KiDSPARK EDUCATION

Developing a STEM Identity as an Educator:

A Design-Based Research Study of Kid Spark Education's STEM Professional Learning Program

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Presented by:
The Nonprofit Institute

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About Kid Spark Education

Kid Spark helps schools and educational service providers disrupt the pattern of educational inequity by providing STEM education early and consistently for Pre-K – 8th grade students. By giving kids of all backgrounds and abilities an equal chance to learn and love STEM, we are nurturing the next generation of successful professionals, bold thinkers, and passionate leaders.

About The Nonprofit Institute

The Nonprofit Institute is housed within the School of Leadership and Educational Sciences at the University of San Diego. The Nonprofit Institute is committed to providing education, training and research to build leaders and strengthen organizations that help meet critical community needs.

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OVERVIEW AND BACKGROUND

Kid Spark Education is an educational nonprofit with a mission to help children learn and love STEM, especially students from communities underrepresented in science, technology, engineering, and math (STEM) fields. Kid Spark has been working to accomplish its mission through the targeted use of a curriculum they developed specifically for underrepresented children and their teachers. Kid Spark prioritized evaluating the effectiveness of their program through a 2018 pilot study of its early childhood curriculum which showed that kindergarten students and teachers who participated in a 16-week Kid Spark program began to develop a STEM identity by the completion of the program. Students in the pilot study showed evidence of growth in building foundational STEM fluencies, engaging in science and engineering practices, and developing knowledge of the field of engineering. Teachers in the pilot study demonstrated early evidence of increased self-efficacy and value for the teaching of STEM, as well as increased knowledge in basic STEM concepts and practices.

Although the findings provided evidence of Kid Spark's positive impact, Kid Spark leadership believed that the teacher professional learning component of the program could be enhanced to better prepare educators to teach STEM and sustain the use of Kid Spark programs beyond the initial implementation. To help them achieve these goals, in spring 2022, Kid Spark commissioned The Nonprofit Institute at the University of San Diego (NPI) to conduct a design-based research study focused on its development and implementation of a professional learning course for early childhood educators. Design-based research is a practice-oriented approach in which educational interventions are designed and tested in real educational contexts. As such, this research study was collaborative, whereby the NPI team partnered with Kid Spark leadership to design the research study, develop and refine the professional learning course, and come together to make sense of the findings. This research project was conducted between April 2022 and June 2023 and the objectives and guiding research questions for the research project are below.

Project Objectives and Research Questions

Objective	Research Question
Develop a professional learning plan for early childhood educators that can be implemented widely in schools across the country.	What is the best method and structure for providing initial training and ongoing support that can be scaled to accommodate a large number of early elementary educators and informal educators that are implementing applied STEM in underrepresented communities?
Gather insights from site administrators on how to sustain STEM learning in schools and informal learning settings over time.	What do formal and informal educational settings need to sustain effective applied STEM and Invention Education programs over the long term?
Pilot the implementation of the professional learning course and Kid Spark curriculum in a variety of early childhood educational settings in order to assess if participation increases educators' self-efficacy in teaching STEM.	How does participation in the professional learning course coupled with delivering the Kid Spark curriculum impact educators' self-efficacy in teaching engineering?

This report begins with a brief description of the Kid Spark professional learning course and early childhood curriculum. Next, is a summary of the research methodology, including information on the educators and sites that participated in the pilot study. Next, the findings are broken up into two sections: 1) conditions necessary for developing and sustaining STEM learning, and 2) how participation in Kid Spark supported educators in the development of a STEM identity. The report concludes with recommendations for Kid Spark based on the project's findings.

Description of the Kid Spark Program

Professional Learning Course

The educator professional learning course was developed collaboratively by the Kid Spark founder and executive director and a USD faculty member in the Department of Learning and Teaching. The course was designed through an iterative process that first involved designing, piloting and refining the course at a single public elementary school in the spring of 2022. After revisions were made to the course based on learnings from the pilot, the revised professional learning course was implemented in fall of 2022 across 10 educational sites, including both after-school and in-school settings. All pilot educators received a stipend and continuing education credits for their participation in the pilot study.

The professional learning program started off with a two-week online asynchronous course, where educators completed four sequential modules at their own pace. The modules introduced the foundational learning theories and neuroscience research that underpin the Kid Spark

program and they provided opportunities for educators to familiarize themselves with the materials and curriculum. Table 1 outlines the four modules.

Table 1: Professional Learning Modules

MODEL NUMBERS	MODULE TITLE	MODULE OBJECTIVES
1	Learning with Understanding	Learning objectives include explaining the importance of engaging prior understanding of learners, explaining experiences that are foundational to building conceptual frameworks, and explaining the importance of monitoring one's thinking, metacognition.
2	See Like a Designer, Think Like an Engineer	Learning objectives for this module included setting up your metacognitive framework, defining the design and engineering from an educator's perspective, and exploring how to use Kid Spark engineering materials. Educators are guided to reflect on their own experiences and assumptions about STEM.
3	Foundational Fluencies and STEM Identity	Learning objectives included seeing one's self as capable of learning and understanding STEM and obtaining the confidence and skills to creatively author technology to solve real-world problems and design new solutions. Modules introduced four foundational STEM fluencies: symbolic language, sequence and correspondence, spatial reasoning, and problem solving
4	Championing Your Students' STEM Identity	Learning objectives included what it means to learn with understanding, reflecting on your own STEM identity and how you will bring that to your students, and extending your Kid Spark skills beyond what is needed for Pre-K - 1st grade STEM.

