New York Hall of Science

Playground Physics

DID PLAYGROUND PHYSICS SUPPORT MIDDLE SCHOOL STUDENTS' KNOWLEDGE OF PHYSICS CONCEPTS, ENGAGEMENT, AND SCIENCE-RELATED ATTITUDES?

Project Overview

THE PROBLEM: What Challenge Did the Program Try to Address?

The National Action Plan for Addressing the Critical Needs of the U.S. Science, Technology, Engineering, and Mathematics Education System calls for better integration of informal and formal science education. This is also a prominent objective in the President's Council of Advisors on Science and Technology report on K-12 STEM Education for America's Future. The program is an attempt to increase middle school students' interest in STEM fields through the use of a software application to encourage informal science education.

THE PROJECT: What Strategies Did the Program Employ?

The New York Hall of Science (NYSCI)[1] used a 2011-2016 i3 development grant[2] to start this project, which is aimed at leveraging students' physical play to increase student engagement with physics and understanding of complex physics concepts: motion, force, and energy. Playground Physics focused on underserved and underrepresented middle school students across New York City. The resulting Playground Physics app visually links children's actual physical play to abstract physics representations. The app platform provides space for iterative exploration of their movement, encourages collaboration, and supports scientific argumentation. The program was evaluated by a randomized controlled trial (RCT) with teachers as the unit of randomization. A total of 60 teachers in New York City were randomly assigned to the treatment (Playground physics) and control (business as usual), serving over 3,000 students.

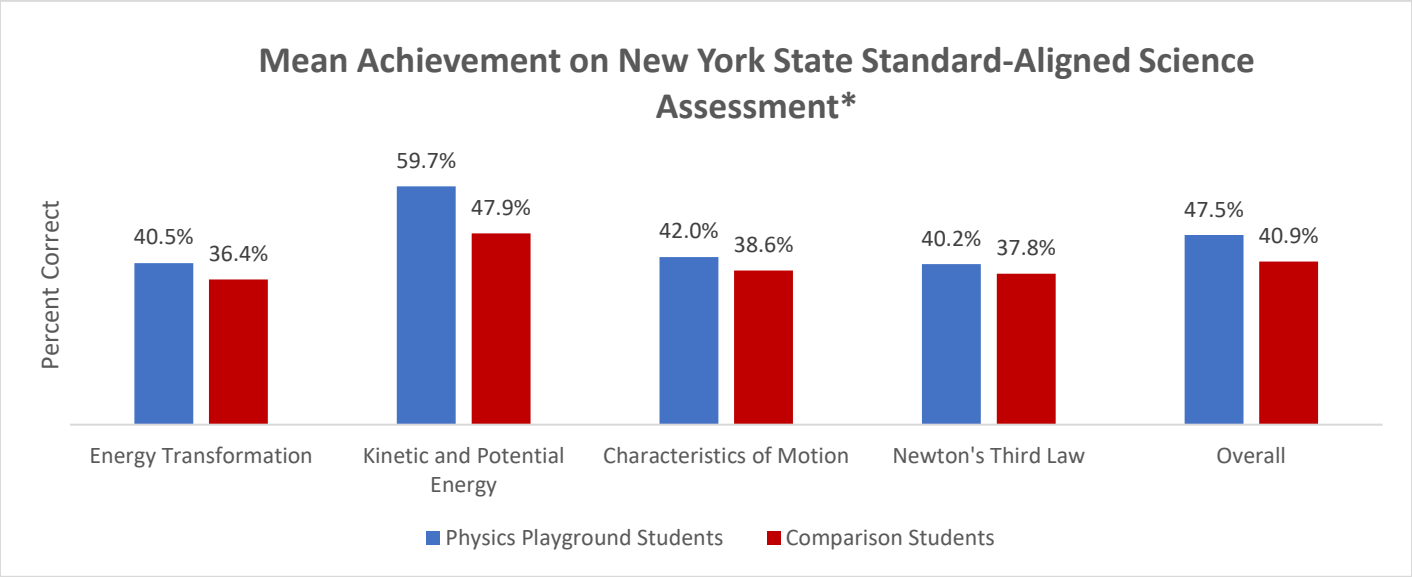
[1] The New York Hall of Science received an i3 development grant supported by the U.S. Department of Education's Investing in Innovation program through Grant Number U411C110310. Development grants provide funding to support the development or testing of novel or substantially more effective practices that address widely shared education challenges. All i3 grantees are required to conduct rigorous evaluations of their projects. The quality of evidence required to demonstrate a project's effectiveness depends on a project's level of scale or grant type.

