Hero Elementary Playlist RCT Study in Formal School and Distance Learning Contexts

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Introduction

For decades, American schools that serve economically disadvantaged students have struggled with limited budgets to find resources and teachers for their science classrooms. On the National Assessment of Educational Progress in 2009, only 15% of American fourth graders who were eligible for free/reduced-price lunch scored at or above proficient in science achievement (NCES, 2011). As schools across the country closed their doors in response to the COVID-19 pandemic this year, addressing issues of access and equity in STEM education has become more urgent than ever.

Well-designed transmedia learning environments provide the opportunity to address student needs in distance learning. In transmedia learning environments, students can extend their learning time and space, across both in-school and out-of-school activities, while experiencing the affordances of game-like, narrative-based curricular materials, enhancing their motivation and engagement in the learning process (Lacasa, 2010). In addition, research on transmedia-related educational programs has found positive impacts in school and at home, including active involvement of the audience in the narrative; creation of a unified learning experience; improvement of the learning process by means of integrating knowledge and skills; development of 21st century skills (e.g., collaboration and critical thinking); and gains in student achievement (Andreu, Marti, & Aldas, 2012; Cohen, Ducamp, Kjellstrom, & Tillman, 2012; McCarthy, Li, Atienza, & Tiu, 2015; Miller, 2012; Thai, Li, & Schachner, 2019).

Funded by the U.S. Department of Education, the Twin Cities Public Television (TPT) Ready to Learn program, *Hero Elementary*, aims to reach Latino communities and support the needs of children with disabilities. The program is designed to provide opportunities for early science engagement and learning across diverse student populations (e.g., English learners, low-income, Latino, students with special needs). It embeds K-2nd-grade Next Generation Science Standards (NGSS) into a series of transmedia playlists that use authentic characters in the *Hero Elementary* television shows; digital games; non-fiction eBooks; hands-on activities; and digital notebooks to connect to diverse students' lived experiences; as well as to inspire, empower, and deepen students' active science learning.

Study Overview

In the spring of 2020, WestEd conducted a randomized controlled study using four NGSS-aligned transmedia playlists focusing on solid and liquid, heating and cooling, properties of materials, and properties and uses, respectively. The purpose of the study is to understand the effects of implementing the playlists in formal science learning environments and to investigate how the playlist activities support student engagement and learning. This randomized controlled study began with in-school implementation before COVID-19 and transitioned to distance learning after COVID-19. In order to provide effective distance learning and draw upon the best practices to ensure students' science engagement and quality education, the study teachers, researchers, and program developers worked together to address students' needs based on the schools' infrastructure, preparations, and resource availability.

As indicated in the logic model (Figure 1), the program containing four transmedia playlists is intended to be implemented for two months in a typical second-grade class. Each playlist involves a science episode, a digital game, non-fiction eBooks, two hands-on activities, an interstitial song, and two digital notebooks. Teachers are expected to implement the program two to three days per week for 50 minutes per day and finish each playlist in two weeks. The four playlists integrate science and literacy to ignite students' natural curiosity and engage them as scientists and communicators. Students learn how to use their *Superpowers of Science* to observe things in the world around them, noting the properties of those objects, describing changes that the objects can go through, and developing a language for asking questions and explaining their observations.

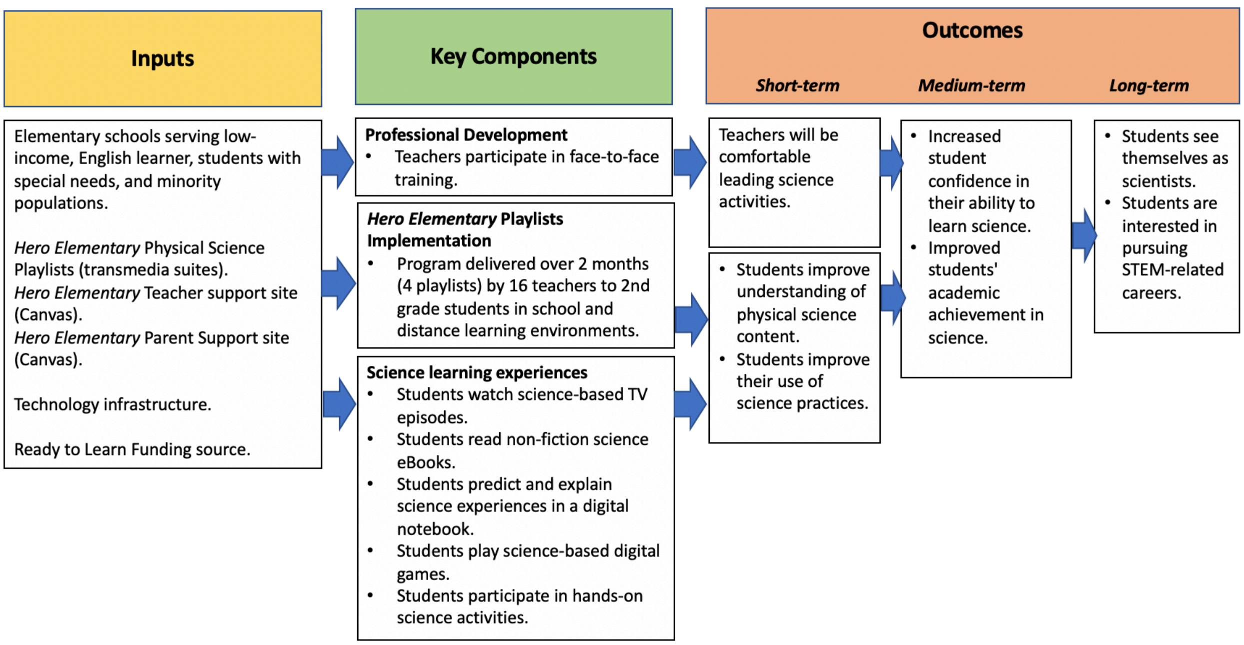


Figure 1. Logic Model

To prepare teachers to implement *Hero Elementary* effectively and with fidelity, the *Hero Elementary* development and research teams provided systematic training, supports, and resources to the teachers. The training focused on: (1) background information about *Hero Elementary* development and the use of *Hero Elementary*; (2) discussion of the *Superpowers of Science* and their application in classrooms; (3) a demonstration of useful classroom practices related to equity-based teaching strategies for all students; and (4) successful integration of technology in the classrooms. Appendix A provides more details about the training.

Research Questions

Guided by the logic model (Figure 1), this study attempts to address the following research questions, which were adapted as the study progressed in order to consider new circumstances emerging from the COVID-19 pandemic and resulting distance learning:

1. How were the playlists implemented in in-school environments?
    - With what frequency and at what pace did teachers implement the playlist activities?

- In what ways did teachers incorporate the *Superpowers of Science* in their instruction?
- Were teachers/students able to implement the digital activities as intended?
- Were teachers/students able to implement the hands-on activities as intended?

2. How were the playlists implemented in the distance-learning environment?
    - Were teachers/students/parents able to implement the activities with fidelity?
        - With what frequency and at what pace did teachers implement the playlist activities?
        - How did teachers and parents implement the playlist activities in the at-home setting?
        - How did teachers and parents modify the program to fit families' needs during shelter-in-place?
    - In what ways did teachers incorporate the *Superpowers of Science* in their instruction?

3. Which components of the *Hero Elementary* Program were most successful and/or challenging in the context of distance learning?
    - Success defined as:
        - High engagement
        - Learning is an important idea
        - Growth in skills (*Superpowers of Science*)
        - Improved attitudes toward or interest in science
    - For the most challenging components:
        - What made them challenging?
        - What could make them easier?

4. What was the potential impact of the playlists on student science knowledge?
    - Did students' science knowledge increase over the course of implementation, as compared to the control group?

Description of Playlists

Solid or Liquid

Students learn about states of matter in the *Solid or Liquid* playlist (Table 1). They observe and describe solids and liquids and learn how to classify materials by state. Students also explore how to heat and cool matter to change its state.

Table 1. ***Solid or Liquid*** **activities**

Activity	Type	Learning Goals
Citytown Meltdown	Digital Game	Explore how changing the temperature of matter affects its state
What is it?	Hands-On Activity	Students identify and describe solids and liquids in their surroundings
Solid or Liquid at the Lake	Digital Notebook	Practice distinguishing solids and liquids
The Lake Mistake	Episode	Investigate how matter changes states along with the Sparks Crew
Melted Materials	Digital Notebook	Use cause and effect reasoning to explain the process of melting
Changing Materials	Hands-On Activity	Explore how objects react when heated
Solid or Liquid Books!	eBooks	Learn the fundamentals of matter and its states
Keep on Collecting	Interstitial	Learn about the superpower of collecting information

Heating and Cooling

In the *Heating and Cooling* playlist (Table 2), students explore what happens when different materials change temperature. They observe how heating and cooling can alter a material's state in ways that are reversible (as with water) and in ways that are not (as with popcorn).

Table 2. ***Heating and Cooling*** **activities**

Activity	Type	Learning Goals
Movie Theater Meltdown	Episode	Follow along with the Sparks Crew as they help Stevie Heat stop melting objects with his hands
Citytown Meltdown	Digital Game	Explore how changing the temperature of matter affects its state
Predict	Interstitial	Learn about the superpower of prediction
Materials and Changes	Digital Notebook	Reflect on what the Sparks Crew learned in the *Movie Theater Meltdown* digital episode
Hot Changes	Hands-On Activity	Use the superpowers of prediction and observation to explore how materials change when heated
Notice the Changes	Digital Notebook	Students record the observations they made during the *Hot Changes* activity
Cold Changes	Hands-On Activity	Use the superpowers of prediction and observation to explore how materials change when cooled
Heating and Cooling Books!	eBooks	Read about matter and how it changes

Properties of Materials

In the *Properties of Materials* playlist (Table 3), students explore the amazing variety of materials that make up the world around them. They observe and describe the characteristics of these materials while performing simple investigations.

Table 3. ***Properties of Materials*** **activities**

Activity	Type	Learning Goals
Toad Road	Digital Game	Construct a bridge out of different materials that will help the toads get across a road
Lots of Liquids!	Hands-On Activity	Investigate the properties of liquids and observe how they interact when mixed
What Did You Observe?	Digital Notebook	Use the digital notebook to record findings from *Lots of Liquids!*
The Blob	Episode	Watch the Sparks Crew figure out the properties of an unknown blobby material to prevent it from taking over the school!
Let's Test Materials	Hands-On Activity	Perform simple tests that help students identify and describe the properties of materials
Properties of Materials Books!	eBooks	Read about the science of materials and their properties
Observation	Interstitial	Learn about the superpower of observation
Gift for Athletica	Digital Notebook	Draw and describe the properties of a gift for Athletica (character from *The Blob* digital episode)

Properties and Uses

In the *Properties and Uses* playlist (Table 4), students explore the world around them, observing which materials are used for which purposes. They investigate what makes materials good for some uses, but not others.

Table 4. ***Properties and Uses*** **activities**

Activity	Type	Learning Goals
Build a Bridge	Hands-On Activity	Build bridges out of different materials and test which is sturdiest
The Strongest Bridge	Digital Notebook	Record the results of the *Build a Bridge* activity
Toadal Confusion	Episode	The Sparks Crew figures out which material works best to build a bridge that helps the toads get out of the skate park
Properties and Uses Books!	eBooks	Read about how the properties of materials make them well suited—or not—for different uses
The Best Raincoat	Hands-On Activity	Test different materials to figure out which would be best for making a raincoat
Figure It Out	Interstitial	Learn about the superpower of solving problems
Lucita's New Raincoat	Digital Notebook	Record findings from *The Best Raincoat* activity
Toad Road	Digital Game	Construct a bridge out of different materials that will help the toads get across a road

Methods

Study Design and Random Assignment

The study used a multi-site cluster randomized, experimental design, which randomly assigned 34 second-grade teachers (n=810 students) from 20 schools in California, who serve economically disadvantaged students, to a treatment or control group. The treatment classrooms implemented the *Hero Elementary* intervention, while control classrooms implemented their business-as-usual science activities.

For schools with an even number of participating teachers, teachers were randomly assigned to one of the two conditions within each school. For schools with an odd number of participating teachers, the research team applied the optimal Mahalanobis matching method to pair up schools. For those schools, the team first calculated the Mahalanobis distance based on four matching variables: (1) percent of students who received free or reduced lunch; (2) percent of English language learners; (3) percent of the Hispanic students; and (4) percent of White students. Then, the team conducted 2,000 random pairing configurations between schools and selected the pairing configuration with the lowest average Mahalanobis distance across pairs. Finally, the research team randomly assigned teachers within each pair to the treatment or control group.

Instruments for Data Collection

Online Science Quest Assessment

The researcher-developed assessment is an NGSS-aligned digital assessment (see Appendix B for test blueprint). It includes 18 items that assess second-grade students' knowledge of matter and its interactions. The reliability of the assessment is 0.70. Students completed the pre-assessment in school before school closures and completed the post-assessment at home during school closures. To ensure the integrity of the assessment scores, teachers communicated with parents about the importance of students completing the assessments independently and the expectation that parents support students only with technical challenges.

Teacher Implementation Logs

Educators completed a brief online log at the end of each week of playlist implementation. These logs were designed to measure the extent to which participating teachers covered *Hero Elementary* content in each playlist in in-school and distance learning environments. The logs collected information about the playlist activities teachers used and the amount of time each activity took. General reporting categories included: (a) amount of teaching time devoted to *Hero Elementary*; (b) implementation and modification of different activities to meet students' needs; (c) teachers' perceptions of student understanding; and (d) questions related to any problems or issues that teachers encountered during implementation. Teachers used the logs to report on technical issues, successes, and challenges that arose when implementing playlist activities.