In addition to listening to the modules and completing activities, educators were also required to participate in an online forum where a Kid Spark staff member served as a moderator prompting and facilitating discussion among participants. In the first phase of the pilot, five educators from the same school participated in the online forum. When the pilot was expanded in the fall of 2022, 20 educators from 10 educational settings across the country participated in the online forum, which was hosted on Facebook.

PreK-1st Grade Program

Once educators completed the two-week professional training modules, they delivered eight weeks of lessons and curriculum to students and also continued to participate in the online forum where they were required to respond to reflection questions and share their children's learnings. This format was the same for both the fall pilot and the expanded spring pilot, but each site delivered the lessons in slightly different ways. Most sites delivered one lesson per week for eight weeks but some sites delivered the same lessons across a longer time frame depending on their other curricular commitments.

Table 2: Description of the Kid Spark PreK-1 Foundational Fluencies Curriculum

UNIT NUMBER	UNIT TITLE	LESSON TITLES
1	It's All About the Blocks	- The Big Yellow Block - The Little Blue Block - The Angled Red Block - The Medium
2	I am an Engineer	- What is an Engineer? - Patterns & Pyramids? - What's in the Lab? - Free Build/Invention
3	Making Things Strong	- How Much Load Can It Hold? - The Long Haul - Make Your Castle Strong - Free Build/Invention
4	Making Things Move	- Pushes & Pulls - Exploring Gravity - Make Your Castle Move - Free Build/Invention

At sites where there were multiple educators trained in the curriculum, trained educators held weekly in-person meetings to plan the Kid Spark lessons together, whereas at sites where there was only one educator at the site in-person collaborative planning was not possible. Each of the pilot settings had a dedicated site coordinator from their site who was paid an additional stipend to oversee the professional learning course and the lesson delivery.

RESEARCH METHODOLOGY

The data presented in this report were collected between April 2022 and June 2023. The findings related to the design of the professional learning program are the result of data collected via focus group interviews with preschool, after-school and PreK-12 educators, a pre/post survey on teacher self-efficacy in engineering completed by all the educators who completed the training, and individual interviews with all site administrators. Additionally, the NPI team conducted six interviews with administrators from schools that had implemented Kid Spark in the past 1-4 years in order to better understand how to effectively sustain STEM programs in educational settings. Table 3 describes each of the data sources.

Table 3: Data Sources and Descriptions

DATA SOURCE	PARTICIPANTS	DESCRIPTION
Pre Focus Groups	n=15 Site 1: 4 Site 2: 8 Site 3: 3	After completing the two-week professional learning course but before implementing Kid Spark with children, NPI conducted three focus group interviews virtually. The focus group questions asked educators for feedback on the format and content of the training and their sense of confidence in being able to implement Kid Spark.
Post Focus Groups	n=24	NPI conducted six final focus group interviews virtually with educators from each of the 11 sites after they had finished implementing the Kid Spark program. The goal was to gather feedback on the educators' experiences with Kid Spark.
Pre/Post Teacher Survey (Teaching Engineering Self-Efficacy Scale)	n=24	Educators completed a pre survey one week before they started the professional learning course and a post survey 1-3 weeks after they finished delivering the Kid Spark lessons. The Teaching Engineering Self-Efficacy Scale (TES)[i] is a validated tool used to measure teachers' self-efficacy in teaching engineering. The constructs of the survey include 1) engineering self-efficacy in pedagogical content knowledge, 2) engaging students, 3) managing behaviors, and 4) teacher effect on student learning.
Kid Spark Final Reflection	n=20	Kid Spark staff administered a post experience reflection survey to participating educators. Educators were asked to reflect on the professional learning, the curriculum, and any challenges they experienced.
Administrator Interviews	n=5	NPI conducted interviews virtually with five site administrators to gather their perspective on Kid Spark and gain insight into the prerequisites for sustaining STEM programs in schools and after-school settings.
Interviews with school site representatives who have implemented Kid Spark	n=6	NPI researchers conducted interviews virtually with an additional six site administrators who had implemented Kid Spark in the past five years. The purpose of the interviews was to better understand if and under what conditions a site was able to sustain Kid Spark programming over time.

