Year 1 Program Evaluation:

Breaking the Code

New Knowledge Organization Ltd.

Facing Society's Grand Challenges Head On

Executive Summary

From 2015 to 2017, Girl Scouts of Greater New York and Vidcode developed and implemented Breaking the Code: a new extracurricular program combining coding skill-building and creative film-making with Girl Scout-style leadership development. Breaking the Code aims to engage middle school girls of all backgrounds in coding and filmmaking lessons, culminating in the collaborative production of video projects enhanced with coded effects. These videos promote issues important to the girls and their communities. The program is designed to help girls increase their coding and filmmaking skills, develop stronger STEM and leadership identities, and ultimately broaden girls' awareness of and access to STEM careers.

What We Did

Breaking the Code was piloted in the summer of 2016 at Girl Scouts of Greater New York's headquarters and implemented in select afterschool program sites in the 2016 – 2017 academic year. New Knowledge Organization Ltd. conducted an evaluation of the pilot program and the academic year program, which included student surveys, group interviews with students, observations of Breaking the Code sessions, and interviews with program instructors and staff. The evaluation measured outcomes in girls' leadership identities and competencies; coding skills and knowledge; STEM and coding identities; and awareness of and interest in coding applications and careers.

What We Found

Engagement – Breaking the Code successfully recruited and engaged girls at multiple sites. Over 20 girls engaged in the summer pilot, and 130 girls at 7 sites participated in the program throughout the academic year. The program served girls in areas with below-average income levels and low education attainment among adults. Program leaders established strong partnerships with several site hosts, with future engagement anticipated by leadership.

Curriculum – The evaluation showed Breaking the Code presented a strong curriculum, where leadership, filmmaking, and coding activities engaged girls in sustained group work. Instructors found the curriculum adaptable to the needs of each girl and the context of multiple afterschool settings.

Leadership – Breaking the Code strengthened girls' leadership skills, using measurements aligned with nationally recognized Girl Scouts leadership competencies (Girl Scouts of the USA, 2008). Observations and interview data showed girls recognized that coding skills were unique and hard won, and as a result they were proud when they could successfully participate in the program. This new understanding led them to gain confidence and a stronger sense of self, where they recognized the unique value of their newfound capabilities. The teamwork component of the program supported social skill development, with instructors reporting that girls at each site assumed new roles and collaborated with peers they otherwise would not have encountered. The program also supported development of advocacy skills: across all sites, girls appreciated their own ability and the power of their films to help others in their communities. They additionally honed their public speaking skills as girls from each site presented their film projects at a film festival at the close of each semester.

Coding Skills & Knowledge – Breaking the Code increased girls' capacity to use coding to achieve special effects in short films. Understanding and use of coding-specific terminology substantially improved over the course of the year, with three times as many girls correctly defining terms like *JavaScript* in a survey at the end of the program versus the beginning. We observed girls were able to comfortably discuss coding principles, such as syntax. Most girls reported in surveys and interviews that Breaking the Code offered the opportunity to creatively express their ideas in coding films. We estimate about 5-10% of girls worked at home on more advanced, unassigned coding projects, indicating a solid understanding of coding and ability to use their skills without instructors' guidance. Barriers to increasing coding knowledge and skills were lack of interest in the program and difficulty with computer skills.

Coding Careers & Applications – Both girls and instructors reported that exposure to people and workplaces that professionally apply coding were engaging and increased girls' interest in this work. Instructors in particular thought workplace visits could transform girls' ideas of an accessible, local career option. Throughout the program, survey data showed girls had a strong understanding of coding applications in artwork, software apps, and other areas.

STEM and Coding Identities – Breaking the Code increased the likelihood that girls identified as coders, but data were inconclusive about their STEM identities. Survey, observation, and group interview data suggest girls' attitudes toward coding became increasingly positive over the course of the program. While many anticipated that computer work would be a tedious extension of the school day, girls were delighted to be able to do hands-on work with coding and become skillful at challenging coding tasks.

Filmmaking – The filmmaking component of the program appeared to be a successful means to engage girls. Creating videos generally and filming in particular were definitively fun for girls and gave them a chance to play and try on new roles (e.g., director, actor, etc.). While filmmaking skills were not a target outcome area, this work supported leadership and coding outcomes. The film projects resulted in dynamic work products that girls to can present family and friends, and that Girl Scouts of Greater New York can use to gain program support.