Researchers created a new log once the teachers transitioned to distance learning implementation. This new log expanded on the previous log's content by asking educators to share any distance learning modifications made to activities and include the number of students who were in attendance for each activity's implementation. Educators were also asked to specify which type of distance learning implementation they used for each activity (implementation with the whole class or individual students, a combination of these options, or another option).

Interim School Closure Survey

Educators completed a survey with information about their specific school closures and distance learning conditions after school closures in March. The survey asked teachers about their students' access to devices and internet services, teachers' methods of communication with students' families, and the feasibility of continuing the playlist activities with students during distance learning.

Teacher Interviews

Two rounds of teacher interviews were conducted. One round was conducted immediately after school closures to understand implementation in in-school environments (interim teacher interview); the other round was conducted toward the end of the study to understand the implementation in distance learning environments (final teacher interview).

- Interim teacher interview
  - Shortly after schools closed in March, teachers participated in a 30- to 45-minute interview. Treatment teachers were asked about the *Hero Elementary* playlist activities that they were able to implement in person with their classes, while control teachers were asked about their typical science curriculum.
- Final teacher interview
  - At the end of the study, teachers participated in an additional 30-minute to 1-hour long interview detailing their experiences with classroom instruction during distance learning. Treatment teachers provided additional information about their implementation of playlist activities after school closures occurred.

Overall, treatment teacher interviews focused on: (a) teachers' use of *Hero Elementary*; (b) student engagement and learning; (c) feedback on implementation successes and challenges; and (4) quality and content of *Hero Elementary*. Control teacher interviews focused on: (a) science instruction in the in-school environment and during distance learning; and (b) student engagement science learning.

Distance Learning Classroom Observations

Due to school closures, researchers were unable to conduct typical in-person classroom observations to view how educators implemented playlist activities. However, a researcher was able to observe one teacher's class-wide Zoom session to view playlist implementation in a distance learning setting. This virtual classroom observation was done in a treatment classroom whose teacher provided synchronous instruction with students who could participate. The classroom observation allowed for documentation of: (a) playlist activities covered in the lesson; (b) resources and equipment; (c) interaction among students and the teacher; (d) a snapshot of student activities in distance learning; and (e) types of parent support, if any.

Parent Survey

At the end of the study, parents in participating treatment and control classrooms were invited to complete a survey about at-home *Hero Elementary* implementation or business-as-usual science learning. This allowed for a better sense of students' usage of playlist activities during distance learning. Treatment parent surveys focused on *Hero Elementary*, whereas control parent surveys focused on school-offered science activities in the distance learning environment: (a) their awareness of *Hero Elementary* or science activities; (b) types of support they provided for different *Hero Elementary* activities or science activities; (c) their feedback on their children's engagement and learning through *Hero Elementary* or science activities; and (d) successes and challenges of using *Hero Elementary* or science activities in distance learning environments.

Parents had the ability to report details about each playlist activity, including the level of support parents provided, challenges that arose, and their opinions about each activity. The treatment survey also asked for parents to specify what modifications they made to the *Hero Elementary* activities, if any.

Playlist Telemetry

While students participated in the digital playlist activities, the LRNG system collected telemetry data, which logged specific student actions.

Characteristics of Study Sites and Participants

Study Sites Demographics

In preparation for recruitment, a recruitment pool was pulled from the 2018-2019 CDE school information database (https://www.cde.ca.gov/ds/dd/index.asp) of all open California elementary schools, using a number of predetermined criteria. After taking into account the location and accessibility of school sites, ideal schools were initially identified using the following criteria: (1) at least 40% Hispanic students; (2) 30% English language learners; and (3) 40% of the students qualified for free or reduced-price lunch. The majority of the sites recruited met those criteria. Table 5 below illustrates some key demographic information for study sites at the time of randomization.

Table 5. Demographic information by study site

School	Free/ Reduced-Price Lunch (%)	Ell (%)	Hispanic (%)	African American (%)	Asian (%)	White (%)
Site A	98	44	94	1	0	4
**Site B	77	16	5	18	10	7
Site C	97	31	96	0	0	2
Site D	90	40	95	3	0	0
Site E	67	12	58	14	13	6
Site F	69	16	44	5	25	11
Site G	94	35	99	0	0	0
Site H	70	28	66	6	5	15
Site I	48	15	41	7	21	23
*Site J	49	35	52	1	6	24
Site K	93	30	95	4	0	0
Site L	89	52	90	2	3	2
Site M	78	42	91	5	0	3
Site N	65	57	53	1	14	4
Site O	57	41	58	7	4	21
Site P	84	63	91	2	1	3
Site Q	59	32	29	2	51	5
*Site R	69	37	87	1	0	10
Site S	80	22	18	67	0	10
**Site T	77	51	95	1	0	2

* School involved teachers from the study during randomization; however, no teachers from these schools continued to be involved by the end of the study.
**After drop-off due to distance learning, no teachers from these schools continued to be involved at the end of the study.

Teacher Participants

Most teachers who participated in the study were regular classroom teachers responsible for providing instruction in all content areas; two were science specialists who provided only science instruction for several different classes. Thirty-two out of thirty-four participating teachers provided additional information related to their science training. All of them reported that they had no specialized science training outside of the general education classes required for their credentials. Table 6 shows teachers' years of teaching experience by condition.

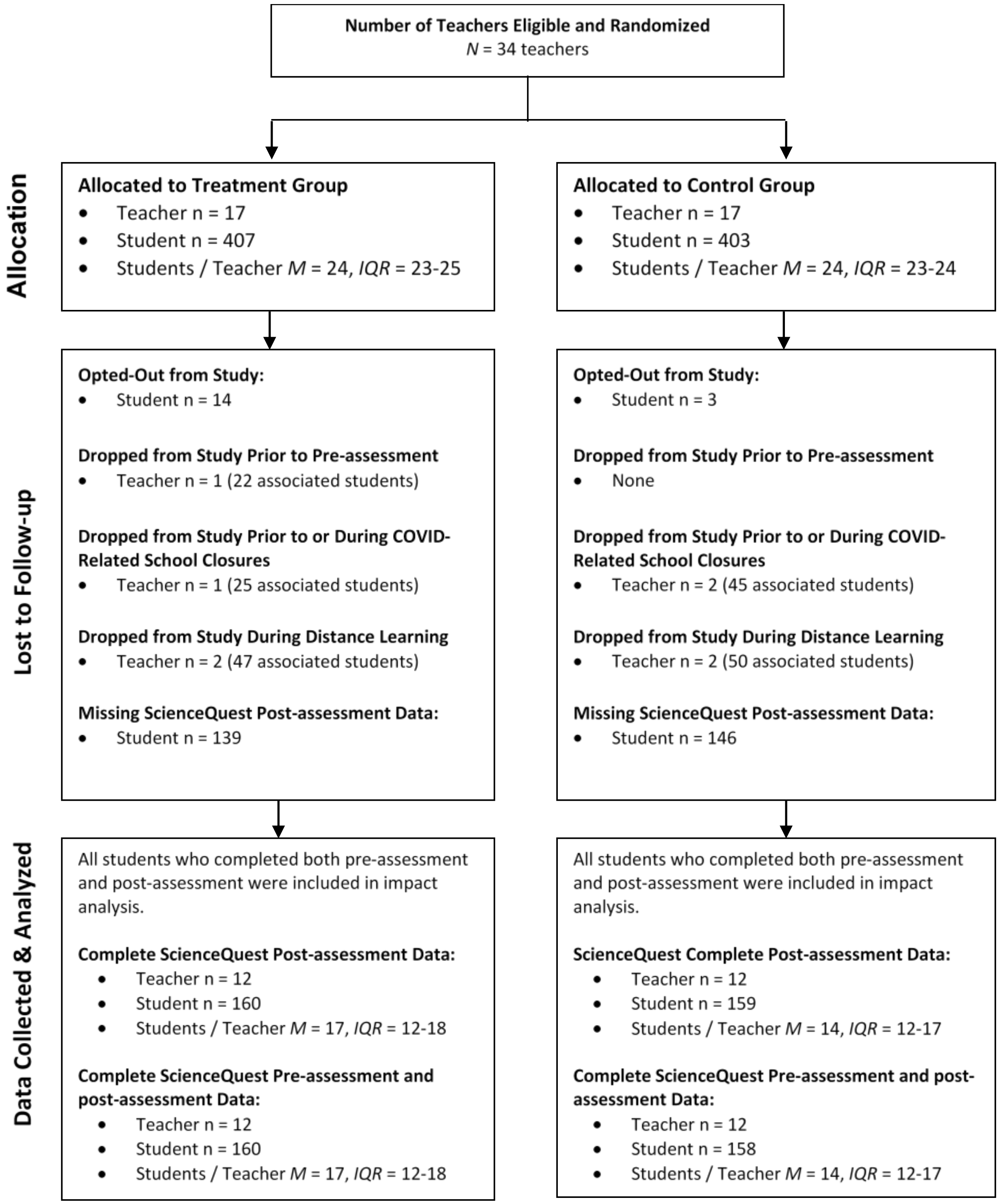
Table 6. Teaching experience (in years) by condition

	First-Years	2-4 Years	5+ Years
Treatment	4	3	9
Control	0	4	12

Student Participants

The consolidated standards of reporting trials (CONSORT) chart (Figure 2) illustrates how the recruitment of 34 teachers across 20 schools (with 810 students prior to randomization) culminated, by the end of the study, in 24 teachers (with 319 students). Each classroom was given informational letters and opt-out forms for the parents to decide whether to allow their children to participate in the study. Informational letters and opt-out forms were available in both English and Spanish languages. Seventeen students in total opted out of the study, leaving 793 students in the study. Among these students, 754 students (not directly shown in the CONSORT figure) completed the pre-assessment (the baseline sample), and 318 students completed both pre- and post-assessment (matched pre- and post-sample), which comprised the impact sample.

There were three reasons that teachers and classrooms dropped out of the study. One treatment teacher left immediately after randomization due to fears of the burden of implementation. An assortment of teachers left during the interim period prior to the official start of distance learning, when COVID-related anxieties were highest (3 teachers, 70 students across both conditions). Finally, a number of teachers dropped out during distance learning instruction, when many teachers cut science courses in favor of core curriculum content (4 teachers, 97 students across both conditions). Greater detail regarding teachers' decisions to drop from the study is provided in later sections regarding the transition from the in-school environment to distance learning.



Note. M = median, IQR= interquartile range.

Figure 2. Study Sample Consolidated Standards of Reporting Trials

The research team collected demographic information around ethnicity, free/reduced price lunch status, English language learner status, and gender of our study sample from the school sites. This information for the impact sample is presented in Table 7 below. A table of the same demographic information for the baseline sample can be found in Appendix C.

Table 7. Demographic information for the impact sample, by condition

	Percentage of Treatment Students	Percentage of Control Students	Percentage of Total Students
Ethnicity			
Asian	14.65	19.87	17.25
Black/African American	5.10	7.69	6.39
Hispanic	68.79	60.90	64.86
White/Caucasian	8.92	5.77	4.15
Other	2.55	5.77	7.35
significance test*	p=0.211#		
Free / Reduced-Price Lunch			
No	19.44	23.58	21.50
Yes	80.56	76.42	78.50
significance test*	p=0.413#		
English Language Learner			
No	55.06	62.66	58.86
Yes	44.94	37.34	41.14
significance test*	p=0.173#		
Gender			
Female	56.60	55.70	56.15
Male	43.40	44.30	43.85
significance test*	p=0.910#		

*Fisher's exact test (n=160 for treatment group, n=158 for control group, total n=318)
#not significant at .05 level

As indicated earlier, because of the pandemic and the shelter-in-place order in CA, all of the schools changed from in-school instruction to distance learning starting in mid-March. This affected participation in the study. As shown in Table 8, 24 out of 34 classrooms remained in the study after school closures. Around 65% of the original student sample participated in distance learning. Among the students who participated in distance learning, about 62% took the post-assessment (40% of the originally recruited sample).

Table 8. Response rate at the end of the study, by condition

	Original Student Sample*	Original Class Sample	Number of Students who Participated in Distance Learning	Number of Students who Completed Post-Assessment (% of the Overall Sample / % of the Distance Learning Sample)	Number of Classrooms that Re-mained in Distance Learning
Treatment	400	17	248 (62.00%)	160 (40.00% / 64.52%)	12
Control	393	17	270 (68.70%)	159 (40.46% / 58.89%)	12
Total	793	34	518 (65.32%)	319 (40.23% / 61.58%)	24

Note: * The original student sample does not include students who opted out of the study.

It is true that the overall response rate is low. However, this is not surprising, given the circumstances. The research team worked diligently to assist the participating teachers in implementing the program and collecting needed data throughout distance learning. The *Hero Elementary* program development team provided additional support materials, including hands-on activity videos to support implementation in distance learning. Teachers, developers, and researchers all made a tremendous effort to ensure a smooth transition from in-school implementation to distance learning. Despite this, not all schools were ready for distance learning in the spring.

As the random assignment was done at the classroom level, the research team calculated the overall and differential attrition rates at the classroom level followed by the individual student level. The overall attrition rate and differential attrition rates at the classroom level were 29.4% and 0%, respectively. The overall attrition rate and differential attrition rates at the individual student level were 59.8% and .46%, respectively. Based on What Works Clearinghouse (WWC), the combination of overall and differential rates of attrition at the random assignment level resulted in tolerable levels of potential bias under both optimistic and cautious assumptions[1]. Based on optimistic assumptions, the combination of overall and differential rates of attrition at the individual student level would also result in tolerable levels of potential bias. However, based on a cautious assumption, the combination of overall and differential rates of attrition at the individual student level would result in unacceptable levels of potential bias.

To examine how data attrition might have affected the baseline equivalence between the treatment and control groups, the research team conducted the baseline equivalence test using two samples: the pre- and post-matched sample and the baseline sample (Table 9). Regardless of the sample used, there were no statistical differences between the treatment group and the control group at baseline. The finding based on the pre- and post-matched sample may indicate that the reason why students dropped out of the study after distance learning is primarily related to the instructional changes (from in-school setting to distance learning) and not related to the intervention itself.