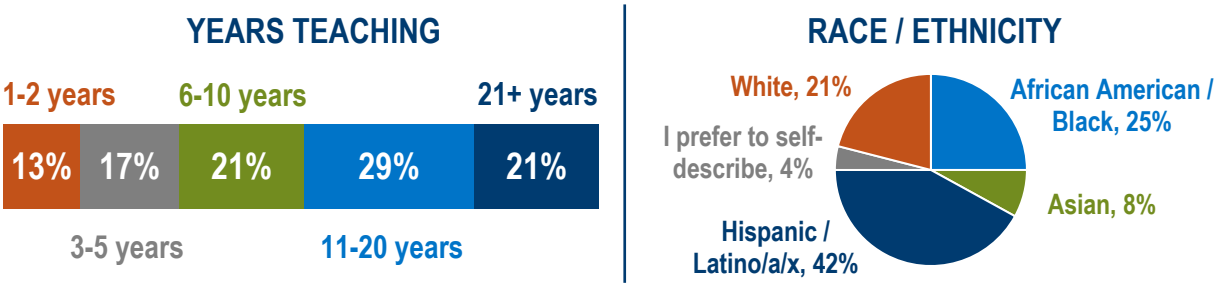
Pilot Educational Settings

Table 4 describes each of the 11 sites where educators completed the professional learning course and delivered the Kid Spark curriculum to children.

Table 4: Pilot Research Sites

EDUCATIONAL SETTING DESCRIPTION	LOCATION	DETAILS
Elementary school with an onsite after-school program (Original Pilot Site)	Southern California	5 elementary school educators (who taught various grades during the school day) delivered the program after school with K-1st grade students
Head Start preschool program with 3 sites	Florida	7 preschool educators delivered the program to classrooms of 3–4-year-old and 4–5-year-old children
Elementary district with 4 participating schools	Texas	2 STEM specialist educators and 2 librarians delivered the program to K-5th grade children during a dedicated STEM class
Afterschool STEM program	Virginia	3 after-school educators delivered the program to K-1st grade children attending an after-school STEM program
Elementary school with an onsite after-school program	Southern California	2 kindergarten educators delivered the program after school with K-1st grade students
Charter Elementary School	Southern California	1 transitional kindergarten educator and 2 kindergarten educators delivered the program during the school day

Educator Participant Demographic Profile



FINDINGS: DEVELOPING AND SUSTAINING STEM LEARNING

CONDITIONS NECESSARY FOR EFFECTIVE STEM PROFESSIONAL LEARNING

Research Question

What is the best method and structure for providing initial training and ongoing support that can be scaled to accommodate a large number of early elementary educators and informal educators that are implementing applied STEM programs in underrepresented communities?

Kid Spark designed the professional learning course with the following objectives in mind:

1. Must be scalable to educational settings across the country
2. Reasonable time commitment for K-8 educators to accommodate
3. Support educators in feeling more confident to teach engineering to young children
4. Requires minimal ongoing support from Kid Spark to sustain at a site over time

Based on focus group interviews with participating educators and individual interviews with school/site administrators, the professional learning course successfully met the objectives and prepared educators to implement Kid Spark with young children. The following conditions of the professional learning course were cited as critical to its success.

CONDITION 1 | Builds a Community of Practice

The study found that building a community of practice is a condition that supports the objectives of the Kid Spark program, specifically by providing ongoing peer-to-peer support to educators in implementing the curriculum. A community of practice is a professional learning approach that promotes collaboration among a group of people focused on a specific topic with the goal of building knowledge and improving practice. There is a strong body of evidence that building communities of practice is an effective professional learning strategy for educators.[ii] Each site implemented Kid Spark in a slightly different way, but across all implementations, the professional learning was designed to promote communities of practice. This element of professional learning was highly valued among the educators that participated in the Kid Spark training and curriculum implementation. Educators built a community of practice in two unique contexts: among educators implementing Kid Spark at the same educational setting and online among educators who implemented Kid Spark in settings across the country.

Developing a Community of Practice among Educators at the Same Site

Some of the educational settings set aside dedicated time for educators to plan the Kid Spark lessons. At the original pilot school site, five K-5th grade educators planned their Kid Spark lessons together weekly. They reported that one of the most beneficial components of Kid Spark was being able to collaborate and learn together as a group.

> *"The weekly meetings were the most important piece. We were able to collaborate, jump off of one another's ideas, it was very pivotal. Helped me as a newish educator hearing from other instructors with more experience. It was just incredible; we were like fireworks going off…it was helpful to talk about it with colleagues that were all going in the same*

direction. Kid Spark was amazing because I was able to talk about the lessons with other teachers."[iii]

"I enjoyed the learning modules very much. I was able to share the knowledge I learned with my co-workers and have great discussions about it."

Developing an Online Community of Practice Among Educators Across the Country

In addition to on-site collaboration, the pilot professional learning course included an online forum where during the first two weeks educators participated in discussions about the modules and then as they began to deliver the lessons they shared about their experiences and challenges working with students. In phase 1, educators from the same school participated in the online forum and then in the second phase, the platform was moved to Facebook and educators from 10 educational settings from across the country participated in the discussion. Educators from the 10 educational settings, in particular, reported that the Facebook forum allowed them to learn from one another and share their own experiences. Below are some examples of how the online forum supported the educators' learning.