Conclusion

In 2016 – 2017 Breaking the Code achieved the objectives of building middle school girls' coding and leadership skills through an afterschool program. The program successfully engaged teen girls in creative, challenging, and rewarding team-based project work. As a proof of concept, the evaluation of this first year of programming has demonstrated that the program can be scaled up to additional sites and potentially more regions. Program refinements may further strengthen leadership and coding activities in the curriculum, so that outcomes are more readily assessed.

Partners

Girl Scouts of Greater New York

Since 1912, Girl Scouting has offered girls and young women the opportunity to develop positive values and to contribute to society as responsible citizens, thinkers, and leaders. The organization is guided by a powerful mission to build girls of courage, confidence, and character who make the world a better place.

The Girl Scouts of Greater New York (GSGNY) Council, one of 112 local councils located throughout the 50 states that constitute the Girl Scouts of the U.S.A., offers the Girl Scout program to all girls in the five boroughs of New York City, serving girls in virtually every ZIP code, with approximately 70% of the girls served in grades K-5 and 30% in grades 6-12. The council benefits from one of the nation's most racially diverse constituencies—34% Caucasian; 27% African American; 35% Multi-Ethnic/Other/Not Reported; and 3% Asian American. In addition, 28% of GSGNY Girl Scouts reported their ethnicity as Latina or Hispanic. Seventy percent of the girls served are from low-to-moderate-income families as determined by the New York City Self-Sufficiency Standard, and 20% live below the Supplemental Poverty Line.

Based on research on the evolving needs of today's girls, GSGNY programming is focused on four key areas: STEM (Science, Technology, Engineering & Math), Business and Entrepreneurship, Environmental Leadership, and Personal Identity Leadership. Girls participate primarily in two ways: in troops led by trained volunteer leaders and through research-driven programming delivered by Council staff. Staff-led programs are a crucial way GSGNY expands access to Girl Scouting in communities where parents cannot always afford the time commitment of being a troop leader.

Vidcode

Vidcode is an award-winning platform and curriculum that teaches computer programming through creative expression. Vidcode enables students to create video filters, simulations, augmented reality, and other creative projects, while learning the fundamentals of *JavaScript*, one of the nation's in-demand programming skills. Vidcode is driven by a mission to provide an engaging and accessible way for all students to learn to code. Founded by an all-female team, the company was built with girls in mind and pays special attention to increasing participation from young women and underrepresented minorities.

Vidcode was founded in 2014 by Alexandra Diracles and Melissa Halfon as a thesis project for NYU's Interactive Telecommunications graduate program. The Vidcode curriculum has been implemented in dozens of schools across New York City through both in-school and afterschool capacities and has reached over 5,000 students within the five boroughs. Vidcode is partnered with CS4All, a city-wide initiative built to provide computer science education to all students by 2025, and has facilitated professional development training for 60 teachers.

NewKnowledge

New Knowledge Organization Ltd. (NewKnowledge) is a nonprofit think tank founded in 2012 to empower change-makers with interdisciplinary social science research so they can create a society where all people live to their greatest potential. NewKnowledge served as the Breaking the Code evaluators for the summer pilot and the first year.

STEM learning is one of several areas of focus for NewKnowledge. In particular, NewKnowledge pursues a deeper understanding of STEM learning in informal settings, like cultural institutions, afterschool programs, and social groups. Their research suggests that these experiences especially for youth and teens, as they often prove to be pathways to transformative, lifelong learning in STEM fields. In addition to Breaking the Code, NewKnowledge studies online video games that help youth who do not identify as science people to explore principles of physics, animal science, and engineering. They also work with an international safety company supporting innovative informal programs for STEM learning through environmental thinking. With PBS NewsHour, NewKnowledge studies how teens can learn and communicate STEM topics through journalistic storytelling.

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Introduction

In 2015 and 2016, Girl Scouts of Greater New York (GSGNY) and Vidcode developed Breaking the Code, a new extracurricular program combining coding skill-building and creative film-making with Girl Scout-style leadership development. Breaking the Code aims to engage middle school girls of all backgrounds in coding and filmmaking lessons, culminating in the collaborative production of video projects enhanced with coded effects. These videos promote issues important to the girls and their communities. The program is designed to help girls increase their coding and filmmaking skills, develop stronger STEM and leadership identities, and ultimately broaden girls' awareness of and access to STEM careers.