[1] When the combination of overall and differential rates of attrition results in unacceptable levels of potential bias, the WWC labels this high attrition. When the combination of overall and differential rates of attrition results in tolerable levels of potential bias, the WWC labels this low attrition.

Table 9. Baseline differences in the pre-assessment scores

	Adjusted means					
Study sample	Treatment (standard deviation)	Control (standard deviation)	Difference (standard error)	*p*-value	95 percent confidence interval	Unweighted student sample size
Pre- and post-matched sample	14.58 (4.02)	15.33 (3.86)	-0.76 (0.46)	0.098	-1.65 – 0.14	318
Baseline sample for random assignment	14.25 (3.95)	14.72 (3.88)	-0.47 (0.37)	0.195	-1.19 – 0.24	754

Note * A two-level regression model that accounted for study design characteristics (blocks used for random assignment purpose) was used to test the baseline equivalence between the treatment group and the control group. The standard error was estimated using the Huber-White procedure (Greene, 2003).

Data Analysis

To study the impacts of *Hero Elementary*, the research team used a two-level hierarchical linear model (HLM) to analyze student science content outcomes. This model takes into account the clustering nature of the data, as students were nested within teachers. To simplify the analysis and avoid further data loss due to the missing data, the team only included the students with both non-missing pre-assessment and post-assessment data. They also did not include any covariates in the model. The strata which served as the unit for the random assignment were included and treated as the fixed effects in the model. No missing data handling method was used.

As indicated in the previous section, the research team collected qualitative data from various sources that included open-ended survey questions, teacher logs, virtual classroom observations, and interviews. They were analyzed using grounded theory (Strauss & Corbin, 1998). In an initial data reduction approach, respondents' comments were reviewed and assigned categories of meaning. Then, these categories, along with quantitative data results, were reviewed for causal linkages and non-causal relationships related to the central phenomenon, which allowed the researchers to develop a "story" that connects the categories, and finally, posit hypotheses or theoretical propositions. These qualitative analyses provided descriptions of: (1) how teachers implemented *Hero Elementary* in school and in distance learning environments; (2) which aspects of the project were most successful and/or challenging in distance learning; and (3) how *Hero Elementary*, along with its modified distance learning materials, may increase students' science engagement and learning.

Playlist Implementation Findings

Educator Training

During the end-of-implementation educator interview, WestEd researchers asked teachers: (1) what they found most valuable in the TPT *Hero Elementary* Training; and (2) what would have been helpful to include / modify in the TPT *Hero Elementary* training in order to better support distance learning.

Overall, teachers reported that the in-person training was thorough and prepared them well for in-school implementation. One teacher stated, "It was very thorough in how to access certain things…I'm going to say I can't think of anything extra that could have been helpful." Another teacher said, "I think it was super valuable all around."

Many teachers enjoyed the interactive and discussion-based facilitation of the in-person training. Teachers particularly appreciated the opportunity to brainstorm with other teachers and ask the facilitator questions throughout the training. Teachers consistently shared that walking through the activities during the training, individually and as a group, supported their understanding of the overall program and helped them visualize how to implement the activities in their classrooms. One teacher shared:

> *I found it valuable when we actually experienced the things like we were kids, whether it was the games on the computer or the activities that we had to do. I think that just really helps internalize the lessons or the different activities when you're actually doing them. So, I found that really valuable during that time.*

While several teachers valued the instruction provided around the online teacher resources, teachers also identified their unfamiliarity with navigating the online resources as a notable challenge during their transition to a distance learning setting. When asked how the in-person training could be improved, many teachers expressed a need for further training pertaining to navigating the online resources. Teachers explained:

> *I think maybe getting to play around with the websites more while we were there would have been helpful.*

> *Having more time to navigate and see what the purpose of each one was. Because now I'm fine, now I totally get it, but it took a while. So, I think that would have been helpful at the training to just have more time to look into all those.*

In-School Implementation

Before participating in the playlist study, most teachers integrated science instruction into their language arts programs and occasionally tied in relevant hands-on activities. Teachers reported that in-school classroom science activities mostly involved students reading science related passages from textbooks, library books, and other resources, and writing about the passages or filling out student workbooks. A majority of teachers utilized hands-on activity resources and corresponding videos from Mystery Science to supplement science lessons. Teachers typically implemented science instruction once a week for about 30-40 minutes.

Hero Elementary Classrooms

The *Hero Elementary* program was implemented in schools for two weeks before school closures. As a result, a majority of teachers were able to complete the first playlist, *Solid or Liquid*. One of the teachers was also able to complete the second playlist, *Heating and Cooling*. All teachers implemented the playlist activities as described. A few teachers supplemented the activities with additional materials to highlight science content vocabulary and deepen students' understanding of the *Superpowers of Science*.

In this section, teachers' implementation methods for each activity in the *Hero Elementary* program within an in-school environment are outlined. Then, the key challenges and successes that teachers experienced while in the classrooms are discussed.

Video Episodes and Interstitials

Most teachers reported that they began their *Hero Elementary* lessons by viewing an episode as a whole class. Teachers used the co-viewing guide to support class discussions. Some teachers would pause during the episode to ask questions; whereas others would return to particular clips following a first viewing or re-watch an episode with pauses for questions. Following the initial class viewing, most teachers gave students multiple opportunities to watch the episode individually. Teachers also interspersed discussions of *Superpowers of Science* into episode discussions.

The teacher who completed two playlists in school felt that her students were more engaged when viewing episodes as a whole class than in small groups. The teacher showed the first episode, *The Lake Mistake*, to students in small groups of four using the co-viewing guide and showed the second episode, *Movie Theater Meltdown*, to the whole class all together. She noticed higher student engagement during *Movie Theater Meltdown* and attributed this to the way the episode was implemented as a whole class in addition to the comedic episode content. She explained:

> *The difference was Movie Theater Meltdown was hysterically funny. They asked to see it again. They thought it was just funny, funny, funny. And they were hugely engaged and that was whole class. So, part of it I would say was the implementation obviously, and part of it was just simply the way it was, and they just really enjoyed it.*

While episodes provided opportunities for students to engage in science stories and *Superpowers of Science* discussions, interstitial videos helped with transition time and digital game time. Two teachers described:

> *I did what I call freeze music. Once they got the song in their head, I play it and stop and whoever could sing the next part got to line up first. It's like a little exit ticket.*

> *It got stuck in their head because I would play it while they were doing something too so they could just hear it while they were doing their game.*

Teachers reported playing the interstitial videos multiple times and encouraging their students to sing and dance along. They wished that the interstitials included subtitles. Two teachers explained:

> *We tried to sing it and put motions to it, and they thought it was cute.*

> *I'd love to have the words involved with it because then we could make it more of a dancing stuff.*

Hands-On Activities

Teachers reported that they often implemented hands-on activities in small groups. Overall, the activities were easy to implement. Hands-on activity implementation challenges were related to the *Changing Materials* activity in the *Heating and Cooling* playlist. Teachers implemented this activity by splitting students up into small groups, with each group selecting a material for the teacher to melt on the hot plate. Teachers reported challenges with managing the hot plate materials in the classroom setting. Several teachers shared that students got bored because it took a long time to heat up the materials from each student group. Additionally, it was challenging for teachers to control the temperature of the hot plate once the materials heated up. One teacher described:

> *I had some of the students who were saying, "When is it going to be my turn? This is taking forever. Like, I want to, I want to melt my stuff." And each student wanted to melt a different item, so it was just hard on that part.*

To help students better understand the *Superpowers of Science,* some teachers incorporated additional content into the hands-on activities. One teacher showed a BrainPOP video about what a hypothesis is and how to make observations prior to introducing the hands-on activity. Another teacher asked students to record notes into their physical science journals as they completed the hands-on activities.

Notebooks

Most teachers conducted a whole-class activity introducing the features of the notebook using a classroom projector. But they did not provide much instruction regarding how to respond to notebook activity prompts. One teacher explained:

> *The first time was really open ended. I mean, I had them follow the prompt. I forget what it was. It was like take a picture of solids and liquids around the room or something like that. I had them explore those same ideas; it wasn't just like do whatever you want. But it was really open in terms of my directions, I was like, "Just go ahead and explore."*

A few teachers noted some technical difficulties related to projecting and loading the notebook activity. One teacher reported:

> *It didn't project the same as the other things. I could log in and play the video on the screen for them, but the notebook wasn't working when I tried to project it. So, I would have to go around in small groups to try and show them. It wasn't as effective as some of the other things I modeled.*

eBooks

Several teachers implemented the eBooks as individual activities and provided teacher support when needed. A few teachers described reading through the eBook as a whole class to introduce the activity, and afterwards, students read through the eBooks individually. One teacher said, "The first one I just showed them the whole thing and I read it, I had volunteers read it too. And then after it was done, I said they can come back to read it at any time."

There were a few issues with getting the eBooks to read to students, and several teachers found the eBook not user friendly, citing issues with the images covering the text.

Another teacher asked students to record novel vocabulary they found within eBooks into a physical science journal. This teacher demonstrated this process to the whole class using a projector: "I modeled … having my journal out and writing the word and let them copy the first one. So, we did it all together for the first part and then they went back and read on their own."

Teachers also shared that students read through the eBooks on their own fairly quickly. One teacher reported, "They got through those pretty quick. But I made them read it a couple times so they would actually try to comprehend what they were looking at."

Games

Most teachers implemented the digital game as an individual activity that the class completed simultaneously and gave students multiple opportunities to play the digital game during in-school implementation.

As students played the game, teachers supervised the classroom and supported students when necessary. One teacher described implementing the game activity in their classroom: "I was just checking to see if it was loading …and going to each table to see what part of the playlist they were doing or if they were on task. Just walking around, monitoring, mostly fixing little things here and there."

Teachers reported having some issues with the loading time of the digital game, but students had no significant issues navigating the digital game once it loaded.

One teacher provided students with free time to select an activity of their choice, and many students chose to play the *City Town Meltdown* game during this time. She explained:

> *I remember that Friday, it was like a day or two after we'd done the Meltdown for the first time. And I remember the kids saying..."Can we go on there and can we play there?" And some of them went to notebook and just played there, but most of them really wanted to do the City Town Meltdown.*

Superpowers of Science

Teachers found that the videos including the episodes and the interstitials provided the most support in building students' *Superpowers of Science* vocabulary. Teachers reported:

> *And then we watched it [the episode] again, and I paused using some of the prompts in there and we talked about those Superpowers of Science. And then again when I talked about the activities and introduced those.*

> *Especially when we would do an experiment, and we were using those ourselves. And I would go through them and discuss what each one meant. Again, the few times that we did it. And I think so. They were using them, and so I would make a point to say them while we were doing it.*

Many teachers tended to emphasize *Superpowers of Science* vocabulary during class discussion and supplement playlist activities with additional supports. Multiple teachers created vocabulary anchor charts for the *Superpowers of Science* that the class updated consistently and which remained visible in classroom. One teacher explained:

> *I had an anchor chart that every time we would have our whole group discussions I would ... Well, I had like a little corner with anchor charts that we would create together. So yes, I did create one that had the super Science powers. We just observe, right? So, every time we would bring back our discussion to the rug, I would point back to, "Oh, that's an observation you just made." So that was very important part of our discussions.*

Another teacher added a physical science journal component that involved students recording the *Superpowers of Science* as they encountered vocabulary while interacting with digital *Hero Elementary* activities. She said:

> *Our whole front page of our science journal was dedicated to just Superpowers of Science, and every time we discovered a new Superpower of Science, we went back to that page and recorded it.*

Although the majority of the teachers felt that the *Superpowers of Science* were a visible or somewhat visible part of the *Hero Elementary* program, many teachers felt that the visibility of the *Superpowers of Science* relied on the teachers to explicitly introduce the related vocabulary to their students. They expressed the desire for more resources to help introduce *Superpowers of Science* vocabulary. Several teachers also reported that they could have done more to incorporate the *Superpowers of Science*. Teachers reported:

> *I think it just has to be more explicitly stated by the teacher.*

> *I really do want the superpowers to stand out more. The words are bigger, and I know they gave kid friendly terms. I also wish that I had like a poster of that list big, so I can just refer to it again and again, but that didn't really stand out as much.*

> *I don't think I did that very well. That's part of the reason that I say no. I remember doing it [discussing Superpowers of Science] near the end, then the students were confused what I was talking about because I hadn't really brought it up, but I think they did see it in the little video, the commercial video, but I don't think I pointed it out as much as I could have.*

Successes and Challenges During In-school Implementation

Teachers encountered both successes and challenges during classroom implementation. The following sections discuss the appropriateness of the activities for in-school use, student engagement, and ease of implementation.

Hero Elementary Activities Were a Good Fit for the In-school Environment

Several teachers responded that the playlist activities were appropriate for second-grade students, including those learning English and with IEPs. One teacher explained:

> *I have a student with an IEP in my classroom that was very eager to play the games, eager to play with the science notebook, more than he usually is. I also have a student who, in that particular class, is very hyper, and he was very excited to also partake in the activities, so that was different from the usual classes. Sometimes he doesn't want to do things. Also, for my English language learners, or for the students that have more difficulty writing, they were really excited to have the option of recording an audio to check for understanding. So, I think it makes it accessible for those students and it feels like*

there's less barriers to learning or to describing what they learned. They don't have this issue of, "I can't write so I can't explain what I'm doing."

A few teachers shared that one of the ways the playlist benefited their students was by giving them the opportunity to be involved in scientific activities to which they typically would not have exposure. One teacher said:

I think because, at our school, they don't do science. If they were doing science since kindergarten, I think then, maybe it would feel a little bit too easy. I feel, because they don't do science, at all, I think it's great, because it has a lot, it's teaching them the scientific method, all the steps. It's a fun way. I feel like that's awesome. Even like the vocabulary that they're using, I feel like it was age appropriate, especially, for the demographic that we're in, that they're able to relate to and they're able to understand.