Generated Ideas

"I enjoyed the feedback you would get from the other educators - I would get ideas for my next lesson. Idea sharing on how you can make the lesson more interesting. You think you do it the best 'til you see other people's [ideas]."

"Because I kept reading like other people's posts, and I'm like, oh, okay, I never thought about doing it this way. But maybe I should try it this way."

Validated Their Own Practices

"Seeing that other classrooms were moving at the same pace was very helpful - "what if I'm doing it wrong" - you could see on FB that people were doing it the same."

"I did like going on Facebook and seeing what other teachers were doing and seeing the results of their lesson and what their kids came up with, and how some of them were the same as my students. And some were different. I know, there are different grade levels. So, some of their builds are a lot more, you know, extravagant or whatnot."

Connection and Collaboration

"…it was really great to just kind of have a connection, and seeing what other schools and other teachers were doing."

"I kind of found it was unique, it was like, basically a sharing spot for everybody to kind of just come together…because I kind of have some STEM experience, it was like a lot of people who were beginning, having no idea where to start from. So, it was a lot of questioning, like asking why. Why do you think of this and you know, just trying in a different way. So, it was more of like a collaboration between everybody on the space…You know, so it was kind of just, again, a big collaborative space. A lot of sharing different ideas. I liked it."

"I actually love this community. And during that community, we actually got to engage with one another. Seeing it from different points of views and to understand that and just see how people's minds work differently."

CONDITION 2 | Asynchronous Flexible, Short Format

Educators appreciated the asynchronous format of the professional learning modules, where they had two weeks to complete the modules at their own pace. Educators reported that they had very limited time in their schedules and being able to fit the learning into their own time was very beneficial.

"I like to go at my own pace with the module, it was really convenient, especially with…everyday life and work life and home life balancing, you know, I had time to sit down and have a peaceful moment to go through each module on my own time, not being rushed to do something."

"I liked that the modules stopped so I could take notes. It was very user friendly. The pace was good. It wouldn't advance until I clicked it. I liked that I was the leader in the pace. The content was easy to understand and follow along."

"I actually think the way that the online module is set up is very accessible for teachers, because it's not too long."

CONDITION 3 | Opportunities for Experiential Learning

Each of the modules included an interactive element where educators had to pause and use the Kid Spark building materials to complete an activity. Many of the educators reported that they were glad they were able to work with the materials prior to introducing it to the children they taught. The experiential learning helped them feel more confident with the materials and better understand the theory behind the program.

"I am enjoying this time so I feel more confident when I bring it to my kids and that affects the way the children perceive it. It also brought me back to my childhood, designing Barbie beds. Now playing with the kits it took me back to the designer mentality."

"The professional development course was very beneficial. I like that we did actual building of objects and designed them, just how the students would do. Yes, I felt ready to teach the units and the STEM was not as intimidating as it has seemed in the past."

"I was nervous. Because we're working with a group of kids, and this is different for me because, like I said, I don't work in an environment where I'm with kids and teaching them something. So, for me to have learned something and I can take what I learned and give it to another child and see what they can do with it made me feel good about what I did in that module, or what I learned from that module."

CONDITION 4 | Includes Accountability

A Kid Spark staff member responded to each educators' online reflections with probing questions or insights. Educators found value in participating in the online forum and reported that receiving feedback from Kid Spark staff increased accountability for them to contribute to the online forum. However, even though they valued the online forum, many of the educators still reported it challenging to keep up with the reflections once they had completed the course modules. Delivering curriculum is an expected part of an educator's workday but contributing to the online forum required educators to complete additional work outside their normal duties. This was mostly true for K-12 educators but even some of the after-school educators found it difficult to make time to complete the reflection posts. Kid Spark staff may need to refine how they build accountability into the professional learning.

"I liked the in-service piece on Facebook. I liked the idea behind the interactive piece but I don't have time during my work day."

CONDITION 5 | Values Educators' Time

Compensation for Educators

As part of the pilot program, educators and site coordinators were financially compensated and received continuing education credits. Although all educators were grateful for the stipend, most reported that they would implement a program like Kid Spark with their students without compensation. However, participating in the professional learning course required additional time beyond their work hours and receiving the stipend motivated them to fully engage in the online forum and keep up with their weekly reflections.

"It was beneficial. I think it kind of motivated me even more to do the Facebook thing. And to get the reflections done, so that encouraged me, okay, go do it so I can get paid."

Site Coordinator reflecting on compensation for the educators: "Within our organization, we have a lot of challenges and they have a lot on their plate - us asking them to participate in a research project I felt would be another thing on top of their plate. I think they would've done it without - but I think it helped create that motivating factor."

Continuing Education Credits

Many K-12 teachers are required to complete continuing education credits and their salaries are sometimes tied to accruing credits. While some educators valued the continuing education credits, many of the educators reported that they had already fulfilled their continuing education and it was of no benefit to them. Providing continuing education was an important incentive, particularly for early career K-12 teachers, but it was not necessary for all. K-12 educators reported that school districts often have a practice of allowing teachers to choose either a stipend or continuing education credits for professional learning trainings.

