, easier, and more enjoyable than traditional group work.

Collaboration created an environment where students felt emotionally safe and mutually respectful of their teammates, empowering them to feel confident learning and communicating about science—positioning collaboration not as an accessory to learning, but as a scientific practice itself.

Multiple Ways to Demonstrate Higher Order Thinking Skills

Students experienced many ways to demonstrate critical thinking, collaboration, and problem-solving skills during LEGO Education Science lessons, whether through brainstorming, testing hypotheses, designing, building, or explaining.

By the end of the study, 89% of teachers reported that students were more likely to show critical thinking in LEGO Education Science lessons than in regular science instruction. This was most evident as students tested, refined, and justified their design choices and reasoned through challenges during elaboration phases.

Throughout the study, teachers frequently observed critical thinking, with “most” or “almost all or all” students demonstrating it in 80% of taught lessons and even higher rates in Grades 1–2 (93%). Younger groups started with competing ideas, while upper grades expanded critical thinking as they discussed, voted, or tested multiple designs.

Cognitive engagement occurred as students moved beyond surface-level participation to think critically, reason through challenges, and construct understanding. In responses from an age-appropriate engagement survey, students reported a lot of “focus on the things we’re learning”, which is a key measure of cognitive engagement:

- 79% of students in grades 1–2
- 87% of students in grades 3–4
- 73% of students in grades 6–7

Students working in groups also experienced more personal cognitive engagement and benefitted from their group’s collective intelligence: “It was perfect—everyone is smart, and when all of us are smart, we get smarter together” (Grade 1 student, CA). This student insight suggests an intuitive understanding of distributed problem-solving.



Conclusions and Implications

As educators seek more research-backed and engaging ways to deliver science instruction, they will find LEGO Education Science is designed to help students develop communication, collaboration, critical thinking, and creativity skills that set them up for success today and in the future.

Teachers participating in this embedded case study reported that highly engaging LEGO Education Science experiences increased collaboration, communication, critical thinking, and creativity among students. The collaborative, hands-on science experiences helped create an inclusive educational atmosphere that nurtured the development of 21st century skills and provided students with ample opportunities to demonstrate their progress.

1. LEGO Education State of Classroom Engagement Report: Science Edition
2. Woods-Groves, S., Choi, T., & Balint-Langel, K. (2021). Examining teachers' judgment of students' 21st century skills and academic and behavioral outcomes. *Psychology in the Schools*, 58(11), 2202–2224. <https://doi.org/10.1002/pits.22585>
3. Parker, R., Thomsen, B. S., & Berry, A. (2022). Learning Through Play at School – a framework for policy and practice. *Frontiers in Education*, 7. <https://doi.org/10.3389/educ.2022.751801>
4. Piaget, J. (1969). *The mechanisms of perception*. Basic Books.
5. Harel, I., & Papert, S. (1991). *Situating constructionism*.
6. BSCS Science Learning. (2024, May 22). The BSCS 5E Instructional Model: Origins and Effectiveness - BSCS Science Learning. <https://bscs.org/reports/the-bscs-5e-instructional-model-origins-and-effectiveness/>
7. Universal Design for Learning | CAST. (n.d.). CAST. <https://www.cast.org/what-we-do/universal-design-for-learning/>
8. Hao, N. (2024, March). The Effectiveness of the 5E Instructional Model in Developing Scientific Competency of Primary Students [PDF]. Proceedings of the 2nd International Conference on Innovation in Learning Instruction and Teacher Education – ILITE 2, Vietnam. https://www.researchgate.net/publication/379309322_THE_EFFECTIVENESS_OF_THE_5E_INSTRUCTIONAL_MODEL_IN_DEVELOPING_SCIENTIFIC_COMPETENCY_OF_PRIMARY_STUDENTS
9. The information presented here is part of a larger case study that evaluates the effectiveness of LEGO Education Science in diverse K–8 classrooms across the United States. This study focused on evaluating the extent that LEGO Education Science provided access to quality science learning for all, a program that is flexible and intuitive to implement, the extent of students understanding of science concepts, and the level of student engagement and collaboration.
10. Office of Special Education Programs (OSEP). (n.d.). U.S. Department of Education. <https://www.ed.gov/about/ed-offices/osers/osep>
11. Blinkoff, E., Hadani, H. S., Hirsh-Pasek, K., & Golinkoff, R. M. (2020b, October 28). A new path to education reform: Playful learning promotes 21st-century skills in schools and beyond. Brookings. <https://www.brookings.edu/articles/a-new-path-to-education-reform-playful-learning-promotes-21st-century-skills-in-schools-and-beyond/>
12. Polanin, J., Taylor, J., Steingut, R. (2024). Effects of the 5E Instructional Model: A Systematic Review and Meta-Analysis. *AERA Open*, 10(1):1–16. https://www.researchgate.net/publication/384293264_Effects_of_the_5E_Instructional_Model_A_Systematic_Review_and_Meta-Analysis