The group work nature of a number of the playlist activities allowed students to help each other and resulted in students becoming more comfortable sharing ideas and observations. One teacher described:

When they were doing the group activity and they were sorting through them, sometimes there was a student where maybe they would put it in the wrong category and together the students, because they were in groups, they were able to kind of guide each other into, "Well, that doesn't make sense, that's not a solid because it doesn't look this way or doesn't act this way." So, I saw a lot of that happening in the group work and the exploration.

Several teachers reported that their students figured out how to successfully navigate the student LRNG website and playlist activities within a few days of using the platform. Teachers noted that the use of icons, instead of words, to represent the different activities made the playlist more user-friendly for students who struggle with reading.

Student Engagement

Teachers reported that students were highly engaged in the in-school environment, and student engagement increased over the duration of in-school implementation. Students especially enjoyed viewing the episodes and playing the games. As one teacher described it, "They were just really excited and looking forward to it. I didn't ever notice that go down."

This excitement was facilitated by the many different modalities students could use to access the content covered. Teachers explained:

I have a couple of students with IEPs who, academically, are at least two grade levels below, and they did an excellent job engaging with the activities. They were able to access everything you can say even with the eBooks, having it read, they were able to fully be a part of almost every science activity we did without really even having to differentiate anything. Which was really cool for them because they were fully engaged in the whole activity that the rest of the class did. They just may have used a little bit different language when they were discussing things for the hands-on activities and things like that. But that was really successful.

In particular, the hands-on activities were highly engaging and initiated meaningful student discourse.

> *They were all very super into it and like telling each other and showing each other what they were doing. I think it really helps with the learning, too.*

However, a teacher reported particularly low engagement with the hands-on activities from one of her students with special needs. She said:

> *I think it worked well for the majority of them. I'm thinking of my special needs student who has autism. He did not connect with most of the activities. He liked the iPad and the iPad activities, but the hands-on type stuff, he wanted nothing to do with it.*

Students strongly identified with the characters. Teachers shared that their students connected with the character's language, ways of communicating, and other personal traits. One teacher explained:

> *They liked that there was Spanish speaking or Spanish characters, and they also liked... I don't know if this is necessarily to their life, but I guess so in a way like emojis, they really like emojis, so they really loved that Furblur could speak in emoji. That was really exciting to them and felt really relevant for them.*

Ease of Implementation

Overall, teachers reported that the *Hero Elementary* program allowed them to be more consistent and organized in their science instruction. One teacher described:

> *It helped me feel more organized… it helped me kind of plan and it helped me feel like I had a more well-rounded classroom curriculum. Because before I started with the Hero Elementary playlists, it was a lot of a little bit here, a little bit there. There's not a lot of these big units like the Hero Elementary has been providing, so it's definitely been helpful for me as a first-year teacher.*

Teachers appreciated having the hands-on materials supplied and found implementation to be relatively easy with the lesson planning materials provided. One teacher explained, "I feel like we were really spoiled because we had everything given to us. Everything was already prepped. It was so easy to do it because everything was already prepped."

Some teachers reported that activities were taking a long time to start. Researchers identified three primary connectivity issues while providing technical support to these teachers: (1) intermittent internet connection or low speed; (2) slow load time of activities (especially games); and (3) technology devices had software uploading or running in the background. In some instances, students who were unfamiliar with technology experienced more difficulty navigating the playlists. One teacher said:

> *I have a couple kids who they actually are ELs, but they're just not very technologically savvy. They struggled with the iPads, just to log in and simple things. They couldn't figure out how to get the program open, that type of thing. I think they connected a little bit less just because it was frustrating for them, whereas most of the students knew how to do it right off the bat because it's things they've seen before.*

Distance Learning Implementation

The playlists were intended to be implemented for eight weeks in typical second-grade classrooms. Due to the COVID-19 pandemic, the study was transitioned to distance learning environments. In this section, the general distance learning contexts in participating classrooms is provided, followed by a discussion of playlist implementation in distance learning environments.

General Distance Learning Contexts

Teachers in treatment and control groups reported that they used both synchronous and asynchronous instructional strategies during distance learning. They generally used Zoom or Google Meet to emulate in-school instruction and discussion. Most of the participating teachers scheduled one or two whole-class meetings per week. About a quarter of the teachers met with students several times a day with the whole class or in small group discussions throughout the week.

In order to address the varying needs of family schedules, all teachers provided students access to assignments asynchronously. They often provided a list of assignments with appropriate links via Google Classroom, Google Calendar, Flipgrid, or SeeSaw. While the lists were arranged by day, some teachers posted an entire week at a time, while others would post assignments one day at a time. Some teachers created paper packets for students to pick up and provided instructional support via online platforms. Some teachers had office hours where they were available to meet with students (and parents). Generally, they would use phone, texting, or online meeting software to provide additional learning support and answer technical questions about accessing materials. In addition, teachers were sensitive to the amount of work students could take on without becoming overwhelmed. One teacher shared:

> *We were mindful that with students at home and without the support that we can provide at school, we needed to shorten and simplify and try to condense as much as we could into limited number of assignments each day.*

Access to Devices and Internet

The sudden school closures revealed teaching and learning challenges related to technology availability and accessibility in low-income communities. Teachers reported that many of their students did not have devices and internet access at home. It took time for schools to provide devices and communicate with families who were in need of devices. A teacher explained:

> *A lot of my students did not have devices at home… We did provide Chromebooks to students from the school, but just with being able to be in touch with students and things like that, it did take time for that to happen. And so, that was a struggle.*

In addition to accessing devices for distance learning, teachers reported that establishing a stable internet connection was a problem for many of their student, particularly at the beginning of distance learning. Lack of internet or inconsistent internet connection impeded students' ability to complete or even attempt to access distance learning activities. Teachers described:

> *I know Spectrum was doing, supposedly they had said in the beginning, for free. And then once parents started calling, okay now, it seems that there was a fee, like a $10 fee. I'm not sure if it was for installment or every month, $10… I had one family who was like, "I can't even afford $10." So, I told that to my principal, they can't even afford the $10. So, then she said, "Okay. Well we'll pay for it." So that happened.*

> *We weren't ready for the distance learning, so not a lot of the students had computers, not a lot of them had internet. The school provided that but we were providing it in pieces. We were getting the computers ready…Then the internet they would have to come back whenever we got internet for them, they provided a hotspot. Those hotspots, since they were in demand, like everything, everybody was trying to get them. We only got a few at a time. Not a lot of the students were able to log in.*

Adult Support

Teachers reported that their second-grade students often struggled with tasks that required independence since they were not old enough or technologically savvy enough to complete online assignments on their own. They needed parents and guardians to act as an extension of their classroom teachers. One teacher explained:

> *I think the main challenge is that at second grade, my students aren't independent on digital technology yet, so it was a lot of me teaching parents to teach students. I think that, and some of the language barriers of, how to upload homework, how to go to this certain website, I think that was causing a lot of issues, especially at the beginning. I had students who just didn't know how to find the homework or don't know how to read yet, so they don't know which button means what. That's, I think, where most of the struggles come in is, "How do I get a student with no support and not being able to read find certain keywords to do their homework?" To me, I think that was the biggest struggle.*

Parent and guardian supports were limited for many of the families involved in the study due to language barriers, work commitments, and computer literacy challenges. One teacher shared, "I know some of these parents don't understand [me], because they speak Spanish." Some other teachers mentioned that it was hard to maintain conversations with more than 25 parents and guardians while adjusting to teach students in distance environments.

Teachers reported that other commitments—most significantly, work—limited parents' and guardians' ability to provide support to their student during distance learning. Parents and guardians employed as essential workers, and even those working from home, had a difficult time balancing work and finding the time to address the needs of their children during distance learning. Teachers described:

> *I also had some students, like one in particular, whose father was an essential worker, was doing deliveries, and he didn't get home until 4:30 to 5:00 PM. And that's when school started for her, because she just wasn't comfortable with the technology. So, I did a lot of late-night check ins with them. Also, I had students that were going back and forth between parents and that was challenging, because they had access in one place that they didn't have in the other. I also had a couple of students whose parents were in the medical field. And so, they were out of the home and they were really on their own. So, that was a struggle.*

> *I think some families were really in crisis, you know, lost their jobs....One in four people are out of work so a lot of my families who are lower income....Their family was in crisis and not able to really think about school.*

Computer literacy was another issue that stood in the way of family support during distance learning. Several teachers shared that some parents struggled to access and use their children's digital programs or websites when attempting to help their children with schoolwork. One teacher shared:

Sometimes our parents didn't know how to use a computer. We would do FaceTime calls, but I think they were just overwhelmed and then they didn't want to and then it was hard for a lot of parents. Even we're offering summer school, but a lot of parents didn't want to do it because they were scared it was going to be the same kind of thing and it was too much on them.

Although parents and guardians faced many challenges, when "classrooms" shifted from schools to homes, many parents rose to the occasion, collaborated with teachers, and added the role of distance learning teacher assistant to their busy daily duties. Parents who were unfamiliar with computers reached out of their comfort zones and helped their children access their schoolwork at home. One teacher reported, "Seventy percent of our parents were very cooperative and very helpful." Another teacher offered the following insight:

The one student I had who is actively involved in [the class] is a student with IEP… And his parents were really involved in helping him and sitting down with him and working with him on it. I thought it was really cool because usually during school they allowed him just to play video games all the time at home but during distance learning, they were just really making sure he was getting his schoolwork done.

Student Participation and Engagement

A number of teachers identified participation and engagement as challenges during distance learning implementation. Teachers noted that participation for all levels of students, including high performing ones, suffered and that some parents opted for alternatives to distance learning, including books and activities they found on their own. Teachers explained:

I just had a group of students that were really not engaged in most of distance learning, …it was just accessing everything or working on anything, because it wasn't school.

One family said, "I just bought him a little book and we're doing that instead of the online stuff," which is okay as long as he's doing some work.

Student engagement, and particularly in-class discussion in distance learning environments, was a challenge. Students were often uncomfortable sharing ideas during online class meetings. In schools, some students needed small group discussions to build their confidence before sharing ideas in whole class discussions. However, small group discussions were not possible in some participating classrooms during distance learning. One teacher described:

The area where it was difficult was in the discourse, in the class discussions, where it was a lot harder to have those meaningful connections across students and the discussion and collaboration that I would have had in the classroom. And so, in that area, I don't have a great solution for it. But that's definitely somewhere where I saw less engagement, less benefit from what we would have had in the classroom versus distance learning.

As teachers, parents, and guardians adjusted to distance learning, students also made progress on adjusting their learning. Several teachers reported that their students' comfort with technology and ability to navigate online assignments increased over the course of distance learning. Many students rose to the challenge of becoming more independent learners.

Several teachers also observed that some of their learners who faced challenges in the classroom seemed to thrive during distance learning. Teachers suggested that these students may have been able to focus better in the distance learning environment due to the lack of distractions and possibly because of their love for computer activities. For instance, a few teachers mentioned students with IEPs as a portion of the group that seemed to perform well during distance learning. One teacher said:

> *I had one kid, who just was loving every single piece of it. That was interesting because he has learning disabilities, and I felt like in the classroom, he struggled a lot to get his work done….Maybe it was easier for him to understand what was happening, versus giving him a paper in the classroom and having 30 other kids....There was something about the digital piece that really helped him even write, because he had that text to speech option, or he had the audio piece option where he didn't feel like he was hindered by his ability to read. He was very into the distance learning and he was doing every single piece.*

Science Instruction During Distance Learning

Science instruction during distance learning varied widely from none at all to daily. Although science was de-emphasized in favor of ELA and math at most sites, teachers tried to include it at least once a week. One teacher in the control group shared, "I can tell you now, that was non-existent, aside from the videos, because we were told we had to focus on math and language arts."

The most common activity for control classrooms was to watch a video from Mystery Science, BrainPOP, or other online source and respond to questions during a class discussion or in writing. A few teachers provided instructions for activities that could be done safely at home. As all participating teachers adjusted their core course instructions to distance learning environments, treatment group teachers also modified their implementation of the *Hero Elementary* program to fit the distance learning environment.

In this section, teachers' implementation methods for each activity in the *Hero Elementary* program in distance learning environment is outlined. Then, the key challenges and successes that teachers experienced in distance learning environments are discussed.

Video Episodes and Interstitials

Implementation. Teachers reported implementing the videos as both individual and whole-class activities. Of the 13 implementing teachers, nine assigned the videos to students as individual work, two watched the videos as a whole class, and two used a combination of both methods.

Eight teachers reported using the co-viewing guides. Their implementation approach of the co-viewing guides varied; four used the guide to lead class discussions after watching the video, and four assigned questions from the guide for students to think about individually as they watched.

Regardless of their implementation method, teachers consistently found that the videos were the easiest activity to implement during distance learning. One teacher explained:

> *I found it very easy to implement the videos because all you have to do is put the YouTube video directly into the Google slide. Just make it full screen. I'll try to make it as big so that way when they put it in present mode, it just automatically plays.*

Engagement. As with the in-school environment, all 13 teachers reported that both the episodes and the interstitials were fun and engaging for students. One teacher pointed out:

> *The videos, I think, were really simple to put in because they were a highly preferred activity for the kids. They loved watching them, they enjoyed the songs, the interstitials, they, they liked that, so that was really simple.*

Teachers saw students connecting with the characters in the episodes and believed this was a key factor in their high engagement. One teacher shared:

> *They, across the board, were connecting with the characters, which was really great to see…everyone was able to connect, and that's what I appreciated, that was across the board. I saw students from different genders, different ethnicities, all connecting to one character or another, or more than one character.*

This same teacher described an in-school experience of a student with autism identifying with AJ's character: "My brain works differently, too, so I really like AJ, or I feel like AJ."