THE PLAYGROUND PHYSICS MODEL

- **Playground Physics App.** NYSCI provided iPads with the Playground Physics iOS app installed to teachers implementing Playground Physics. The app is designed to help students build a bridge between the kinesthetic experience of physical play (e.g., running, jumping, sliding) and physics concepts. Students can use the app to record ordinary play activities (e.g., cartwheeling, jumping, running, swinging) and analyze their recordings in three modes: Motion, Force, and Energy.
- **Professional Development (PD).** The Playground Physics PD activities were designed to help teachers understand how to use the app and activity guide as part of their motion, force, and energy instruction. During PD, teachers explore the concepts of energy, motion, and force and practice how they might use the Playground Physics app and review the activity guide to engage their students in informal science learning.
- **Curriculum changes.** The Playground Physics activity guide supports teacher instruction focused on motion, force, and energy while using the Playground Physics iOS app. The activity guide includes a teacher guide and a student activity workbook that are organized into three curriculum units. These units were written to align with the following four New York State Intermediate Level Science Standards: transformation, energy, motion, and force..

Summary of Results

DID PLAYGROUND PHYSICS SUPPORT MIDDLE SCHOOL STUDENTS' KNOWLEDGE OF PHYSICS CONCEPTS, ENGAGEMENT, AND SCIENCE-RELATED ATTITUDES?



*While aligned with New York State Science Standards, the assessment consisted of items from multiple sources, including publicly available state assessment items (New York, Massachusetts, Illinois, and California) and research-based instruments from the American Association for the Advancement of Science.

The mean overall score on the physics knowledge assessment was higher for students in the Playground Physics group than for the comparison (non-program) group. This difference is statistically significant. There is no statistically significant difference between the groups' mean scores on individual components (standards) of the assessment. No significant differences were noted for student engagement in science class or across four constructs of science-related attitudes. The following are some of the main results highlighted in the study of the program:

- **KNOWLEDGE.** Students in classrooms that implemented Playground Physics demonstrated greater knowledge of content across the different standards tested, as indicated by percent correct at posttest.
- **ENGAGEMENT.** The engagement scale score of students in Playground Physics was not statistically significantly greater than for students in the control group.
- **ATTITUDES.** There was no statistically significant impact of Playground Physics on the attitudinal constructs of motivation, interest in science, science self-concept, or interest in pursuing a science career.

Please see Appendices A and B for information about the evaluation's design and the quality of the evidence, respectively.

SECONDARY FINDINGS

- **GENDER**. The interaction of treatment and gender was not significant for any of the six outcome variables, indicating that the impact of Playground Physics did not differ for females compared to males.
- **RACE**. Race/ethnicity of students did not correspond to different outcomes of Playground Physics than White students. Study explored the following groups: black, Hispanic and "other."

OTHER CONSIDERATIONS

The study noted other considerations that may have affected findings. It also discussed how participating teachers described the way in which they used Playground Physics to teach the physics concepts of energy, force, and motion with a few program features.

- **RANGE OF STUDENT RESPONSES.** The restriction of range in student response to the survey scales for outcomes suggests that these measures may not have been sensitive to the impact of Playground Physics.
- **FIDELITY OF IMPLEMENTATION.** Fidelity of implementation examined the extent to which program developers and teachers implemented the program as intended. During the academic year in the study, the program met the fidelity criteria across the three components: teacher attendance of PD, receipt of curriculum materials, and classroom use of the curriculum.
- **TIME SPENT ON DIFFERENT TOPICS.** Teachers with students in the Playground Physics program spent more time, on average, on the motion unit than on either of the other two units. However, students in those classes did not seem to have an advantage in that specific area, compared to students who did not participate in Playground Physics.
- **OVERALL TIME SPENT TEACHING PHYSICS.** Teachers in the treatment and control groups spent about the same amount of time teaching the physics topics covered in Playground Physics
- **PLAYGROUND PHYSICS AS A SUPPLEMENT.** Most teachers in the treatment group did not exclusively teach Playground Physics to address the topics of energy, force, and motion. Rather, they combined it with their regular curriculum.

For More Information

Evaluation Reports	Additional Reports
Enhancing Middle School Science Lessons with Playground Activities: A Study of the Impact of Playground Physics (AIR, April 2017)[3]	Playground Physics 2014-15 Implementation Study Report (AIR, April 2017)

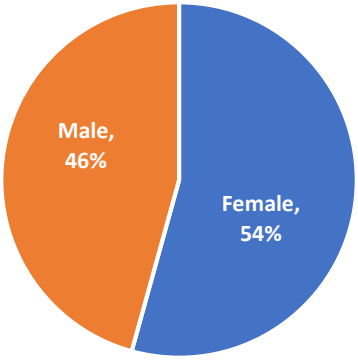
[3] The information and data for this result summary was collected from the most recent report as of 02/10/2020: AIR. (2015, September). *Enhancing Middle School Science Lessons with Playground Activities: A Study of the Impact of Playground Physics*. Retrieved from https://www.air.org/sites/default/files/downloads/report/PlaygroudPhysics-2015-16-508-rev.pdf