"If I needed them, it would be very, very helpful. But I already have so many from the summer so I just didn't want to go through the process of adding more if I don't really need them."

Compensation for Site Coordinators

Site coordinators were required to take on additional tasks and, as such, felt the compensation was necessary and fair. However, one site coordinator felt like it was more than she needed and another appreciated it but felt that if she were to implement the program again at her site, she would not need additional compensation. Though compensation was not essential for all site coordinators, it did seem important to make sure all site coordinators were aware of their roles as one site coordinator reported that she did not realize she had been designated as a site coordinator and did not take on the additional responsibilities.

CONDITIONS NECESSARY TO SUSTAIN APPLIED STEM EDUCATION LONG-TERM

Research Question

What do formal and informal educational settings need to sustain effective applied STEM and Invention Education programs over the long term?

Kid Spark's mission is to provide applied STEM educational opportunities to students and educators that are sustained over time. One of the challenges for Kid Spark in meeting their goal of sustained STEM education is that educators and children are typically very positive about the program initially but as time goes on, some educators have reported that they stop implementing the curriculum in their settings. Based on interviews with site administrators from the pilot sites, as well as with sites that have been utilizing the Kid Spark materials for a few years, the following conditions are critical to achieving the goal of long-term sustainability. Note, that these conditions apply more for K-12 settings than to informal learning and preschool settings.

CONDITION 1 | Strong Leadership-Level Support

Leadership at the highest level must mandate that STEM be incorporated into the existing curriculum at their sites and they must provide the necessary resources to support educators and children. Administrators who had been successfully implementing Kid Spark for a number of years at their sites reported that it was possible to sustain the program because STEM education was required and Kid Spark helped to fill that requirement. In one school site where Kid Spark was implemented in all elementary grade levels, the curriculum was used to satisfy the design and engineering unit of their science curriculum. In another setting, the district needed higher level science content for English Language learners in middle school and Kid Spark filled that gap.

"Our Director of Curriculum said this is an expected unit that you are going to teach this isn't a 'do this if you have time,' or 'just do this after testing or instead of this, you guys can do this for one day.' Like, this is an expected unit that you are teaching, and it's across all grades. It's not just a fun little fifth grade unit that they do for a week. Like we're scaling this out. And…at the end of the day, like I said, [our state] has engineering standards that we have to meet now. So, this is how we're going to do it."

"It would be about finding a way to get into the mainstream curriculum."

"If STEM is a priority for the district, then you're going to put your resources toward that. STEM becomes a distraction if it is not a priority. Or it becomes with little fidelity."

CONDITION 2 | Dedicated Time for STEM

Traditionally, educators face significant pressure to cover literacy and math, which has historically meant that science and engineering are not prioritized in the classroom. Administrators in this study emphasized that in order to sustain STEM over time, schools must set time aside exclusively for STEM. For K-12 settings, this most often meant having a dedicated class for STEM built into the master schedule.

"I think, dedicated time. So, we've moved to gardening / science curriculum where we have prioritized science learning within our program and that's dedicated, it doesn't get pushed off."

"Before science standards were a formal thing, it was pursued with less fidelity. In our middle schools we had math and science coupled, but once we had science testing, we decoupled those content areas because we found these teachers were primarily teaching math and not that well. This helped a lot."

"Just having the time in the day to complete the unit – built into the actual master schedule."

CONDITION 3 | Dedicated Point Person to Coordinate Applied STEM Activities

An on-site coordinator with historical knowledge of STEM learning initiatives at the site is necessary to ensure any program is implemented across multiple classrooms/grade levels with hands-on materials, particularly if the goal is to sustain the program over time. In the case of implementing the Kid Spark program, an on-site coordinator was critical to serving as a liaison between Kid Spark staff and the educators, and was responsible for making sure time is set aside for planning and for developing materials to enhance the curriculum, as needed. Because there is always staff turnover, a coordinator can ensure continuity of the program by creating the systems necessary for training new educators.

"You need someone to help coordinate the rollout, especially if you're doing it over multiple grades, because that's really something that we had to sit down and think about like, okay, they're [going to] learn this in year one, this in year two, and then thinking about how it translates by grade."

CONDITION 4 | Professional Development for Educators and Administrators that Builds a Community of Practice Around STEM

Specific to K-12 schools, administrators reported that educators and principals need more hands-on training in the science standards where they get ample opportunities to practice and learn with each other. Incorporating state or national science standards into the elementary school curriculum is still new for most schools. Professional learning programs like the modules developed by Kid Spark can help fill this existing gap in hands-on training but in order to ensure the implementation is successful and sustained, educators and administrators need comprehensive professional learning, optimally where they can develop a community of practice

and learn together.

