RESEARCH BRIEF

Gizmos and STEM Cases Deliver Transformative Impacts

Results from a survey of Collab Crew teachers who were active Gizmos and/or STEM Case users in 2022-2023

Gizmos and STEM Cases are interactive math and science labs and simulations for grades 3-12. Gizmos help teachers take advantage of research-proven instructional strategies and enable students of all ability levels to develop conceptual understanding in math and science. With a library of more than 500 academic learning standards-aligned Gizmos and 24 STEM Cases, teachers can supplement and enhance students' blended learning experiences with interactive visualizations of math and science concepts that are tough to teach and tough to understand.

In each Gizmos simulation, students can manipulate key variables, generate and test hypotheses, and engage in extensive "what-if" investigations. STEM Cases are virtual case studies where students assume the role of a STEM professional trying to solve a real-world problem.

> As an educator, I've found Gizmos to be a game-changer in the classroom. These interactive online simulations bring science to life, allowing students to experiment, manipulate variables, and witness real-time outcomes. Additionally, STEM Cases have enriched my teaching by immersing students in authentic, real-world scenarios, sparking their curiosity and nurturing critical thinking and problem-solving skills. The combination of Gizmos and STEM Cases has truly transformed the learning experience, making STEM education more engaging and relevant for my students.
>
> —High School Science Teacher, Arizona

The current study was conducted with teachers in the ExploreLearning Collab Crew, a group of educators working with the ExploreLearning Design and Research teams to help co-design the latest math and science Edtech solutions. 66 teachers (four Elementary, 24 Middle School, and 38 High School) completed the online survey in December 2023, which asked them to reflect on their past experiences using Gizmos and STEM Cases, including:

- *How do teachers use Gizmos and STEM Cases?*
- *How do Gizmos and STEM Cases support teachers' classroom needs?*
- *What learning goals are being addressed with Gizmos and STEM Cases?*
- *How do Gizmos and STEM Cases impact student learning?*

These findings can be helpful for teachers, curriculum coordinators, and administrators to see the variety of ways that teachers are using Gizmos and STEM Cases in the classroom, and the learning outcomes that their students are achieving as a result.

How do teachers use Gizmos and STEM Cases?

Teachers' responses highlight that Gizmos and STEM Cases can serve as flexible and modifiable tools, capable of fitting a variety of pedagogical approaches and classroom needs. Every respondent provided at least two different methods that they used to implement Gizmos into their classroom, with over 70% of teachers providing at least four different methods of using Gizmos with their students. Similarly, 48% of teachers provided at least four different methods they used to implement STEM Cases into their teaching and 77% of STEM Case users provided at least three different methods.

The most typical implementation style was to use the Gizmo or STEM Case as a stand-alone lab activity; 83% of teachers said they typically used Gizmos and STEM Cases in this method. Other common implementation styles included working on the Gizmo/Case as a part of the lecture, as an activity for interactive full-class discussion, as an optional course resource, and as a homework assignment.

How do Gizmos and STEM Cases support teachers' classroom needs?

Overall, Gizmos and STEM Cases are recognized for their ability to provide dynamic visualizations, facilitate formative assessments, and deepen student understanding. These tools bridge gaps in resources, time, and practical constraints, offering educators a means to enrich science education, engage students, and bring real-world applications into the classroom.
Here are some of the most common responses regarding how Gizmos and STEM Cases support teaching:

Enhancement of Hands-On Teaching: Teachers find Gizmos and STEM Cases to be a helpful substitute for traditional labs, especially when real-life exploration is impossible due to resource limitations, time constraints, or safety concerns. The tools provide opportunities for “hands-on” exploration of scientific concepts that students would not have access to otherwise.

Reinforcement of Concepts and Visualization: Many educators use Gizmos and STEM Cases to reinforce concepts visually, making topics more accessible. Animations and models enable students to visualize abstract or complex concepts, such as cellular respiration, and understand the interconnections between different elements, fostering a deeper comprehension of content. STEM Cases, in particular, help teachers to facilitate engagement in “real-world” scenarios.

> I find that it makes concepts more accessible to students, especially those that are hard (or impossible) to visualize, involve step-wise processes or involve motion/movement. Teaching concepts such as passive transport, membrane function, the details of cellular respiration, etc. are so much easier for me than in the past because students can see animations of the processes and the ways in which different pieces of a process fit together. I can then draw on the understanding they have built by doing the Gizmo or Case Study.
>
> —High School Science Teacher, North Carolina

Gizmos

> Both Gizmos and STEM Cases allow my students to tackle big ideas and engage with experiments to identify or understand relationships between simple concepts that impact complex systems. It allows them to experiment and collect data that time and location would not otherwise permit. They are essential to my inquiry-based style of science instruction.
>
> —High School Science Teacher, Virginia

