MAKERS EMPIRE

ACADEMY FOR INTEGRATED ARTS & OPERATION BREAKTHROUGH

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LEANLAB EDUCATION

Cohort 6

Research

ACADEMY for INTEGRATED ARTS, OPERATION BREAKTHROUGH, & MAKERS EMPIRE

2020 Research Report

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SCHOOL SUMMARY AND PROBLEM OF PRACTICE

Academy for Integrated Arts (AFIA) is a public, charter elementary school serving grades Pre-K through sixth grade. AFIA is unique from other elementary schools in that students use the arts—dance, music, visual art, and theatre—as a way to learn core academic subjects. "This fusion of art with academics sparks the imagination and challenges the intellect, preparing students for vibrant, successful lives in secondary school and beyond" (afiakc.org).

The problem of practice at AFIA centered on **connecting math, the sciences, and the arts to real-world applications.** Many students from disadvantaged neighborhoods in Pre-Kindergarten through third grade do not have the opportunity to learn problem-solving and spatial reasoning skills in their classroom. Teachers needed, therefore, more support in creating intentional learning opportunities that brought together the arts and real world learning. In particular, the teachers of the youngest children in Pre-K and Kindergarten were looking for new and innovative approaches for bringing spatial reasoning skills to their classrooms. **AFIA chose to conduct research with Mrs. Andrea Davis' Pre-K/Kindergarten classroom.**

Operation Breakthrough is a before- and after-school enrichment program that serves 265 kids between Kindergarten and 8th grade. The mission of Operation Breakthrough is "to provide a safe, loving and educational environment for children in poverty and to empower their families through advocacy, emergency aid and education." Of the families served, 80% live on less than $12,000 annually. It is located in central Kansas City and is open to all public school students.

Similar to AFIA, Operation Breakthrough was looking for new approaches in real-world learning to implement in their STEM Lab, under the direction of Jadwin Rowles, with kids in first and second grade.

VENTURE SUMMARY AND INTENDED EFFECT

Makers Empire—founded by Jon Soong—helps K-8 educators teach design thinking, STEM, and 21st-century learning skills with 3D printing and 3D design so they develop the critical thinking, design thinking, creative, collaborative and problem-solving skills, and growth mindset they'll need to thrive in the future. With Makers Empire, "students learn how to use Project-Based Learning and Design Thinking to identify real-world needs, problems and opportunities. They then use Makers Empire to create, prototype, test and refine their original 3D solutions." Makers Empire encourages a "love of STEM by making it fun." Jon Soong points out that "85% of jobs that will exist in 2030 haven't been invented yet so today's students need to be adaptable and innovative problem solvers. Makers Empire provides teachers with everything they need to equip students with the skills, mindsets and dispositions to help them thrive in a dynamic future."

RESEARCH GOALS

There were three research goals of this study. Two goals focused on testing the efficacy of Makers Empire on two student outcomes: **spatial reasoning skills and oral language development. The first hypothesis was that students who use Makers Empire will see an increase in their spatial reasoning skills. The second hypothesis is that students will exhibit greater oral language competency after using Makers Empire.** The third goal was to gather feedback from the teacher and students on usability and implementation of Makers Empire in order to modify and/or enhance product features that were more user-friendly for young children.

METHODOLOGY

Sample

At AFIA, the sample for this study consisted of **24 students** in Mrs. Andrea Davis' Pre-K/Kindergarten classroom. Of the 24 students in the sample, 92% were Black and 8% were white and all were eligible for free and reduced-price lunch. AFIA was not particularly interested in comparing student outcomes with their other Pre-K/K classrooms and wanted to focus more on understanding conditions that might make Makers Empire most feasible for young ages, so a control group was not used in this study. Therefore, this study is purely descriptive in terms of efficacy results as it assessed pre- and post-performance among just this sample of students, all of whom used Makers Empire.