Student Learning. Teachers appreciated that the video episodes established compelling, real-world contexts for the playlists' key science concepts. They found that students were able to understand the key idea in each video. Teachers explained:

> *I think some of the plot lines really do highlight like properties, there was the frosting being sticky and then… the glue being sticky. They did get those, and they even answered those questions.*

> *The video, "The Blob" had a storyline that highlighted different properties. When students were asked about the properties of materials used by the characters, they were able to identify them."*

Teachers also found that the videos did a good job of engaging all students in a shared learning experience. One teacher explained that the easy-to-understand storylines provided students with IEPs and ELLs "an entry point where they could actively participate in discussion about topics that they maybe didn't fully understand, but that they could connect to through the video and through the characters in the cartoon." Another teacher agreed, characterizing the episodes as "a great equalizer" that "created the most equal platform for special ed, ELL and other abilities to all come together." For these reasons, teachers found the episodes to be "one of the strongest components of the program."

Teachers also found that the interstitial supported student learning by highlighting the *Superpowers of Science*. They did a good job providing clear definitions and examples of the superpowers. This was especially useful during distance learning because class discussions were challenging, and having a short, easy to understand video felt like a more effective way to introduce a superpower. One teacher explained:

> *But then in the distance learning I was using the videos, the little short videos on what the superpowers were more than I was in the classroom. Just because in the classroom, I felt like I could just skip that and just go and talk to them about why this was important.*

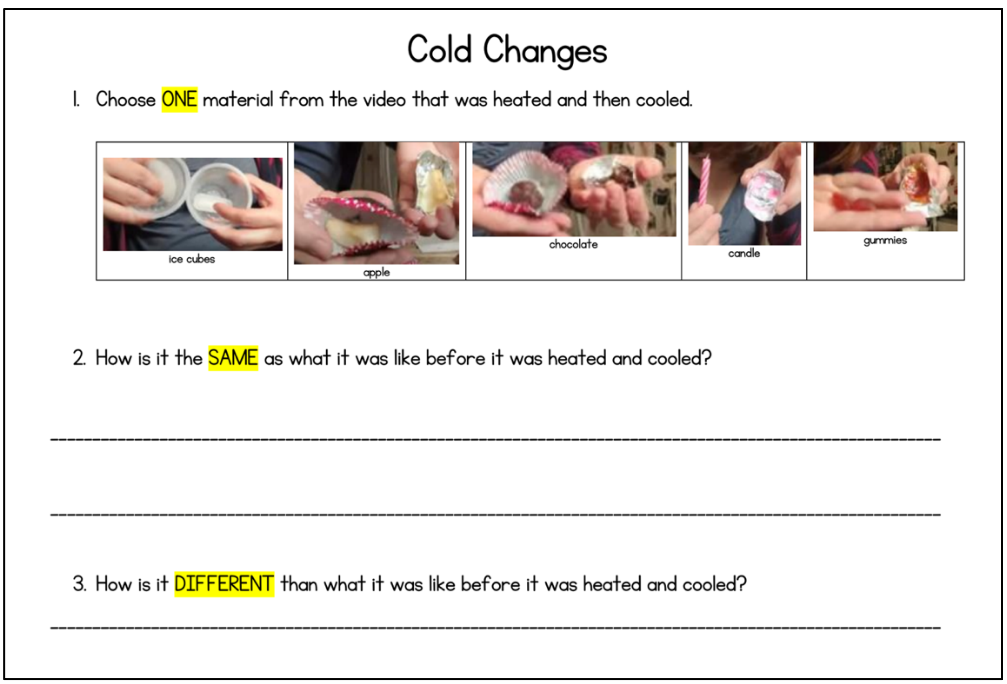
> *Whereas, through distance learning, I was using those little videos because I didn't have the ability to explicitly state it.*

Hands-On Activities

Implementation. Teachers identified students' lack of access to the physical hands-on activity materials as a prominent barrier to implementation during distance learning. Many teachers found the video option for the hands-on activities to be a good alternative. Most teachers assigned videos of the hands-on activities for students to watch on their own. One teacher demonstrated the activity live on Zoom; at least one other teacher had students watch the video as a class.

Some teachers sent instructions to students so that they could try the activities on their own at home if they had the materials. One enterprising teacher took it upon herself to send materials to a subset of students and have them conduct the experiment live on Zoom for the rest of the class as the "professor of the classroom."

Regardless of their approach to implementation, most teachers reported discussing the experiment during whole class meetings. Some teachers also posted questions for students to respond to asynchronously (see Figure 3 for an example of a teacher-created response sheet for students).


Cold Changes

1. Choose ONE material from the video that was heated and then cooled.

ice cubes | apple | chocolate | candle | gummies

2. How is it the SAME as what it was like before it was heated and cooled?

3. How is it DIFFERENT than what it was like before it was heated and cooled?

Figure 3. A teacher-created response sheet for students to complete as they watched a hands-on activity video

Engagement. Overall, teachers noticed a decline in student engagement during the distance learning setting in comparison to the high levels of engagement during the in-school implementation. Teachers attributed the decline to the fact that students were no longer directly interacting with materials, classmates, and their teacher:

I definitely think it would be more [engaging] if we were in the classroom and they were doing these experiments themselves as opposed to just watching and talking about it….I would say it was probably more [engaging] when we were in the class

I think when the kids see a stranger on their computer, it's less engaging than if you're like, "Oh, this is my teacher, and she's talking to me, and I haven't seen her."

However, teachers reported high engagement from several students who managed to conduct the hands-on activities at home either individually or with parental support: "For students that got to try it on their own, it was amazing." One teacher described their students' enthusiasm:

I would ask, like, "Oh, did anybody try out the experiments?" And we would have a little discussion, and it was so fun because they would bring in what they made or what they use, like the melting of the ice cubes and the heating and cooling. They showed a lot of cool melted things.

Student Learning. Teachers found it challenging to tell how much learning occurred when they assigned the videos as individual, at-home work because they did not have a good way to tell how many students completed the assignment. However, they found that the explanations in the videos were thorough and easy to follow. One teacher shared:

I actually really thought she did, like, a way better job than I could have done because she was really prepared and, like, there's a script on how to tie in the concept and you know, how they talk about it. I think that was really helpful even in the future...Not that, like, a teacher would use the video then, but they could watch it to see, like, how to introduce it or what kinds of things you can say as you're talking about, talking through the experiment.

Teachers also appreciated that the videos did a good job of highlighting the *Superpowers of Science*. One teacher said:

With the distance learning, when I would send them the hands-on activity video, I love that that was a really common thing that she always said, "We're going to use our Superpowers of Science," because I think my students, when we were implementing it in the class, I think that was when the dots were starting to connect, with each activity we do is building on the next. I think that was definitely educational, those Superpowers of Science.

Notebooks

Implementation. Teachers attempted to implement the notebooks synchronously and asynchronously but encountered problems with both models. When implementing synchronously, teachers observed that students needed significant support with navigating the platform. They noted that in particular, students had a lot of trouble fitting their work onto the digital notepad and accessing the camera and audio recording features. One teacher summarized the experience of trying to implement the notebook remotely:

I think they just weren't confident in the recording part or using the camera to take pictures. And then there was some frustration around this space, but at the same time they really liked it. They liked being able to go through and click on things and draw. I wish it would let them go to a new page or scroll or have different tabs, so that they could show multiple stages of things and not try to cram it all in on one. If they couldn't have that *option, then have multiple notebook assignments where they could break it apart that way, but they enjoyed it a lot.*

She noted that while students were excited to record their ideas, the notebook platform made it challenging for them to do so successfully.

When assigning the notebook as individual, asynchronous work, teachers found that students often did not do the activity. While noting that they could not be sure why students did not do notebook work on their own, teachers believed that the issues noted above (small notepad size, trouble accessing camera and audio recording features) made it challenging for students to navigate and, ultimately, enjoy the activity on their own.

Many teachers also tried to review students' work on the LRNG platform but reported not being able to do so successfully. They reported that the LRNG interface made it challenging to efficiently view student work:

While I was initially blown away by the Science Notebook for Hero, some work needs to be done for teachers to be able to see the children's notebook without having to open each child's work and then click five times. It would be nice to just have a screenshot of all the ones that finished and what their entries were and, thus, be able to 'follow up' with those that didn't complete the assignment.

Engagement. Teachers report that while students enjoyed doing the notebooks in the classroom, engagement dropped significantly in the distance learning environment. A key factor that contributed to this was that many students switched from using the notebook on tablets in the classroom to using laptops at home. "The students lost their interest because it's not the same as on the tablet," explained one teacher. Another teacher added, "They can't take pictures. It was just like typing and dragging pictures." Teachers also attribute diminished engagement to the challenges that students experienced with the platform noted above. Providing support was more challenging when implementing remotely; without being able to easily get their questions answered, students lost interest in the activity.

Student Learning. A few teachers believed that the notebooks supported student learning by creating opportunities for expression through pictures and drawing, which is "beneficial for students who struggle with writing." However, most teachers found that while they saw value in creating a space for students to record their ideas and observations, the challenges noted above made it difficult to observe learning.

eBooks

Implementation. A majority of teachers (9 of 13) assigned the eBooks to students as an individual activity to do on their own. The other four teachers experimented with reading the eBooks as a class. Some teachers read aloud, and others asked students to read aloud.

Some teachers also supplemented the eBooks with their own materials. For example, one teacher asked students to record vocabulary in science journals. Another teacher created comprehension and "cite the evidence" questions for students to answer during discussion, after having read independently. A third teacher supplemented the text by asking students to answer questions about the eBooks' content, report something they learned, and annotate the text.

Overall, similar to in-school implementation, teachers found the platform difficult for students to navigate, and reported that the eBook activities were challenging to implement as a result. Teachers described issues beginning as soon as students attempted to navigate to the correct book within the platform. One teacher shared:

> *I feel like the eBooks were just the hardest because there was so many steps like, "Click on eBooks, then click physical matter, then click here and then click here," and then it was just hard because if you click somewhere else, it gives you options but it really takes you to a dead end just kind of like a maze. That was hard because then students are getting lost before even getting to the book.*

Even after successfully locating the eBook, students experienced challenges navigating the platform. Teachers explained:

> *I think the eBooks aren't set up well; my kids got frustrated every single time that the text is here, and you can only see half the picture. It's just, I don't know what's wrong with it, but they want to see the picture and so then they'd click on the picture and then the picture covers the text. And so, then they put it away.*

> *That was a struggle for some of my kiddos too with technical issues with the reading, like not being able to scroll down…. There was one of the eBooks in particular that had more than one fit across one row. And so, the titles to the other two sections were at the bottom, but they couldn't see the icon or picture underneath. And so, they were hard to click on, or they missed them completely. So, I would do snips and insert pictures to show them you need to click here, here, and here. But the reading was a little more challenging. The eBooks were a little challenging for them to navigate, just because you had to click through so many things to get to the part they were reading.*

Although the partially displayed images and text that the quotes refer to are not glitches, both teachers and students experienced them as frustrating impediments to their ability to navigate the platform. Given the challenge of providing extensive support in a distance learning environment, these issues made it difficult to implement the eBooks remotely.

Engagement. Teachers report that the eBooks were already among the least engaging activities for students while in the classroom, and engagement diminished after transitioning to distance learning. Difficulties related to the logistics of accessing and navigating the platform contributed to the low engagement. But teachers also noted that students did not appear interested in the content itself. They described how students found the content "boring," and "not as fun or exciting as the episode or a game," "even though it was read to them." The science topics were "harder to understand," and multiple teachers said they thought that students "just wanted to get through it," and often "just clicked through the different pages and didn't necessarily take the time to read at all."

One teacher described how they were able to increase engagement while they were in the classroom by creating a vocabulary scavenger hunt in which students searched for and recorded the definitions of particular words:

> *They had their tablet on their desk and their journal on their desk and…they wanted to make sure they wrote everything. I had kids showing me they were so excited because they wrote an extra thing that they thought was interesting that I didn't even ask them to write.*

However, teachers found it difficult to overcome the platform's challenges while teaching remotely. One teacher shared a story about colleagues engaging their students during distance learning by inviting guests into the "online classroom" to read aloud, but none of the implementing teachers tried this with the eBooks.

Student Learning. Several teachers noted that the read-aloud feature of the eBooks was critical to engaging students that struggled to read, including ELLs and students with IEPs. "They were easy books for the struggling readers," one teacher explained. "The read-aloud feature made it accessible for English learners and struggling students." Another added that this was especially important because, "A lot of my students struggle with reading still." Yet another teacher elaborated:

> *What I appreciated most…was that it read to them because I do have some students who would not have been able to access the text otherwise. And then I did have a few students who played with the Spanish version and were listening to that just because they wanted to. I do have some Spanish speakers, but they don't read in Spanish, not much, but it was a new feature for them. But definitely helped that it had the options you read to them.*

For the most part, however, teachers did not provide specific examples of student learning related to the eBooks.

Games

Implementation. All 13 teachers implemented the games as individual activities. Three teachers had students play the game during group meeting times in order to monitor them; the rest implemented the activity asynchronously. Teachers did not describe facilitating discussions about the game after assigning it to students.

While some teachers reported that the game took a long time to load, most agreed that it was easy to implement. Students understood the games' mechanics and were able to play independently, making the games well-suited to the distance learning environment.