Appendix A: Students Served by the Project[4]

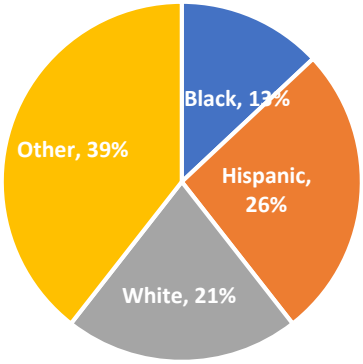
GRADE(S)

PK	K	1	2	3	4	5	6	7	8	9	10	11	12

GENDER



RACE/ETHNICITY



COMMUNITY

Not Reported

HIGH-NEED STUDENTS[i5]

Free/Reduced-Price Lunch	English Learner	Students with Disabilities
61%	2%	10%

[4] These data reflect the entire student population served by the intervention, not just the evaluation sample used in the impact study.
[5] The data in this table refer to the program group only.

Appendix B: Impact Evaluation Methodology[6]

RESEARCH DESIGN:

Design:	Randomized Controlled Trial
Approach:	▪ Sixty teachers were randomly assigned to the Treatment of Control group. With attrition, the resulting groups contained 24 and 21 teachers, respectively. ▪ The analysis included pre- and post-testing, using HLM in the analysis, with students nested in classrooms. ▪ Means and differences were regression-adjusted to account for confounding variables.
Study Length:	Five years

DATA COLLECTION AND ANALYSIS

Study Setting:	Forty-eight New York City public middle schools
Final Sample Sizes:	▪ *Intervention Group*: 759 students ▪ *Comparison Group*: 438 students
Intervention Group Characteristics:	▪ Free/Reduced Priced Lunch: 61% ▪ Students with disabilities: 10% ▪ English Language Learners: 2% ▪ Female: 54% ▪ Black: 13% ▪ Hispanic: 26% ▪ Other Race/Ethnicity: 39% ▪ Teacher total years of instructional experience: 11
Comparison Group Characteristics	▪ Free/Reduced Priced Lunch: 78% ▪ Students with disabilities: 17% ▪ English Language Learners: 12% ▪ Female: 51% ▪ Black: 14% ▪ Hispanic: 46% ▪ Other Race/Ethnicity: 27% ▪ Teacher total years of instructional experience: nine
Data Sources:	▪ Pre-post knowledge assessments of 20 multiple-choice questions ▪ Survey with items on engagement in science class, and science-related attitudes ▪ Student demographic data ▪ Professional Development delivery and attendance records ▪ Teacher surveys

[6] These data reflect only the evaluation sample in the impact study, not the entire population served.

Key Measures:

- Knowledge of physics concepts
- Engagement in science class
- Intrinsic motivation, attitudes toward learning science, and attitudes toward science careers

Appendix C: Quality of the Evidence

Although an evaluation may not have been reviewed by the time of publication for this summary, it is possible that the study will be reviewed at a later date. Please visit the websites found in the footnotes on this page to check for updates.

WHAT WORKS CLEARINGHOUSE REVIEW[7]

STUDY	RATING
Not reviewed as of 02/10/2020	N/A

EVIDENCE FOR ESSA REVIEW[8]

STUDY	RATING
Not reviewed as of 02/10/2020	N/A

NATIONAL CENTER ON INTENSIVE INTERVENTIONS REVIEW[9]

STUDY	RATING
Not reviewed as of 02/10/2020	N/A

[7] https://ies.ed.gov/ncee/wwc/FWW
[8] https://www.evidenceforessa.org/
[9] https://intensiveintervention.org/

*The **Investing in Innovation Fund (i3)**, established under section 14007 of the American Recovery and Reinvestment Act of 2009, is a Federal discretionary grant program at the U.S. Department of Education within the Office of Elementary and Secondary Education (OESE). i3 grants help schools and local education agencies work in partnership with the private sector and the philanthropic community to develop and expand innovative practices that improve student achievement or student growth, close achievement gaps, decrease dropout rates, increase high school graduation rates, and/or increase college enrollment and completion rates for high-need students.*

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[i] "High-need student" refers to a student at risk of academic failure or otherwise in need of special assistance and support, such as students who are living in poverty, attend high-minority schools, are far below grade level, who have left school before receiving a regular high school diploma, at risk of not graduating with a diploma on time, who are homeless, in foster care, have been incarcerated, have disabilities, or who are English learners. For more information see: Applications for New Awards; Investing in Innovation Fund-Development Grants, 81 FR 24070 (April 25, 2016).