> *"...I think we do need more comprehensive PD, to really feel what it's like, see the difference, experience the difference between what we've been doing for science."*

> *"I just feel that for me, maybe a little bit more training and how to support our teachers. I think that for me is the biggest component, is being able to have a small cohort of principals that are also looking into how to improve or strengthen and sustain the STEM at their school."*

CONDITION 5 | Curriculum that Can Be Easily Adapted to Meet Student Needs

Administrators and educators reported that in order to implement applied STEM curriculum successfully, the curriculum must be flexible enough to allow adaptations depending on the unique context of each educational setting. Educators and administrators felt that Kid Spark was highly adaptable and most educators reported that they did in fact adapt the existing curriculum to meet student needs. However, one administrator said that she was unsure to what degree she could encourage her teachers to adapt the existing lessons and would have benefitted from Kid Spark explicitly stating that the curriculum was designed to be adapted as needed. Another administrator was hopeful that Kid Spark would make some adaptations for students with intellectual disabilities.

Examples of Adaptations to Kid Spark

- **Administrator Gave Guidance to Educators to be Creative with the Curriculum**

  > *"I think it's exactly what I did with them, which was, I encouraged them to try the lesson. But also said integrate it, use it, use the tools, use the manipulatives, see what you can do with it and encourage the creativity around it."*

- **Created Slide Decks for Each Unit**

  > *"Our elementary teachers do it all, they teach all of the subjects, so they can't possibly be masters of all of the subjects. So, they need support, especially in these areas like design and engineering that are new to them, or they may not be super familiar with…The one thing that our district took a lot of time to do, what has been actually a game changer, is we had a teacher team and myself create slide decks to go with each of the units."*

- **Made Printed Copies for Children from the Provided Booklet**

  > *"So instead of us using the pamphlet that came in the boxes, we pretty much just printed whatever copy it was that they [needed]. I think the printout helped them out a lot, because they didn't have to flip through the whole book to figure out and they got a better visual on how to build [what] we were doing that day."*

- **Developed a Lesson on Creating Blueprints**

  One educator created an additional lesson on blueprints. The educator explained the role of blueprints in the design process and had students create their own blueprints to go along with the Kid Spark lessons.

- **Started with Free Play Before Introducing the Lessons**

> *"I had them have a period of about two or three weeks of just exploring the blocks before I ever started instructing them on what they were."*

CONDITION 6 | Introduction for Parents on What to Expect from Kid Spark

Two administrators affiliated with after-school programs suggested that there be a formal introduction to Kid Spark for parents so that they understand the format and purpose of the program and can better support their children. In both of these programs, parents had to sign their children up for the after-school program, and thus had to encourage their children to participate. Although this suggestion came specifically from after-school program settings, it is likely that engaging with parents for school-day programs can support long term sustainability of STEM programs. When parents see the value of STEM, they can advocate better for strong STEM curriculum.

> *"I think the one thing I would change is maybe have an information session for the parents…I don't want to say that they were disappointed. I'm not sure what they expected for that particular age group, but I think that maybe an info session that could educate them on how the program addresses STEM…and how their children will be introduced to the various concepts of STEM."*

CHALLENGES FOR EFFECTIVE STEM LEARNING

Professional Learning Course Challenges

Although all of the educators expressed enthusiasm for the Kid Spark professional learning course, there were some challenges that arose.

- **Facebook as the forum platform** - Some educators did not like using Facebook as the platform for the online forum. They did not personally use Facebook and did not like having to regularly visit the platform. A couple of other educators found it difficult to post photos because of their own limited knowledge of how to use Facebook.
- **Time for weekly reflections** - Some educators found it difficult to find time to post weekly reflections once they were implementing the program with their students.

"It was hard for me to. Not very familiar with Facebook. I would forget to take photos. I liked the in-service piece on Facebook. I liked the idea behind the interactive piece but I don't have time during my work day."

- **Lack of in-person training** - Although educators felt the online training was adequate, some said they would like in-person training as well. In particular, the preschool educators had attended a Kid Spark event at a learning conference prior to joining the pilot, and they viewed the session at the conference to be fundamental to building their confidence as STEM educators and belief in the value of Kid Spark for their students.
- **Time investment from Kid Spark** - Managing the professional learning course was very time intensive for Kid Spark. In addition to moderating the online forum, Kid Spark staff had to send frequent reminders to the site coordinators to encourage educators to complete tasks. Kid Spark would only be able to sustain the same level of involvement with future sites if additional staff were hired.

Kid Spark Curriculum Challenges

Educators experienced some challenges with the curriculum and implementation once they started delivering the Kid Spark lessons to students.

- **Adaptations needed** - The first lessons start very slowly so children can explore each of the blocks and get to know its functionality. Because the students had already opened the kits and seen all of the materials, it was difficult for some educators to keep them engaged in the initial lessons. Multiple educators made adaptations such as having free play with the blocks prior to the first lesson.
- **Developmental differences** - There are significant developmental differences among young children and some struggled to physically manipulate the blocks while others struggled to follow directions. These developmental differences led some children to become disinterested in the directed lessons.

"You have to encourage them (3-year-olds) to keep trying - they get easily discouraged. If they can't pull the block apart, they give up."