In summer 2016, GSGNY hosted a one-week pilot at their office in Manhattan to test the curriculum and implementation process with Girl Scouts from across the city. In the 2016 – 2017 academic year, Breaking the Code launched at seven afterschool programs in the Bronx, Brooklyn, and Manhattan.

In its first year, Breaking the Code reached over 150 girls in the one-week summer pilot and in seven afterschool sites during the academic year. The sites were: Bronx Academy of Letters, The Essence School/I.S. 311, Cypress Hills Community School/P.S.89, Highland Park Community School/I.S. 171, Johnson Cornerstone Community Center, Liberty Avenue Middle School, and the Newport School. All sites participated in two semesters, with the exception of the Bronx Academy of Letters (spring semester only) and the Newport School (fall semester only).

All students lived in ZIP codes with below average income levels, where 28% - 40% of the population lives in poverty. These communities also had low education attainment among adults (NYU Furman Center, 2016), suggesting that Breaking the Code could present students with a unique STEM programming opportunity. During the academic year, Breaking the Code served 130 girls, with 115 students enrolled as new Girl Scouts through the program and 87 considered active members in the program: girls who regularly attended sessions and completed at least one video

project. Over the course of the year, girls completed 35 video projects.

Breaking the Code consists of a 20-week curriculum designed to be taught in afterschool programs over the course of two semesters, in either one two-hour or two one-hour sessions per week. Each semester, girls work in teams to produce a short video project: during the first semester, they produce a personal identity story, and in the second semester, they create a public service announcement (PSA). Lessons each week feature elements from the three program foci: leadership, filmmaking, and coding. In addition to weekly lesson plans, the curriculum includes one visit to a STEM workplace that uses coding and one meeting with a STEM mentor per semester to increase girls' exposure to career options. Each semester culminates in a film festival where girls present their projects to other students, their parents, and representatives from their schools and communities.

Figure 1. Breaking the Code Girl Scout patch earned by all girls who complete the program.

Evaluation of Breaking the Code

From March 2016 to July 2017, NewKnowledge Organization Ltd. (NewKnowledge) partnered with GSGNY and Vidcode to conceptualize Breaking the Code and evaluate program outcomes. NewKnowledge's approach to the program evaluation emphasized a continuous, iterative learning and feedback process among the project team and program participants. We used a mixed methods approach, combining survey, observation, interview, and focus group activities. Across several methods, we employed pre/post comparisons to measure change over time in relation to the program.

We conducted all evaluation activities under the auspices of Solutions IRB (IRB00008523, IRB Type: OHRP/FDA), in accordance with federal legislation for protection of human subjects in research and NewKnowledge's Federal Wide Assurance certification.

Reporting

In January 2017, we produced an interim report to present evaluation results from the pilot program in summer 2016 and preliminary results from the first semester of Breaking the Code implementation at six afterschool programs (NewKnowledge Publication #NPO.144.301.02). The interim report also provided observations on implementation to help inform program design shifts in the spring semester, and a formative evaluation strategy to track the development of this new program and be responsive to the needs of program participants and leaders.