Engagement. According to teachers, students continued to find the games to be interesting, engaging, and easy to use during distance learning—just as they had while in the classroom. Students regularly chose to play the games when they had the freedom to choose, such as after completing a different *Hero Elementary* activity. Students enjoyed talking to each other about the game and would often comment on it when they were together as a class. One teacher shared:

> *I had a lot of comments about the game. They really like it…students would say, "You guys, it's so funny, you get to do X, Y, and Z. Got to try it out. This was my high score, what was your high score?" Different things like that.*

Student Learning. Teachers felt that they were not able to determine how the game supported learning. One teacher expressed concern that their students were spending too much time playing the game, to the exclusion of other activities. This teacher noted that the games felt repetitive and seemed to have no end and was not sure it benefitted the students to continue playing as long as was required to complete all the levels.

Successes and Challenges During Distance Learning

Appropriately Pacing Implementation

Many teachers found it difficult to implement the playlists at a pace that worked for the whole class. With unreliable attendance at synchronous sessions, students working at different speeds, and different levels of parent/guardian involvement, teachers did not know how many activities to assign at once. One teacher explained:

> *And then I'd think, how am I going to do that when they're all doing it on their own at different times, sometimes on different days? Because I would have students that were behind or were working ahead, so it was definitely an adjustment to figure out how you approach it through distance learning.*

The lack of a reliable way to monitor progress and keep track of which students had completed which activities made pacing especially difficult. Despite the existence of the dashboard, which is designed to track progress, teachers listed "not knowing when our students were all finished" as a major challenge. "Some [students] missed things that they hadn't gotten to because the playlist moved on," a teacher explained.

Diminished Focus on the *Superpowers of Science*

Several teachers noted that it became harder to incorporate the *Superpowers of Science* into the playlist experience during distance learning. This was in large part due to the fact that facilitating effective classroom discussions became much more difficult during distance learning, as noted previously. While some of the activities did a good job highlighting the superpowers for students, others relied more heavily on teachers to make the superpowers a part of the experience. It was with these activities that teachers noticed the superpowers becoming less of a focal point:

> *I think it did a little bit, only because again, it wasn't always as much of a discussion as it would have been in class. So, I think unfortunately it did a little bit because we probably would've discussed them more together as a class, or they would have been more visibly seeing to students, because I think I had them posted on the whiteboard and things like that.*

Maintaining High Levels of Engagement

Many teachers reported that students were highly engaged and interested in the playlist activities prior to distance learning. They were excited to continue with the *Hero Elementary* program after schools closed. As one teacher described:

> *They were really excited, because they were very worried that they weren't going to get to continue it. That was their biggest thing. Not like... It was asked even before, "When do we come back to school?" it was, "Can we still do our science?" So, they were properly hyped up prior to distance learning.*

But teachers noticed a decline in interest and engagement after starting remote instruction. Another teacher explained:

> *Before distance learning, they were in love. They loved it. It was their favorite time of the day. They were always hoping for us to do it every day but because it was broken up into*

weeks, it was like every other day and they were just so bummed when it wasn't that day that they didn't get to do it. They were so excited but then once we switched to distance learning, they were excited that they got to do it but then the excitement faded away when they're at home and they could choose to do a different activity. It started to fade away.

Assessing Students' Engagement and Understanding

While teachers observed a general decline in student engagement, they found it harder to get a sense of students' engagement levels on specific activities for the simple reason that students did much of the work on their own, out of the teacher's sight. This also made it harder for teachers to figure out whether their students were reaching the learning goals associated with each activity. One teacher explained, "It's kind of hard to speak on what I didn't see."

Fidelity of Implementation

The fidelity matrix was designed to quantify and evaluate teachers' fidelity of implementation. It is composed of 5 key components, the first being attending the pre-implementation training/professional development and the remaining four corresponding to each *Hero Elementary* playlist:

1. Training/Professional Development
2. Implementation of *Solids or Liquids* Playlist
3. Implementation of *Heating and Cooling* Playlist
4. Implementation of *Properties and Uses* Playlist
5. Implementation of *Properties of Materials* Playlist

Scores for the first component were derived from training attendance records. Scores for the playlist-based components were derived from a mixture of teacher logs and student telemetry derived from the LRNG system. While teacher log information was available for each of the eight activities of each playlist, LRNG telemetry was only reliably available for a subset of the activities (the Hero Elementary episode, notebook tasks, and the digital game). Therefore, the fidelity rating was used for descriptive purposes rather than as a variable in the analysis model, as it provided a broad picture of program implementation. These two fidelity sources were combined such that teachers received a score based on assigning the activity (as reflected in their teacher logs) and then implementing that activity with enough students (based on a 70 percent threshold of students in the teacher's class who demonstrated access to Hero Elementary activities at any point during distance learning).

From a total score combining across all components, the study team used the median of the total possible score as a cut-point to determine the level of fidelity of implementation such that teachers with at-or-below-median total fidelity scores were categorized as "low fidelity" implementers while the "high fidelity" category was used to describe teachers above the median. The total possible score for each teacher is 49. The median is 37.5 based on information from 16 teachers.

A more explicit description of the fidelity matrix listing the indicators of fidelity, their data sources, and the roll-up to ascribing fidelity categories to teacher implementation quality is illustrated in Appendix D.

Potential Impact on Student Science Knowledge

Using the procedure described in the data analysis section, the research team conducted the impact analysis to answer our research question #4: *Did students' science knowledge increase over the course of implementation, as compared to the control group?* Table 10 below summarizes the finding.

Treatment students performed better than control students on the post-assessment, but the difference was not statistically significant (the adjusted mean for the treatment group is 13.27 versus 12.76 for the control group; effect size is 0.15). The mean difference is 0.51, which is not statistically significant at .05 level.

This finding is not unexpected given the high data attrition rate (primarily due to an instructional change from in-school setting to distance learning) and that the original intervention was not designed for distance learning. Based on the implementation information collected from the participating teachers, one of the challenges teachers faced was a lack of consistent student engagement during distance learning. Because of that, the expected intervention impact on student learning may have been diluted. Appendix E provides additional descriptive results at individual item level.

Table 10. The effect of *Hero Elementary* on student science achievement

	Adjusted means					
Outcome measure	Treatment (standard deviation)	Control (standard deviation)	Difference (standard error)	*p*-value	Effect size	Unweighted student sample size
Post-assessment	13.27 (3.11)	12.76 (3.55)	0.51 (0.38)	0.176	0.15	318

Note * Standard errors were estimated using the Huber-White procedure (Greene, 2003). Effect sizes were calculated by dividing impact estimates by the pooled standard deviation of the outcome variable.

Discussion and Conclusion

A key takeaway from the interviews with participating teachers was that the challenges reflected from distance learning spotlighted the inequities that students and their families face on a regular basis. Distance learning provided a glimpse into the homes of families that did not have access to the technology necessary for their students to function as online learners. This technology ranged from devices like computers, laptops and tablets, to high speed internet. The cost of technology was discussed as a barrier to access for some families that possibly resulted in families using older computers or students having to share devices with their siblings.

Technology was just one hurdle. Inequities in the form of insufficient adult support and guidance for young students and those with IEPs were mentioned by numerous teachers. Many parents and guardians did not have the time needed to help their children, lacked the computer literacy necessary to navigate online activities, and faced language barriers when attempting to communicate with their child's teacher. Parents and guardians of students with IEPs also may not have had the requisite pedagogical skills to assist their child when schools were not providing the appropriate support. One teacher summarized:

> *Yeah, so that is another equity issue where students with IEPs and students from lower socio-economic backgrounds had a lot less support in general during distance learning because they didn't have their parents, they didn't have any of the pullout services, they didn't have anyone providing guidance, and so that was one of the hardest affected groups in my classroom and unfortunately probably one of the groups that had the least engagement with Hero Elementary.*

Once distance learning became a reality in the spring 2020, schools were forced to make decisions about how much time students would be spending learning online. This resulted in science and other subjects being labeled as optional for distance learners at some schools. Schools with adequate resources may not have had to sacrifice certain subjects to transition to distance learning. Students attending schools that were not requiring all subjects to be taught during distance learning did not have the benefit of having access to a well-rounded education, which may cause educational issues down the road.

It is imperative that the *Hero Elementary* program can be implemented flexibly and in different environments so that teachers and students can have continued learning opportunities. In order to provide effective distance learning and draw upon best practices to ensure students' science engagement and quality education during this study, the teachers, researchers, and program developers worked together to address students' needs based on the schools' infrastructure, preparations, and resource availability. With researchers' and program developers' support, teachers were able to implement the *Hero Elementary* program in in-school and distance-learning environments with fidelity. The results indicated that the *Hero Elementary* program was positively associated with gains in students' knowledge in matter and its interactions (effect size = 0.15), although differences from the control group were not statistically significant. In addition, treatment teachers reported that the *Hero Elementary* program helped them transition to distance learning. Students became more comfortable with the technology and devices throughout the study. During class discussions and in written work, students were using more scientific vocabulary and making connections between the activities in the *Hero Elementary* program and their own lives.

While those in the education field seek answers on how to deliver instruction when students are required to stay home, future research work can focus on understanding which of the available remote learning strategies are most effective—with or without the internet, web-enabled devices, and comprehensive educational supports. As transmedia learning environments, such as the *Hero Elementary* program, provide the potential to address student needs in distance learning, developers of transmedia program can further leverage play and television narratives in their designs and make interactives that are engaging and meaningful to students by building socio-technical structures that engage users, allow for a continual growth of individuals within the communities and cultures in which they are nested, and encourage active learner, child-centered, inquiry-based learning (Barab, Thomas, Dodge, Carteaux, & Tuzun, 2005).

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Appendix A: Educator Training

Treatment Educator Training

WestEd research staff coordinated with Twin Cities Public Television (TPT) staff to arrange a one-day, in-person *Hero Elementary* implementation and research logistics training for Treatment Teachers. Teacher participants were located across California, so the team held two identical trainings: one at the WestEd Los Alamitos Office on February 11, 2020 and the other at the WestEd Redwood City office on February 13, 2020. All 16 Treatment Teachers attended one of the two trainings, with six teachers attending on February 11 and ten teachers attending on February 13. WestEd staff prepared a teacher training binder for each participant, which included:

- *Hero Elementary* Glossary
- Training Agenda
- Playlist Overview
- Notebook Talk Lesson Plan
- HOA What Is It Lesson Plan
- *The Lake Mistake* Co-Viewing Guide
- Superpowers of Science
- HOA Changing Materials Lesson Plan
- Educator Action Plan
- Playlist Description for Educator Action Plan
- Canvas Scavenger Hunt
- Lots of Liquids Lesson Plan
- Build a Bridge Lesson Plan
- Activity Stations Reflection Questions
- TPT Training Slide Deck
- WestEd Research Slide Deck

The two trainings followed the same format. The bulk of the training was led by a TPT-trained trainer who lead participants through the *Hero Elementary* Implementation Training. Following the *Hero Elementary* Implementation Training, WestEd staff led a short Research Logistics Training.

Hero Elementary Implementation Training

Introduction. The trainer started the training by having participants fill out a pre-training survey. Then, each participant and researcher introduced themselves, and the trainer walked through an overview of *Hero Elementary*. This included an introduction to the Playlists, the Superpowers of Science, and the interstitials.

Implementing a Playlist Part I. Next, the trainer led participants through the first half of the *Solid or Liquid* playlist. Participants logged in to WestEd-provided tablets as students and experienced each activity as their students would. First, participants opened the Science Notebook and explored the features. The trainer showed student samples so teachers would know what they could expect from their students. Next, participants pulled out the lesson plan for the *What Is It* activity and planned in groups how they would lead the activity with their students. They then discussed as a whole group. After, the participants watched *The Lake Mistake* episode and discussed what they liked about it. The trainer explained that students would have another chance to use their Science Notebook again at this point, but teacher participants did not do this activity again. Finally, participants played the *City Town Meltdown* digital game on their tablets. Then, they discussed what they liked about it as a full group.

Hero Elementary Equity Strategies. The trainer gave each participant an equity puzzle piece. Participants found the person whose piece fit with theirs, and they discussed in partners how the strategy listed on their puzzle pieces could be implemented in their classrooms. Pairs shared out about their discussions one at a time.

Implementing a Playlist Part II. The trainer led participants through the rest of the *Solid or Liquid* playlist activities. Teachers pulled out the lesson plan for the *Changing Materials* activity and read through it but did not participate in the activity during the training. Next, they watched another interstitial. They used the Science Power Notebook once again to reflect on what they thought about the interstitial. Finally, teachers took time to read through the eBooks individually on their tablets.

Playlist Debrief. Teachers took two post-it notes and reflected on two questions: (1) "What excited you about the playlist?" and (2) "How do you think your children will experience the playlist?" After reflecting, teachers discussed their answers in small groups.

Educator Action Plan. Teachers pulled out the Educator Action Plan hard copy from their training binders and filled out a sample schedule, planning the timeline for how they would implement the *Solid or Liquid* playlist in their classrooms.

Educator Platform. Next, the trainer demonstrated how to navigate the Playlist Prep section of the Canvas website. WestEd staff pointed teachers to their login information provided on their training binders. Teachers logged into their own Canvas accounts and completed the Canvas Scavenger Hunt for the *Solids or Liquids* playlist. After familiarizing themselves with the Canvas website, teachers asked clarifying questions about the platform.

Hands-On Activity Stations. The trainer divided the participants into two groups. Half of the teachers read the lesson plan for and participated in the *Lots of Liquids* activity, while the other half read the lesson plan for and participated in the *Build a Bridge* activity. Afterward, teachers shared their experiences with the whole group.

Reflection and Post-Training Survey. At the end of the *Hero Elementary* Implementation Training, the trainer asked participants to share one word to describe how they were feeling about implementing *Hero Elementary*. Then, participants completed the post-training survey.

Research Logistics Training

Following the *Hero Elementary* Implementation Training, the TPT-trained trainer left, and WestEd researchers led the Research Logistics Training.