At Operation Breakthrough, the sample consisted of just **10 students** in Mr. Rowles' STEM lab. All students in this sample were Black and all were eligible for free and reduced lunch at their respective schools. There was no viable comparison group at Operation Breakthrough, so the study is strictly a usability study in that it identifies conditions of successful implementation of Makers Empire.

Measurement of Outcomes

The first outcome evaluated in this study is ***spatial reasoning skills***. Students at AFIA were given a pre- and a post-assessment, in which they were tasked with creating a house within Makers Empire. Teachers then assessed students' spatial reasoning abilities along four indicators: 1) number of shapes a student used to make a house, 2) number of shapes a student could match with the same side of another shape, 3) number of shapes a student used in a symmetrical way, and 4) number of connecting points a student could make and identify. For each indicator, the numeric score ranged from 0 to 5. Spatial reasoning skills were not assessed at Operation Breakthrough because a consistent sample of students to test in a pre- and post-fashion was not possible.

The second outcome evaluated in this study is ***oral language development***. Along with the spatial reasoning assessment described above, there was an oral component to the assessment. After students completed their house creation within Makers Empire, the teacher or research assistant asked each student a series of questions that the student had to respond to verbally. The questions were used to assess the extent to which a student could accurately describe and count the shapes used in their creation as well as the process they followed to create the house. Teachers and research assistants assessed their communication along five dimensions: 1) number of shapes a student could name, 2) number of different shapes a student could count, 3) number of attributes about a shape a student could describe, 4) number of directional terms (eg. above, below) a student could use, and 5) number of sequential steps a student could use to describe their process of creation. For each indicator, the score ranged from 0 to 5. Oral

language development was not assessed at Operation Breakthrough because a consistent sample of students to test in a pre- and post-fashion was not possible.

Teacher and Student Interviews

Once a month for three months, in-person interviews were conducted with the teachers and with students at AIFA and with just the teacher at Operation Breakthrough to collect feedback on implementation. A standardized questionnaire was created to guide the interview and collect feedback that could be iterated in a second and third round.

RESULTS

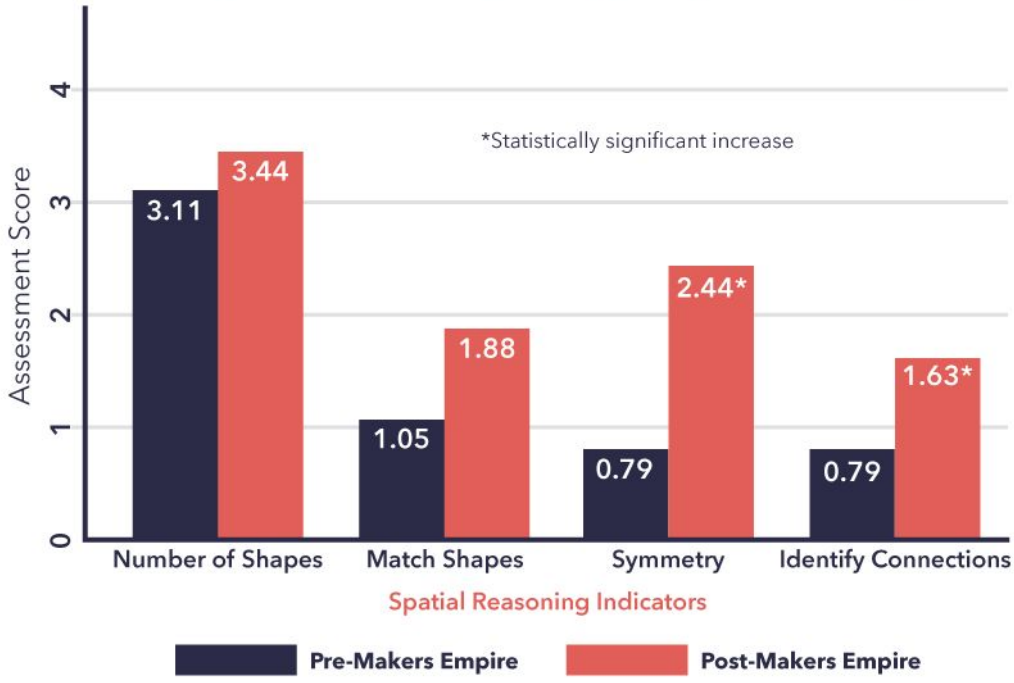
In this section, the quantitative results are presented in regards to the two efficacy research outcomes: **spatial reasoning skills** and **oral language development**. The evidence presented here is strictly descriptive. The results illustrate pre- and post-changes in student assessment scores among only the students who used Makers Empire at AFIA. There was no control group and no other confounding variables were controlled for, so causation is neither tested nor implied in this study.