"Biggest challenges as an educator with those that wanted to do their own plan. And so, you have to, basically, that's where teaching comes in, you can't just read the book, and, you know, go spew it out, you need to adapt to the child in front of you."

- **Classroom management challenges** - Newer educators struggled with classroom management which negatively impacted their ability to implement the curriculum. Being able to problem solve and share classroom management techniques with other educators was important for being able to properly implement the Kid Spark curriculum.
- **Timing of curriculum implementation** - The second phase of the pilot took place in the fall, the first semester of school. PreK-1st grade educators expressed that it would have been better for them to deliver Kid Spark during the spring, in the second semester, when young students are more accustomed to the norms and expectations of school.

FINDINGS: KID SPARK IMPACT ON THE DEVELOPMENT OF AN EDUCATOR'S STEM IDENTITY

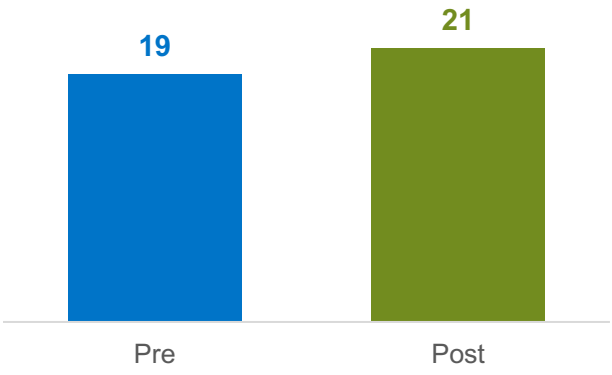
Research Question

How does participation in the professional learning course coupled with delivering the Kid Spark curriculum impact educators' self-efficacy in teaching engineering?

Research suggests that a teacher's belief in their ability to teach a specific content area can have an impact on student achievement in that content area. Historically, teachers have received very little training and instruction in how to teach engineering to children, and up until recently there were no standards defining what children should learn about engineering. Now that 20 states have adopted the Next Generation Science Standards (NGSS), which define science and engineering practices and concepts students should learn, it is increasingly important for educators to feel prepared and capable of teaching engineering to children of all ages. Based on an analysis of data from a pre/post Teaching Engineering Self-Efficacy Scale (TES) survey that measured educators' self-efficacy in teaching engineering and an analysis of the educators' final reflections, the Kid Spark professional learning course and curriculum shows early evidence of positively impacting educators' confidence and self-efficacy in applied STEM generally and engineering specifically.

Figure 1 shows that overall educators' self-efficacy in teaching engineering, which is defined as a teacher's personal belief in their ability to positively influence student learning of engineering, increased after participating in the professional learning course and implementing the curriculum.

Figure 1: Pre/Post Overall Self-Efficacy in Teaching Engineering (Overall score range: 0-30 points)



"I came out more confident teaching STEM."

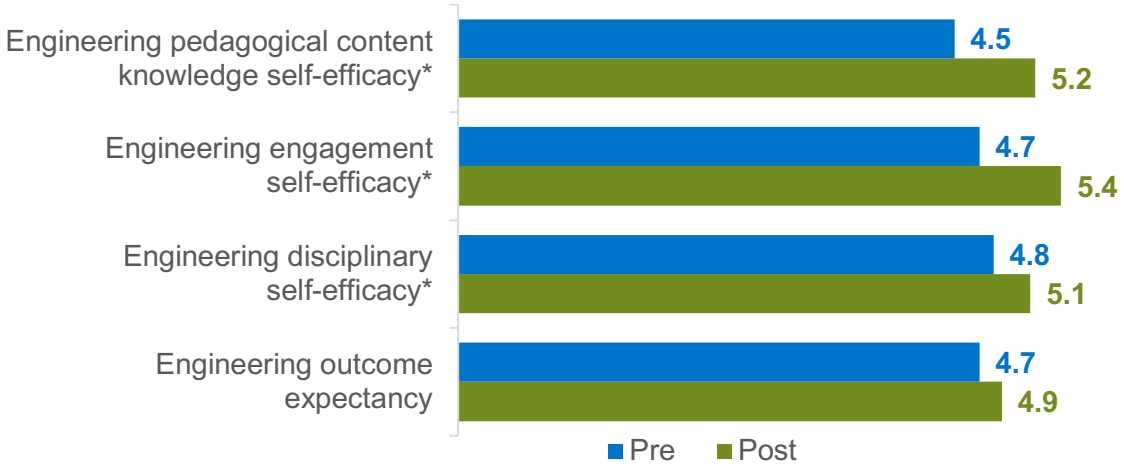
** The difference from Pre to Post was statistically significant (p<.05)*

The TES survey is composed of four unique factors associated with self-efficacy in engineering.

- **Engineering pedagogical content knowledge self-efficacy** – Teachers' personal belief in their ability to teach engineering to facilitate student learning, based on knowledge of engineering that will be useful in a teaching context.
- **Engagement self-efficacy** – Teachers' personal belief in their ability to engage students while teaching engineering.
- **Disciplinary self-efficacy** – Teachers' personal belief in their ability to cope with a wide range of student behaviors during engineering activities.
- **Outcome expectancy** – Teachers' personal belief in the effect of teaching on student learning of engineering.