Introduction. First, WestEd staff introduced the materials provided to teachers for playlist implementation. Participants gathered their materials:

- One accordion folder containing hard copies of all print materials
- Two bins of prepared hands-on activity materials

- One bin of technology (1 class set of tablets, 1 modem, 1 router), provided to teachers who did not have 1:1 technology in their classrooms already

Researchers walked through the contents of provided materials to ensure that participants were familiar with them and to ensure that no pieces were missing.

Study Overview. WestEd researchers provided context for participants about how this study fit in with the series of studies being completed to determine the impact of the *Hero Elementary* playlists. Researchers explained that the study was a randomized control trial and introduced the study activities and timeline.

WestEd Contacts. WestEd researchers shared the contact information for each of the WestEd region leads.

Student Opt-Out Forms. WestEd researchers reminded participants about the importance of handing out and collecting opt-out forms from students. Most teachers had already handed out the forms and brought any returned forms to the training.

Pre- and Post-Assessments. WestEd researchers explained that assessors would travel to school sites to administer pre- and post-assessments in order to ensure assessment fidelity and completion. Teacher responsibilities during pre- and post-assessments included classroom management and as-needed support for administrators.

Playlist Implementation. WestEd researchers reminded participants to implement the playlists in the following order:

1. *Solid or Liquid*
2. *Heating and Cooling*
3. *Properties and Uses*
4. *Properties of Materials*

Study Tasks. WestEd researchers reviewed the study tasks that participants were to complete, including completing weekly teacher logs, allowing WestEd staff to make observation visits to classrooms, allowing WestEd staff to run performance tasks with a handful of students, and participating in an educator interview. A WestEd staff member demonstrated how to fill out the weekly teacher log. Researchers explained what to expect during classroom observations, performance tasks, and educator interviews.

Stipends. WestEd researchers reminded participants that they would be required to complete all study activities in order to receive their full stipend. One third of the stipend would be paid after half of the study activities were completed, and the other two thirds would be paid at the completion of the study.

Next Steps. WestEd researchers encouraged participants to bookmark Canvas and LRNG sites on their laptops and asked them to fill out an observation availability survey.

Closing. At the end of the Research Logistics Training, WestEd researchers helped participants load the implementation materials into their cars.

Control Educator Training

WestEd research staff arranged a one-hour, virtual *Hero Elementary* training for participating Control Teachers. The team held three identical trainings over the week of February 2, 2020. All 17 Control Teachers attended one of the virtual trainings, with three participants attending on February 4, seven participants attending on February 5, and seven participants attending on February 6. WestEd researchers led the virtual training by sharing a slide deck over Zoom.

Study Overview and Timeline. WestEd researchers explained that WestEd was conducting an independent evaluation of the *Hero Elementary* program. The goal of the study was to investigate the effects of the program on student science learning and engagement. Researchers reminded participants that the Control group allowed researchers to compare the gains of their students to the gains of students in the Treatment groups. Researchers explained the timeline of expected study activities.

Student Opt-Out Forms. WestEd researchers reminded participants about the importance of handing out and collecting opt-out forms from students. Most teachers had already handed out the forms. WestEd staff would collect any returned forms when they arrived to pre-assess students.

Pre-Assessments. WestEd researchers explained that assessors would travel to school sites to administer pre-assessments in order to ensure assessment fidelity and completion. Teacher responsibilities included classroom management and as-needed support for administrators.

Classroom Visits. WestEd researchers explained that not every Control classroom would be observed. The focus of the visit would be to gather information about how science classes are structured and how activities are implemented in a control "business-as-usual" classroom.

Interviews. Like classroom visits, not every Control educator would participate in an educator interview. The focus of the interview would be how technology is used in the classroom, typical science activities, and the structure of science class.

Post-Assessments. WestEd researchers explained that assessors would travel to school sites to administer post-assessments, just like for pre-assessments, in order to ensure assessment fidelity and completion. Teacher responsibilities included classroom management and as-needed support for administrators.

Student Performance Task. WestEd researchers explained that performance tasks would take place after post-assessments. Researchers would ask for five to seven students per class to participate. The task would take five to eight minutes per student to complete.

Stipends. WestEd researchers reminded participants that they would be required to complete all study activities in order to receive their full stipend. Each participant would receive their stipend in one installment at the completion of the study.

Next Steps. WestEd researchers explained that region leads would be in touch soon about scheduling pre-assessments. They also reminded teachers to collect opt-out forms by February 18 and have them ready to give to WestEd staff during pre-assessments.

Appendix B: Test Blueprint

Table 1. Test Blueprint

Item Name*	Item Order in Pre-Assessment	Item Order in Post-Assessment	Primary Target Playlist	Solid or Liquid	Heating and Cooling	Properties of Materials	Properties and Uses	DCI: PS1.A	DCI: PS1.B
H00X24	1	13	Properties of Materials		X	X		X	X
H00X25	2	14	Properties of Materials		X	X		X	X
H00X22	3	N/A	Properties of Materials			X		X	
H00X29	4	16	Solids and Liquids	X		X		X	
G02L19	5	N/A	Heating and Cooling	X	X				X
G02E09	6	1	Heating and Cooling	X	X				X
G02X12	7	3	Solids and Liquids	X	X				X
H00X23	8	12	Solids and Liquids	X		X		X	
G02X11	9	2	Solids and Liquids	X	X				X
G02L13	10	18	Heating and Cooling	X	X				X
G02X01	11	N/A	Properties and Uses			X	X	X	
G02E17	12	20	Heating and Cooling	X	X				X
H00X28	13	15	Solids and Liquids	X		X		X	X
H00PU03	14	17	Properties and Uses			X	X	X	
H00HC01	15	4	Heating and Cooling	X	X				X
H00HC02	16	5	Heating and Cooling		X	X		X	X
H00PM04	17	19	Properties of Materials			X	X	X	
H00PM03	18	10	Properties of Materials			X		X	
H00HC03	19	6	Heating and Cooling		X	X		X	X
H00PM02	20	9	Properties of Materials			X	X	X	
H00HC04	21	7	Heating and Cooling		X				X
H00PU02	22	11	Properties and Uses			X	X	X	
H00PM01	23	8	Properties of Materials			X	X	X	

*Note: Bold item names signify items which were included in the post-assessment score in the study report.

DCI: PS1.A – "Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties. Different properties are suited to different purposes. A great variety of objects can be built up from a small set of pieces."

DCI: PS1.B – "Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not."

Appendix C: Additional Demographic Information

Table 1. Demographic Information for the Baseline Sample

	Percentage of Treatment Students	Percentage of Control Students	Percentage of Total Students
Ethnicity			
Asian	9.34	13.39	11.41
Black/African American	9.07	7.35	8.19
Hispanic	71.15	72.70	71.95
White/Caucasian	7.69	2.89	3.22
Other	2.75	3.67	5.23
significance test*	***p*=0.017****		
Free / Reduced-Price Lunch			
No	17.09	24.83	21.09
Yes	82.91	75.17	78.91
significance test*	***p*=0.010****		
English Language Learner			
No	57.30	61.10	59.25
Yes	42.70	38.90	40.75
significance test*	*p*=0.299#		
Gender			
Female	51.91	53.65	52.80
Male	48.09	46.35	47.20
significance test*	*p*=0.662#		

*Fisher's exact test (n=370 for treatment group, n=384 for control group, total n=754)
****significant at .05 level**
#not significant at .05 level

Appendix D: Spring 2020 Hero Elementary Fidelity Matrix

Table 1. Spring 2020 Hero Elementary Fidelity Matrix

Indicators	Definition	Unit of Implementation	Data Source(s)	Score for levels of implementation at unit level	Roll-up to teacher level (score and threshold for adequate implementation)
Key Component 1: Training/Professional Development					
1.1 Attended in-person training on TPT Playlists	Teachers attend 1-day training session	Teachers	TPT records: attendance rosters	0-1 points 0 = Did not attend 1 = Attended	N/A
All indicators					Only 1 indicator
Key Component 2: Implemented Playlist X – exemplified with activities from Solids and Liquids Playlist					
2.1a Hero Elementary Episode Co-viewing (T-level)	Teacher shows students Hero Elementary episode and facilitates discussion related to Solids and Liquids	Teacher	Teacher Log	Completion Level 0-1 points 0 = Did not complete 1 = Completed Completion Mode (categorical) A = Online Asynchronous S = Online Synchronous M = Mixed Modes O = Primarily Offline	Fidelity score from completion level Implementation category from completion mode
2.1b Hero Elementary Episode Co-viewing (S-level)	Student watches Hero Elementary episode and participates in discussion related to Solids and Liquids	Student	Teacher Log or Telemetry	The highest of either of the following: From Teacher Log 0 = Did not implement activity or assigned activity during distance learning (see telemetry) 1 = Implemented activity in in-class setting (prior to distance learning) Or From Telemetry 0 = Did not have a telemetry entry for this activity 1 = Had at least 1 telemetry entry for this activity.	% of students* who got at least a 1 0 = less than 70% 1 = at least 70%

Indicators	Definition	Unit of Implementation	Data Source(s)	Score for levels of implementation at unit level	Roll-up to teacher level (score and threshold for adequate implementation)
2.2a Interstitial Co-viewing (T-level)	Teacher shows students interstitial and facilitates discussion related to relevant science practice	Teacher	Teacher Log	Completion Level 0-1 points 0 = Did not complete 1 = Completed Completion Mode (categorical) A = Online Asynchronous S = Online Synchronous M = Mixed Modes O = Primarily Offline	Fidelity score from completion level Implementation category from completion mode
2.3a Notebook Activity 1 "*Solid or Liquid* at the Lake" (T-level)	Teacher assigns activity	Teacher	Teacher Log	Completion Level 0-1 points 0 = Did not assign activity 1 = Assigned activity Completion Mode (categorical) A = Online Asynchronous S = Online Synchronous M = Mixed Modes O = Primarily Offline	Fidelity score from completion level Implementation category from completion mode
2.3b Notebook Activity 1 "*Solid or Liquid* at the Lake" (S-level)	Student creates an image in their notebook	Student	Teacher Log or Telemetry	The highest of either of the following: From Teacher Log 0 = Did not implement activity or assigned activity during distance learning (see telemetry) 1 = Implemented activity in in-class setting (prior to distance learning) Or From Telemetry 0 = Did not have a telemetry entry for this activity 1 = Had at least 1 telemetry entry for this activity.	% of students* who got at least a 1 0 = less than 70% 1 = at least 70%
2.4a Notebook Activity 2 "Melted Materials" (T-level)	Teacher assigns activity	Teacher	Teacher Log	Completion Level 0-1 points 0 = Did not assign activity 1 = Assigned activity Completion Mode (categorical) A = Online Asynchronous S = Online Synchronous M = Mixed Modes O = Primarily Offline	Fidelity score from completion level Implementation category from completion mode

Indicators	Definition	Unit of Implementation	Data Source(s)	Score for levels of implementation at unit level	Roll-up to teacher level (score and threshold for adequate implementation)
2.4b Notebook Activity 2 "Melted Materials" (S-level)	Student creates an image in their notebook	Student	Teacher Log or Telemetry	The highest of either of the following: From Teacher Log 0 = Did not implement activity or assigned activity during distance learning (see telemetry) 1 = Implemented activity in in-class setting (prior to distance learning) Or From Telemetry 0 = Did not have a telemetry entry for this activity 1 = Had at least 1 telemetry entry for this activity.	% of students* who got at least a 1 0 = less than 70% 1 = at least 70%
2.5a Digital Game "Citytown Meltdown" (T-level)	Teacher assigns digital game	Teacher	Teacher Log	Completion Level 0-1 points 0 = Did not assign activity 1 = Assigned activity Completion Mode (categorical) A = Online Asynchronous S = Online Synchronous M = Mixed Modes O = Primarily Offline	Fidelity score from completion level Implementation category from completion mode
2.5b Digital Game "Citytown Meltdown" (S-level)	Student plays digital game	Student	Teacher Log or Telemetry	The highest of either of the following: From Teacher Log 0 = Did not implement activity or assigned activity during distance learning (see telemetry) 1 = Implemented activity in in-class setting (prior to distance learning) Or From Telemetry 0 = Did not have a telemetry entry for this activity 1 = Had at least 1 telemetry entry for this activity.	% of students* who got at least a 1 0 = less than 70% 1 = at least 70%

Indicators	Definition	Unit of Implementation	Data Source(s)	Score for levels of implementation at unit level	Roll-up to teacher level (score and threshold for adequate implementation)
2.6a E-book (T-level)	Teacher assigns e-book	Teacher	Teacher Log	Completion Level 0-1 points 0 = Did not assign activity 1 = Assigned activity Completion Mode (categorical) A = Online Asynchronous S = Online Synchronous M = Mixed Modes O = Primarily Offline	Fidelity score from completion level Implementation category from completion mode
2.7a Hands-On Activity 1 "What Is It?" (T-level)	Teacher facilitates hands-on activity and post-activity discussion	Teacher	Teacher Log	Completion Level 0-1 points 0 = Did not assign activity 1 = Assigned activity Completion Mode (categorical) A = Significant Online Asynchronous Component S = Significant Online Synchronous component (including group work) M = Mixed Modes O = Primarily Offline	Fidelity score from completion level Implementation category from completion mode
2.8a Hands-On Activity 2 "Changing Materials?" (T-level)	Teacher facilitates hands-on activity and post-activity discussion	Teacher	Teacher Log	Completion Level 0-1 points 0 = Did not assign activity 1 = Assigned activity Completion Mode (categorical) A = Significant Online Asynchronous Component S = Significant Online Synchronous component (including group work) M = Mixed Modes O = Primarily Offline	Fidelity score from completion level Implementation category from completion mode
All indicators					Implementation Category A = More than 50% of activities were online but asynchronous S = More than 50% of activities were completed online synchronously O = More than 50% of activities had no meaningful online component M = Teacher implemented mixed modes Fidelity Score Sum of fidelity score indicators 0-12

Indicators	Definition	Unit of Implementation	Data Source(s)	Score for levels of implementation at unit level	Roll-up to teacher level (score and threshold for adequate implementation)
Key Component 3-5: Implemented *Heating and Cooling* Playlist; Implemented *Properties and Uses* Playlist; Implemented *Properties of Materials* Playlist – Approximately the same as for key component 2					
For all indicators in each component					Implementation Category A = More than 50% of activities were online but asynchronous S = More than 50% of activities were completed online synchronously O = More than 50% of activities had no meaningful online component M = Teacher implemented mixed modes Fidelity Score Sum of fidelity score indicators 0-12 for each playlist
Fidelity Categorization					
All indicators					Fidelity Score Sum of Fidelity Scores across all components 0-49 Fidelity Category 0 (low fidelity of implementation) = Fidelity score at or below median (≤37.5) 1 (high fidelity of implementation) = Fidelity score above median (>37.5)
*percent (%) of students calculated by dividing the number of students who had a telemetry entry for an activity by the number of students who had at least one telemetry entry across all distance learning playlists.					