SPATIAL REASONING SKILLS

Overall, there is preliminary support for the first hypothesis that students who use Makers Empire will experience an increase in spatial reasoning skills.

In Figure 1, the class average scores from AFIA on the pre- and post-assessments are shown. For each indicator, the class improved from the pre- to the post-assessment. Students could count and match more shapes but the increase was not statistically significant. Students were already able to count and identify shapes at relatively high levels, so there was less improvement needed. There were, however, statistically significant increases (based on paired t-tests) in the *symmetry* indicator and the *identifying connections* indicator. Overall, students were significantly better at building a house with symmetry and were better able to make appropriate connections with the shapes.

Figure 1: Class Average Change in Spatial Reasoning



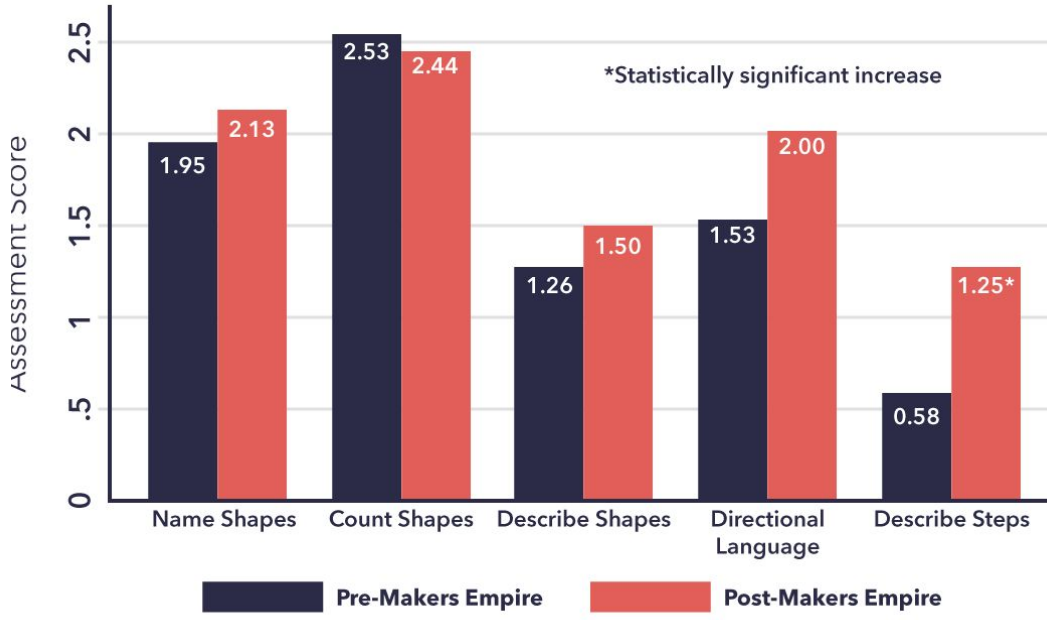
ORAL LANGUAGE DEVELOPMENT

Oral Language Development

Overall, there is a little support for the second hypothesis that students will exhibit greater oral language competency regarding spatial reasoning after using Makers Empire than before.