This report focuses on the results of the evaluation of the first academic year of the Breaking the Code program, ending with the second semester of programming in spring 2017. Here we discuss the activities and outcomes identified in the program diagram (Figure 2) – coding skills and knowledge, STEM identities, leadership competencies, awareness of STEM careers related to coding, and filmmaking skills –
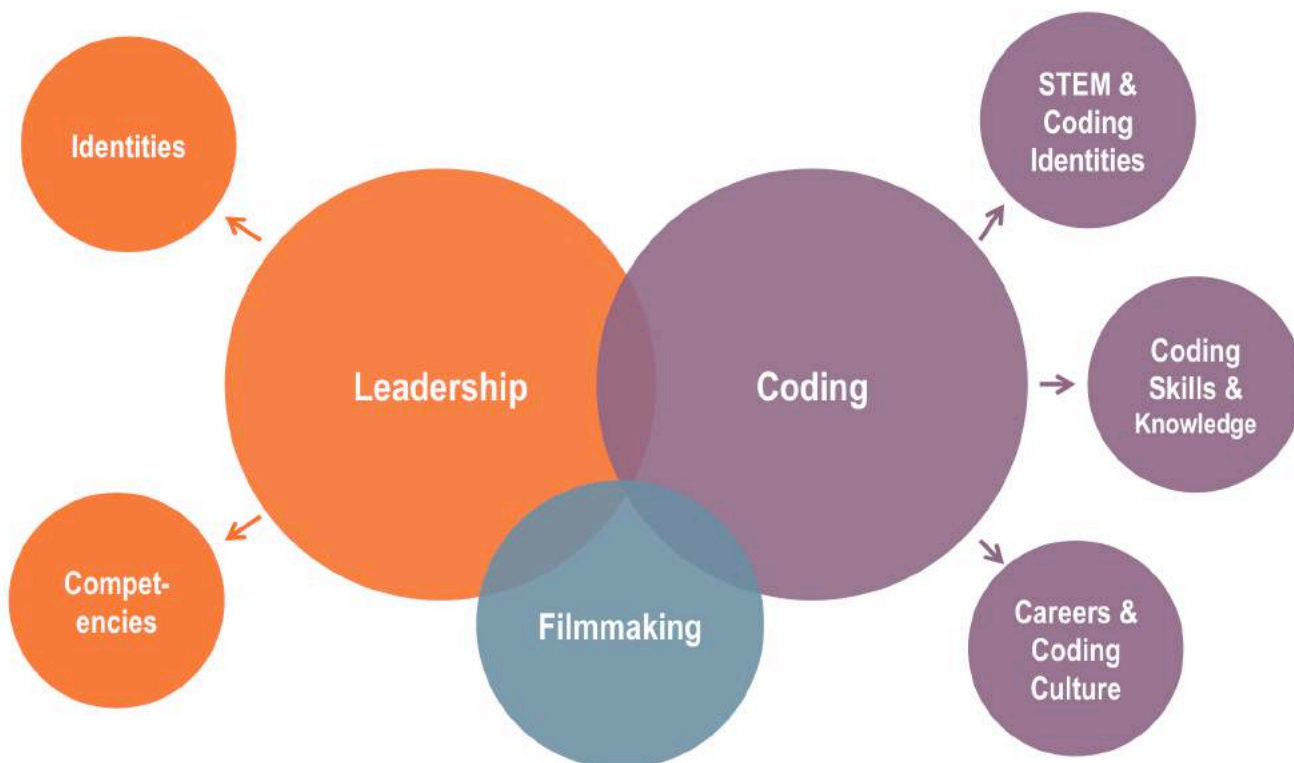

Figure 2. Primary activities (in large circles) and target outcomes (in small circles) for Breaking the Code.

comparing pre/post-program data where possible. We focus the discussion of the results mostly on the second semester's data, as this information demonstrates outcomes when the program was most mature. Appendix A summarizes the results of the pilot program evaluation. Appendix B, we explain programmatic and evaluation shifts that occurred over the course of Breaking the Code in Year 1. Additional appendices (C, D, E, and F) provide the evaluation instruments in another document.

LOGIC MODEL & DEFINING OUTCOMES

The evaluation focused on measuring program outcomes, compared with intended outcomes. This work aimed to help the leadership team understand the value of the program. Here, we define the desired outcomes, as articulated by the leadership team.

Leadership Identities & Competencies

Where possible, leadership identities and competencies are defined based on *Transforming Leadership: Focusing on Outcomes of the New Girl Scout Leadership Experience* (Girl Scouts of the USA, 2008). Breaking the Code addressed many, but not all of the leadership competencies identified in that resource. There are two additional competencies – project management and reflection – that were incorporated on account of the unique focus of the Breaking the Code curriculum.

Sense of self – Increased confidence in themselves and their abilities; increasingly feeling they are able to achieve their goals; and confidence in forming positive gender, social, and cultural identities.

Advocacy – Development of the ability to speak out on their own behalf and seek opportunities to act and speak on behalf of others.

Critical thinking – Increased ability to examine ideas from a variety of viewpoints and further use critical thinking to explore implications of gender issues for their lives and their leadership development.

Problem solving – Increasingly use knowledge and skills to set up and implement creative and effective "action plans"; locate tools and resources they need; and know when, where, and how to enlist help from others.

Teamwork and conflict resolution – Increasingly recognize the value of working together and learn to make decisions that benefit the whole group. Increasingly build effective teams, learn to be accountable for shared goals, and show recognition for others' accomplishments and contributions. Increasingly recognize and analyze different conflict situations and develop skills for constructive conflict resolution and prevention.