Appendix E: Additional Descriptive Analysis

Table 1. Within-Group Item Level Counts and Analysis using McNemar's chi-squared

Question	Group	No improvement N	No improvement %	Regression N	Regression %	Improvement N	Improvement %	Perfect N	Perfect %	Total (N)	p-value
G02E09											
	control	19	12%	28	18%	36	23%	75	47%	158	0.317
	treatment	19	12%	12	8%	54	34%	73	46%	158	0.000
	all	38	12%	40	13%	90	28%	148	47%	316	0.000
G02X11											
	control	10	6%	16	10%	40	25%	91	58%	157	0.001
	treatment	12	8%	17	11%	45	28%	84	53%	158	0.000
	all	22	7%	33	10%	85	27%	175	56%	315	0.000
G02X12											
	control	35	22%	26	17%	46	29%	49	31%	156	0.018
	treatment	33	21%	19	12%	57	36%	50	31%	159	0.000
	all	68	22%	45	14%	103	33%	99	31%	315	0.000
H00HC01											
	control	34	22%	14	9%	40	25%	69	44%	157	0.000
	treatment	25	16%	10	6%	57	36%	66	42%	158	0.000
	all	59	19%	24	8%	97	31%	135	43%	315	0.000
H00HC02											
	control	48	31%	29	19%	39	25%	40	26%	156	0.225
	treatment	60	38%	27	17%	32	20%	39	25%	158	0.515
	all	108	34%	56	18%	71	23%	79	25%	314	0.183
H00HC03											
	control	23	15%	18	12%	45	29%	69	45%	155	0.001
	treatment	22	14%	14	9%	51	32%	72	45%	159	0.000
	all	45	14%	32	10%	96	31%	141	45%	314	0.000
H00HC04											
	control	42	27%	31	20%	35	23%	47	30%	155	0.622
	treatment	39	25%	24	15%	34	21%	62	39%	159	0.189
	all	81	26%	55	18%	69	22%	109	35%	314	0.209
H00PM01											
	control	25	16%	19	12%	48	31%	62	40%	154	0.000
	treatment	23	14%	28	18%	44	28%	65	41%	160	0.059
	all	48	15%	47	15%	92	29%	127	40%	314	0.000
H00PM02											

	control	18	12%	15	10%	25	16%	96	62%	154	0.000
	treatment	15	9%	27	17%	33	21%	85	53%	160	0.000
	all	33	11%	42	13%	58	18%	181	58%	314	0.000
H00PM03											
	control	11	7%	16	10%	24	16%	103	67%	154	0.206
	treatment	11	7%	12	8%	23	14%	113	71%	159	0.063
	all	22	7%	28	9%	47	15%	216	69%	313	0.028
H00PU02											
	control	3	2%	11	7%	34	22%	106	69%	154	0.001
	treatment	7	4%	9	6%	24	15%	119	75%	159	0.009
	all	10	3%	20	6%	58	19%	225	72%	313	0.000
H00X23											
	control	10	6%	10	6%	28	18%	106	69%	154	0.004
	treatment	16	10%	5	3%	36	23%	100	64%	157	0.000
	all	26	8%	15	5%	64	21%	206	66%	311	0.000
H00X24											
	control	38	25%	38	25%	29	19%	49	32%	154	0.272
	treatment	31	20%	31	20%	36	23%	60	38%	158	0.541
	all	69	22%	69	22%	65	21%	109	35%	312	0.730
H00X25											
	control	41	27%	27	18%	40	26%	45	29%	153	0.112
	treatment	42	26%	25	16%	48	30%	45	28%	160	0.007
	all	83	27%	52	17%	88	28%	90	29%	313	0.002
H00X28											
	control	20	13%	16	10%	42	27%	75	49%	153	0.001
	treatment	22	14%	11	7%	47	30%	78	49%	158	0.000
	all	42	14%	27	9%	89	29%	153	49%	311	0.000
H00X29											
	control	48	31%	95	62%	4	3%	6	4%	153	0.000
	treatment	51	33%	95	61%	3	2%	6	4%	155	0.000
	all	99	32%	190	62%	7	2%	12	4%	308	0.000
H00PU03											
	control	20	13%	20	13%	40	26%	72	47%	152	0.010
	treatment	25	16%	17	11%	41	26%	74	47%	157	0.002
	all	45	15%	37	12%	81	26%	146	47%	309	0.000
G02L13											
	control	6	4%	18	12%	16	10%	113	74%	153	0.732
	treatment	7	4%	7	4%	19	12%	125	79%	158	0.019
	all	13	4%	25	8%	35	11%	238	77%	311	0.197
H00PM04											

	control	4	3%	8	5%	18	12%	123	80%	153	0.050
	treatment	10	6%	14	9%	22	14%	112	71%	158	0.182
	all	14	5%	22	7%	40	13%	235	76%	311	0.022
G02E17											
	control	0	0%	9	6%	8	5%	136	89%	153	0.808
	treatment	1	1%	9	6%	16	10%	131	83%	157	0.162
	all	1	0%	18	6%	24	8%	267	86%	310	0.355

Table 2. Pre-Assessment Between-Group Item Level Counts and Analysis using Pearson's chi-squared for all students who participated in the Pre-test

Cross-tabulations				Pearson's chi-squared	
		Pre-test			
Question	Condition	0	1	statistic	p-value
H00X24					
	control	103	122	1.763	0.184
	treatment	109	100		
H00X25					
	control	116	109	0.105	0.746
	treatment	111	98		
H00X22					
	control	62	163	0.236	0.627
	treatment	62	147		
H00X29					
	control	93	132	0.027	0.871
	treatment	88	121		
G02L19					
	control	66	159	0.133	0.715
	treatment	58	151		
G02E09					
	control	90	135	0.027	0.871
	treatment	82	127		
G02X12					
	control	109	116	0.030	0.861
	treatment	103	106		
H00X23					
	control	82	143	0.108	0.742
	treatment	73	136		
G02X11					
	control	84	141	1.246	0.264
	treatment	89	120		
G02L13					
	control	36	189	0.584	0.445
	treatment	28	181		
G02X01					
	control	53	172	0.001	0.978
	treatment	49	160		
G02E17					
	control	20	205	0.005	0.941

	treatment	19	190		
H00X28					
	control	112	113	0.009	0.923
	treatment	105	104		
H00PU03					
	control	98	127	0.158	0.691
	treatment	95	114		
H00HC01					
	control	110	115	1.388	0.239
	treatment	114	95		
H00HC02					
	control	138	87	0.050	0.823
	treatment	126	83		
H00PM04					
	control	45	180	2.097	0.148
	treatment	54	155		
H00PM03					
	control	63	162	0.079	0.778
	treatment	56	153		
H00HC03					
	control	100	125	2.579	0.108
	treatment	109	100		
H00PM02					
	control	71	154	0.010	0.919
	treatment	65	144		
H00HC04					
	control	109	116	4.717	0.030
	treatment	123	86		
H00PU02					
	control	61	164	0.415	0.519
	treatment	51	158		
H00PM01					
	control	133	92	0.066	0.797
	treatment	121	88		

Table 3. Pre-Assessment Between-Group Item Level Counts and Analysis using Pearson's chi-squared for all students who participated in both the Pre-Assessment & Post-Assessment

Cross-tabulations				Pearson's chi-squared	
		Pre-test			
Question	Condition	0	1	statistic	p-value
H00X24					
	control	69	90	0.000	0.988
	treatment	70	91		
H00X25					
	control	86	73	0.106	0.745
	treatment	90	71		
H00X22					
	control	36	123	4.701	0.030
	treatment	54	107		
H00X29					
	control	56	103	0.023	0.881
	treatment	58	103		
G02L19					
	control	35	124	0.957	0.328
	treatment	43	118		
G02E09					
	control	55	104	4.770	0.029
	treatment	75	86		
G02X12					
	control	81	78	0.790	0.374
	treatment	90	71		
H00X23					
	control	39	120	3.151	0.076
	treatment	54	107		
G02X11					
	control	51	108	0.741	0.389
	treatment	59	102		
G02L13					
	control	22	137	0.336	0.562
	treatment	26	135		
G02X01					
	control	24	135	4.217	0.040
	treatment	39	122		
G02E17					

	control	8	151	4.051	0.044
	treatment	18	143		
H00X28					
	control	65	94	0.221	0.638
	treatment	70	91		
H00PU03					
	control	64	95	0.224	0.636
	treatment	69	92		
H00HC01					
	control	75	84	0.801	0.371
	treatment	84	77		
H00HC02					
	control	88	71	0.190	0.663
	treatment	93	68		
H00PM04					
	control	25	134	1.548	0.213
	treatment	34	127		
H00PM03					
	control	36	123	0.109	0.742
	treatment	34	127		
H00HC03					
	control	71	88	0.120	0.729
	treatment	75	86		
H00PM02					
	control	44	115	0.179	0.672
	treatment	48	113		
H00HC04					
	control	78	81	0.307	0.579
	treatment	74	87		
H00PU02					
	control	37	122	0.545	0.460
	treatment	32	129		
H00PM01					
	control	75	84	0.788	0.375
	treatment	68	93		

Table 4. Pre-Assessment Between-Group Item Level Counts and Analysis using Pearson's chi-squared for all students who participated in the Pre-Assessment only

Cross-tabulations				Pearson's chi-squared	
		Pre-test			
Question	Condition	0	1	statistic	p-value
H00X24					
	control	103	122	1.763	0.184
	treatment	109	100		
H00X25					
	control	116	109	0.105	0.746
	treatment	111	98		
H00X22					
	control	62	163	0.236	0.627
	treatment	62	147		
H00X29					
	control	93	132	0.027	0.871
	treatment	88	121		
G02L19					
	control	66	159	0.133	0.715
	treatment	58	151		
G02E09					
	control	90	135	0.027	0.871
	treatment	82	127		
G02X12					
	control	109	116	0.030	0.861
	treatment	103	106		
H00X23					
	control	82	143	0.108	0.742
	treatment	73	136		
G02X11					
	control	84	141	1.246	0.264
	treatment	89	120		
G02L13					
	control	36	189	0.584	0.445
	treatment	28	181		
G02X01					
	control	53	172	0.001	0.978
	treatment	49	160		
G02E17					
	control	20	205	0.005	0.941

	treatment	19	190		
H00X28					
	control	112	113	0.009	0.923
	treatment	105	104		
H00PU03					
	control	98	127	0.158	0.691
	treatment	95	114		
H00HC01					
	control	110	115	1.388	0.239
	treatment	114	95		
H00HC02					
	control	138	87	0.050	0.823
	treatment	126	83		
H00PM04					
	control	45	180	2.097	0.148
	treatment	54	155		
H00PM03					
	control	63	162	0.079	0.778
	treatment	56	153		
H00HC03					
	control	100	125	2.579	0.108
	treatment	109	100		
H00PM02					
	control	71	154	0.010	0.919
	treatment	65	144		
H00HC04					
	control	109	116	4.717	0.030
	treatment	123	86		
H00PU02					
	control	61	164	0.415	0.519
	treatment	51	158		
H00PM01					
	control	133	92	0.066	0.797
	treatment	121	88		

Table 5. Post-Assessment Between-Group Item Level Counts and Analysis using Pearson's chi-squared

Cross-tabulations				Pearson's chi-squared	
		Post-test			
Question	Condition	0	1	statistic	p-value
G02E09					
	control	47	111	4.358	0.037
	treatment	31	127		
G02X11					
	control	26	131	0.176	0.675
	treatment	29	129		
G02X12					
	control	61	95	1.401	0.237
	treatment	52	107		
H00HC01					
	control	48	109	2.878	0.090
	treatment	35	123		
H00HC02					
	control	77	79	1.024	0.312
	treatment	87	71		
H00HC03					
	control	41	114	0.616	0.433
	treatment	36	123		
H00HC04					
	control	73	82	1.786	0.181
	treatment	63	96		
H00PM01					
	control	44	110	0.406	0.524
	treatment	51	109		
H00PM02					
	control	33	121	1.003	0.316
	treatment	42	118		
H00PM03					
	control	27	127	0.548	0.459
	treatment	23	136		
H00PU02					
	control	14	140	0.085	0.770
	treatment	16	143		
H00X23					
	control	20	134	0.010	0.919

	treatment	21	136		
H00X24					
	control	76	78	3.232	0.072
	treatment	62	96		
H00X25					
	control	68	85	0.211	0.646
	treatment	67	93		
H00X28					
	control	36	117	0.315	0.575
	treatment	33	125		
H00X29					
	control	143	10	0.071	0.790
	treatment	146	9		
H00PU03					
	control	40	112	0.008	0.931
	treatment	42	115		
G02L13					
	control	24	129	3.376	0.066
	treatment	14	144		
H00PM04					
	control	12	141	4.099	0.043
	treatment	24	134		
G02E17					
	control	9	144	0.032	0.858
	treatment	10	147		