Figure 2 demonstrates that educators increased their self-efficacy across all four self-efficacy factors and in three of the factors this increase was statistically significant, meaning this difference was likely not due to chance. After participating in the pilot, educators held a stronger belief in their ability to facilitate student learning, engage students, and manage student behaviors within the context of teaching engineering. The one factor that was not statistically significant was outcome expectancy which measures the degree to which educators believe their teaching of engineering affects student learning outcomes.

Figure 2: Pre and Post Teaching Engineering Self-Efficacy Factors (n=24) (Average on a 6-point scale where 1=Strongly Disagree and 6=Strongly Agree)



** The difference from Pre to Post was statistically significant (p<.05)*

The educators' final reflections on the program provides further evidence that the Kid Spark program increased their self-confidence in teaching STEM, particularly for educators who did not have a background in science and engineering. Some educators reported that they felt more confident in their ability to teach STEM after Kid Spark, and others reported that they felt confident teaching STEM prior to Kid Spark but now had a new resource and program to use.

> *"Before this course I would teach a concept and have student try it after. Now my STEM identity is presenting a problem and allowing students time to create, share with peers, and then allowing time to make it better. Using real world problems are key along with content and practices that are relevant. I see myself teaching this way in all subject areas."*

“I feel more comfortable than I did before I started because [before] we were doing STEM, but it wasn't exactly STEM. We had Legos and we had Lego challenges… There is more of a creative aspect than it was. That STEM element was needed.”

“I feel about the same... I wouldn't say more comfortable, but just more options because of it.”

“I have a great experience during my two-week development course, I learned a lot, it was very beneficial to me, I feel more confident now using the materials, it been joyful to see how the children can creatively use the materials by building different objects.”

“Even for me, being a teacher in the classroom, I learn a lot about STEM, and the joy to transfer what we learn into the lessons we teach; the children get to create, our creativity has opened as we are using the STEM course.”

CONCLUSION AND RECOMMENDATIONS

Kid Spark Education has developed a comprehensive STEM education resource that now incorporates a scalable professional learning component into the curriculum. Although the program was piloted with early childhood educators delivering the PreK-2 Kid Spark program, the effectiveness of the asynchronous professional learning modules and online forum would likely apply to educators delivering Kid Spark to children of all ages. The addition of the professional learning component makes it possible for new and experienced educators across a variety of learning settings to be able to confidently facilitate applied STEM with preschool-aged up through middle school-aged children. In light of Kid Spark's ongoing commitment to learning and improvement, the following recommendations could help further support educators and children.

Develop a system for following up with educational sites after the first implementation: Nearly all educators and administrators were interested in continuing to deliver Kid Spark in future years. However, educational settings, and formal schools in particular, have many competing priorities that historically impede instruction in STEM. Additionally, staff turnover is often high in schools, making it difficult to sustain programs even when they are very popular. Kid Spark could help support schools in finding dedicated time and a plan for ongoing use of the program.

Kid Spark hires dedicated staff to coordinate program delivery: The professional learning program was developed to be scalable to sites across the country, but the administrative burden on Kid Spark was very high. For Kid Spark to be able to provide the professional learning component in such a way that it builds a community of practice for educators both online and in-person at each site, they will need a dedicated staff position to coordinate that component with the sites.

Seek buy-in for Kid Spark and applied STEM education at the highest leadership level: Schools and informal learning settings that have successfully sustained Kid Spark over time had buy-in and accountability at the top, such as school and district administrators. For STEM to be prioritized in schools and informal learning environments, administrators must perceive it as a "need to have" instead of a "nice to have".

Leverage Kid Spark's strength in supporting children with disabilities and/or English language learners: Multiple administrators and educators shared that Kid Spark worked very well for students who were pre-literate or needed literacy support because the lessons were visually very strong. Kid Spark could be more intentionally marketed to schools and informal learning settings with large English language learner populations and/or students with learning disabilities.

Be explicit that the curriculum is designed to be adaptable: Because educators and learners come to a setting with such a wide range of knowledge, skills, and experience, the curriculum must be adapted to fit the context. All educators in the pilot made at least small adaptations to the curriculum, and making clear from the outset that this is encouraged may free educators up to be creative in their implementation. At the same time, administrators emphasized the need for the program, at its base level, to be "plug and play" ready.

END NOTES

[i] Yoon, S.Y., Evans, M.G., & Strobel, J. (2014). Validation of the Teaching Engineering Self-Efficacy Scale for K-12 teachers: A structural equation modeling approach. *Journal of Engineering Education (103)*3, 463-485.

[ii] Vescio, V. Ross, D. & Adams, A. 2008. A review of research on the impact of professional learning communities on teaching practice and student learning, *Teaching and Teacher Education, 24*(1), 80-91.

[iii] All quotes have been edited for readability.