In Figure 2, the class-average scores on the pre- and post-oral language assessment at AFIA are shown. While students improved or maintained communication skills in every category, the only indicator where the class, on average, improved in a statistically significant way (based on paired t-tests) was the ability to describe the sequential steps in creating a house. In the pre-assessment, students had difficulty describing the steps at all, and by the post-assessment they were, on average, able to describe the first two steps.

Figure 2: Change in Class Average Communication Assessment Scores



PRODUCT MODIFICATIONS

The third goal of this research study was to gather feedback from teachers at AFIA and at Operation Breakthrough about product usability and implementation requirements for young children. The main purpose of the study was to understand how to adapt the Makers Empire app to be the most suitable for very young children. A number of significant challenges for children arose early in the pilot, and as a result of teacher feedback, three product enhancements were made to try to make Makers Empire easier for young children to use.

First, instructional videos were created to show to students before using the app for the first time, so that they could see how it is meant to be used and how to navigate the world in the Makers Empire app. Since students in this age-group cannot yet read very well, written instructions or words were not helpful. The instructional videos helped students navigate the app a little bit better.

Second, the teachers noted that because Makers Empire did not have any sound or audio with it, students were not sure if and when they were doing something correctly and generally struggled to stay engaged. They suggested that it would help students know they are on the right track if "happy" or "sad" sounds could play while a student is creating something in the app. Furthermore, with sounds or narration, she believed the students would be more engaged generally with the app. Therefore, Makers Empire is currently working with its tech developers to add sound and text narration.

Third, the most exciting part of Makers Empire for these students was creating an avatar. Students enjoyed working with partners in creating an avatar and seeing their classmates' avatars. The teacher and some students noticed, however, the lack of character attributes that reflected racial diversity. "Where's the afro option?!" exclaimed one student. Makers Empire is currently developing more inclusive character attributes in response.

Finally, the key to successful implementation with young children was working in small groups of 4 or less. There was a lot of frustration early on from kids because they were unable to use it without constant support from the teacher. In return, the teacher would get overwhelmed as well. With this age group—Pre-K and Kindergarten—Makers Empire worked best for children when it was one "station" or "center" during small group time. In that way, the teacher could stay with one group and more easily manage the attention demanded from students using the app.

DISCUSSION AND NEXT STEPS

The usability component of this research pilot was the most insightful part and helped Makers Empire adapt the platform in a way that was more user-friendly for very young children in pre-K and Kindergarten. While students did get a little better at using the app over the course of the semester, it was still very difficult for them to navigate. Further usability research with young children is encouraged once Makers Empire establishes new sound features to test the extent to which audio improves the user experience.

While the efficacy results of this study lend preliminary support for the two hypotheses linking Makers Empire with improved spatial reasoning skills and oral language development, the study was limited in many ways and additional efficacy research is warranted. First, the sample size in this study was very small. With only 24 students, it was a very small group to infer generalizability to a wider context. More importantly, this study did not compare changes in assessment scores with a control group. As stated earlier, the main goal of the study was usability and not efficacy so a control group was not prioritized. We cannot say, therefore, that any of the results we see are due to Makers Empire without having a control group and/or controlling for other possible explanations for change. Future efficacy research should, therefore, have a much larger sample size and include a proper control group and collect data on confounding variables to control for in a statistical analysis.

CONCLUSION

AFIA is excited about continuing to partner with Makers Empire on further research and about the promise it has at connecting the arts, the sciences, and real-world learning. This study showed that students who used Makers Empire experienced, on average, an increase in some spatial reasoning skills and were better able to describe the steps in the process of creating something from scratch. While the efficacy evidence is only descriptive and limited by sample size, the preliminary positive evidence this study did find lends support for a larger, more robust efficacy research study. Makers Empire also proved to be a responsive partner in co-design with the school, as it is adding features specifically designed to help young users navigate the app more easily.