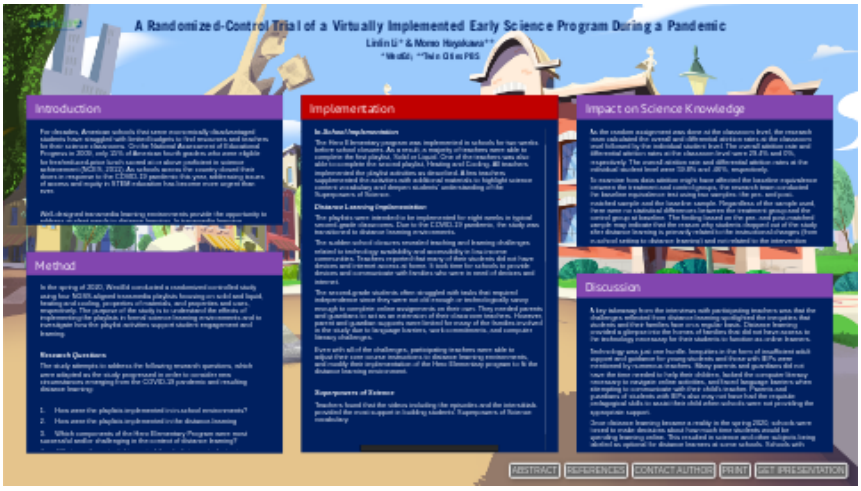
A Randomized-Control Trial of a Virtually Implemented Early Science Program During a Pandemic



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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)

Funded by the U.S. Department of Education, the Twin Cities Public Television (TPT) Ready to Learn program, *Hero Elementary*, aims to reach underserved 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.

[VIDEO] https://www.youtube.com/embed/tuZy4suwhRE?rel=0&fs=1&modestbranding=1&rel=0&showinfo=0

METHOD

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.

Research Questions

The 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?

2. How were the playlists implemented in the distance-learning

3. Which components of the Hero Elementary Program were most successful and/or challenging in the context of distance learning?

4. What was the potential impact of the playlists on student science knowledge?

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. Due to COVID-19 school closure, by the end of the study, post assessment data were collected from 24 classrooms (with 319 students).

Instruments

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.

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.

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).

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.

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

IMPLEMENTATION

In-School Implementation

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.

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.

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 and internet.

The 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. However, 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.

Even with all of the challenges, participating teachers were able to adjust their core course instructions to distance learning environments, and modify their implementation of the Hero Elementary program to fit the distance learning environment.

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.

[VIDEO] https://www.youtube.com/embed/Vwt1R-KaeoU?rel=0&fs=1&modestbranding=1&rel=0&showinfo=0

- *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.

- 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.
- 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.

IMPACT ON SCIENCE KNOWLEDGE

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.

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. 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.

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. The results indicated that 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.

DISCUSSION

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.

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.

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.

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).

ABSTRACT

School closures because of natural phenomena, such as COVID-19, underscore the importance of effective distance learning strategies when there are no in-school alternatives. Our study describes the implementation of a transmedia science program before and after school closure due to COVID-19 in a variety of ways depending on schools' infrastructure and preparations for distance learning. In addition to the successes associated with implementation, the preliminary results have indicated that the program was positively associated with gains in students' science.

REFERENCES

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