Project management – Increased ability to manage aspects of personal and group work, including allocating work and project roles, completing tasks, and working within deadlines. This competency was not identified in *Transforming Leadership*.

Public speaking and presentation skills – Increases in effective explanation of ideas to others and motivating others to get involved in community service and action.

Reflection – Increases in the ability to consider aspects of the program, including the work girls have undertaken, goals for the future, and the value of Breaking the Code efforts. This competency was not identified in *Transforming Leadership*.

Coding Knowledge & Skills

Increased understanding of coding principles and systems, and develop the ability to work with those principles and systems.

STEM & Coding Identities

Interest in and positive attitudes towards coding – Increased interest in and positive attitudes toward coding activities, such that girls enjoy and desire to do coding.

Coding self-efficacy – Increased confidence in girls' ability to achieve intended results in coding activities (Ormrod, 2006; Bandura, 1977).

STEM Identity – Increase in the degree to which girls identify as STEM (science, technology, engineering, and/or math) people.

Careers & Coding Culture

Increased awareness of STEM and coding careers. Increased understanding of coding careers and other professional applications of coding.

Awareness of applications for coding – Increased understanding of how coding can be used in real world activities or projects, such as special effects in videos, video games, art work, etc.

Other Outcomes

In addition to the primary outcomes described above, Breaking the Code worked toward several secondary outcomes. While these were not the focus of the evaluation, we include them here to explain the breadth of the program's outcomes.

Filmmaking Skills – Increased learning and practicing of filmmaking skills, including storyboarding, recording, and editing.

Staff Capacity – Increased capacity for program staff to deliver an effective curriculum-based coding and leadership program. Capacity building includes developing partnerships with host sites, training and supporting instructors, and reinforcing outcomes with girls.

Evaluation Methods & Analysis

The evaluation of Breaking the Code spanned the academic year from October 2016 to June 2017. In this chapter, we describe in detail the methods we used to evaluate the program outcomes, the analytical approach, and the girls who participated in the evaluation.

METHODS

We used a mixed-method approach for the evaluation of the year-long implementation of Breaking the Code. With the pre- and post-program survey and observation design from the pilot program serving as a foundation, we expanded the study to include one-on-one interviews with instructors and interviews with groups of students. Given that the program was in its first year and a full evaluation had not yet been completed, we designed some overlap into the evaluation activities. For example, both the surveys and group interviews explored leadership and coding career interests. This redundancy allowed us to assess the best method to measure program outcomes. Here we describe each evaluation activity and how each one measured outcomes. Instruments can be found in Appendices C, D, E, and F in a separate document (NewKnowledge Publication #NPO.144.301.03-A).

Surveys

Instrument and Data Collection

Similar to the pilot program phase, girls participating in the full program completed a NewKnowledge survey at the beginning of Breaking the Code. They completed the same survey at the end of the program, allowing us to make comparisons between pre- and post-conditions.

The NewKnowledge survey measured several target outcomes identified in the Breaking the Code logic model: 1) leadership identities and competencies, 2) STEM identities and coding experience, and 3) coding applications and careers. Most questions were close-ended and assessed on a 5-point Likert scale from *Strongly Disagree* to *Strongly Agree*. There were, however, several open-ended questions

targeting coding knowledge and applications and general feedback about the program.

Leadership identity questions targeted the development of a number of leadership competencies: sense of self, advocacy, problem solving as it relates to coding, teamwork, and public speaking. Critical thinking, project management, and reflection were not measured by the survey in order to keep the survey at a reasonable length.

Questions about STEM identities focused on coding self-efficacy, awareness of applications for coding, and interest in and positive attitudes towards coding. A set of questions explored girls' knowledge of coding by asking them to explain vocabulary like *JavaScript*. We also asked girls about parts of the program they enjoyed, did not enjoy, and found challenging. We included two demographic questions: grade and race or ethnicity.

Instructors administered the survey to the girls during the first or second week of Breaking the Code, and again in the second to last or last week of the program in the spring. A total of 49 girls with parental consent took the pre-program survey and 31 took the post-survey. However, student attrition meant that there were 23 girls with parent consent who took both surveys.