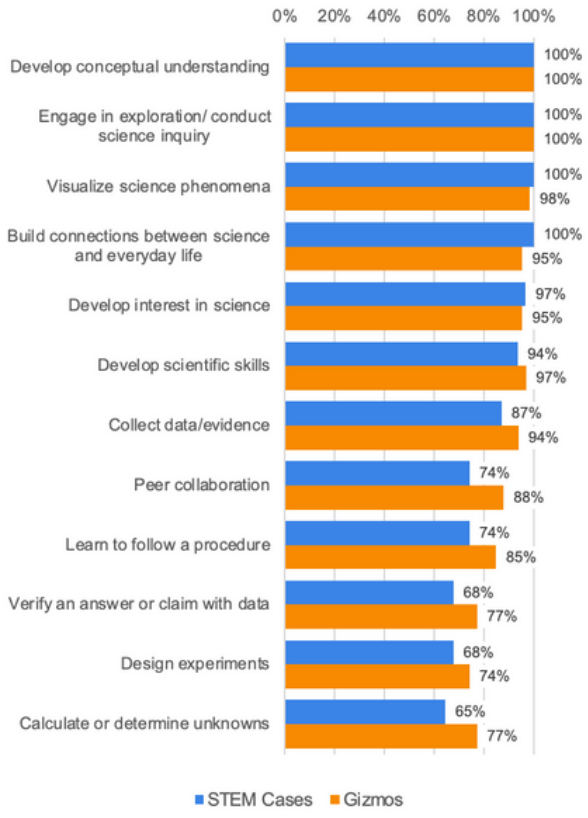
Enhancing Inquiry-Based Learning: Gizmos and STEM Cases play a crucial role in supporting inquiry-based science instruction, allowing students to experiment and think critically about complex problems and systems. Unlike traditional labs, students can easily manipulate variables across many trials without the concern of resource availability or lab setup, leading to a deeper understanding of the related scientific principles.

Flexibility in Hybrid Learning and Virtual Environments: Teachers highlighted the flexibility Gizmos and STEM Cases offer in hybrid learning situations, allowing for engagement and exploration, particularly during times like the COVID-19 pandemic when virtual teaching became essential. Additionally, Gizmos are used to provide virtual hands-on laboratory experiences for entirely virtual classrooms.

What learning goals are being addressed with Gizmos and STEM Cases?

Teachers reported using Gizmos and STEM Cases to achieve several different learning goals. All teachers reported typically or occasionally using Gizmos to support conceptual knowledge growth and engage in scientific inquiry. The majority of teachers also reported using Gizmos to visualize science concepts, support enjoyment and interest in science, and enable data collection. STEM Case users also typically used the tool to build connections with everyday life and develop scientific reasoning skills.

Every respondent provided at least six different learning goals that they used Gizmos to support, with 94% of teachers providing at least eight other goals. Similarly, all STEM Case users provided at least five different learning goals that they typically or occasionally used STEM Cases to support, and 81% of STEM Case users provided at least eight different goals.



How do Gizmos and STEM Cases impact student learning?

Overall, teacher responses underscored the transformative impact of Gizmos and STEM Cases on student learning experiences, engagement, and academic achievement in STEM. Here are some of the most common student improvements and changes reported by teachers:

> Students are grasping some of the more difficult concepts much faster and easier... It seems that they are able to learn about the big picture of a concept and then piece together how the details work within it. My students particularly enjoy the Case Studies for the real-world application, which can be hard when discussing advanced biological concepts.
>
> —High School Science Teacher, North Carolina

Increased Conceptual Understanding of Difficult Concepts: Teachers observed significant improvement in their students' conceptual understanding of challenging science topics with the use of Gizmos and STEM Cases. The simulations helped students to break down complex concepts, using appropriate vocabulary as well. With STEM Cases, students demonstrated an improved understanding of how scientific concepts learned in class are used in practical, real-world applications.

Increased Engagement and Interest in Science: Teachers noted a substantial increase in student engagement and interest in science. The interactive nature of Gizmos and STEM Cases, coupled with their real-world applications, increased curiosity and excitement among their students. Teachers also reported that the tools helped foster a genuine interest in scientific exploration, a positive attitude toward learning, and a more dynamic classroom experience.

Improved Test Scores and Academic Performance: Several teachers reported that their students had increased test scores after they integrated Gizmos and STEM Cases into their teaching. Some teachers also said that they used Gizmos and STEM Cases as supplemental review material before tests for their struggling students and that their test scores improved significantly as a result.

Enhanced Data Analysis Skills and Scientific Thinking: Teachers reported that Gizmos and STEM Cases fostered essential NGSS-aligned skills; students developed stronger reasoning skills, honed their ability to analyze data critically, and practiced explaining the reasoning behind their opinions and conclusions. The incorporation of STEM Cases, in particular, was highlighted for its contribution to fostering scientific thinking and challenging students to draw evidence-supported conclusions from their observations.

> The students' ability to model concepts is always strengthened when using the STEM Case. They also reference data and observations more readily when they have multiple sources to draw from.
>
> -High School Biology teacher, New Jersey