Several factors contributed to the survey's low response rate. First and foremost, obtaining parental consent proved challenging because students forgot to ask their parents or take home the forms. Second, some girls did not attend the first few sessions of Breaking the Code when the survey was first administered. Finally, as mentioned above, the high attrition rates at some schools resulted in a lack of post-program data for many students. We anticipate that incorporating the evaluation consent form into the same packet as the rest of the Breaking the Code parental forms will increase study participation in the future.

We used the psych package (version 1.5.1; Revelle, 2014) in RStudio version 0.99.892 to calculate scale reliability (Cronbach's alpha) for each set of questions relating to an outcome, separating responses to the pre- and post-program surveys. Scale reliability is a measure of the degree to which a set of survey items measure the same construct, in this case, a target outcome, such as leadership competencies. We judged a scale to be reliable if the standardized Cronbach's alpha was greater than .70 (Nunnally & Bernstein, 1994). Almost all scales were reliable in both pre- and post-program conditions, and we calculated the mean value across all questions in the scale to generate a single aggregate measure for each girl on each of the two surveys. There was one exception: the five items on the pre-program coding identity scale were not reliable. We removed this scale from the analysis and only reported responses to the item, *I think of myself as a coder*.

We used paired t-tests to analyze the changes between the pre- and post-program responses for the subset of 23 girls who completed both surveys. We found no significant differences between responses to the pre- and post-surveys, likely because of the small sample size. As such, these results remain inconclusive. However, we present the total number of respondents and mean values or frequencies for responses to the questions to illustrate the data collected. As mentioned above, we aim to implement a survey strategy in Year 2 that will increase the sample size and allow a more robust analysis of change in the target outcomes. Despite the limitations of the survey data, other evaluation methods targeted similar outcomes and provide further insight into patterns of change.

The survey included several open-ended questions about coding knowledge and applications and general program feedback. We reviewed the responses from all girls with parental consent (pre-program survey *N* = 49; post-program survey *N* = 31) to identify themes.

Participants

The 23 girls who participated in both pre- and post-program surveys represented all six sites (Figure 3) and included 14 sixth graders, 5 seventh graders, and 1 eighth grader (two

students did not specify grade level). Of the 21 girls who indicated their race or ethnicity, 11 identified as Hispanic or Latina, 5 as Black or African American, one as White, and 4 selected multiple categories.
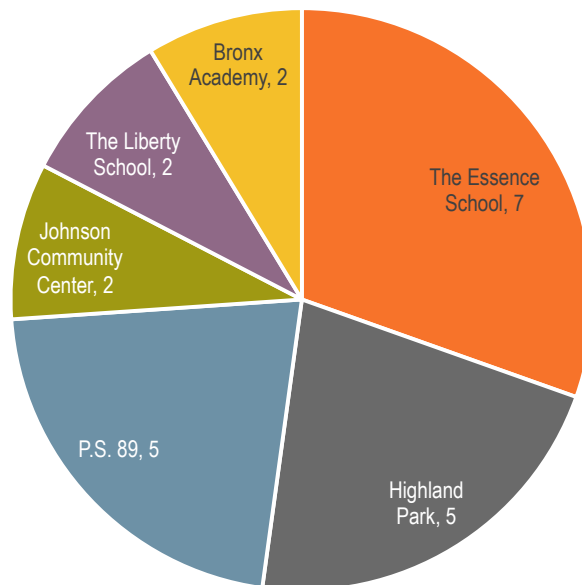
Figure 3. Distribution of survey respondents across sites.

Note. Includes only those girls with parent consent who responded to both the pre- and post-program surveys.

Observations

NewKnowledge researchers conducted observations at four of the seven sites at the beginning of the fall semester and again at the end of the spring semester. Sites were selected in collaboration with GSGNY and represented a variety of instructors, class sizes, and type of technology available. The researcher recorded features of the sessions observed, focusing on understanding the development of leadership and coding skills and documenting opportunities for authentic inquiry and reflection. Overall, we observed 55 students in the fall and 34 in the spring.

We also observed the Breaking the Code film festival in the spring, where girls from 5 sites presented their PSA films in front of an audience of about approximately 75 people, including students from other program sites, parents, and program staff.

Group Interviews

At the end of each semester, NewKnowledge researchers visited four of the seven sites to conduct group interviews with girls enrolled in Breaking the Code. We designed questions to address specific program outcomes to understand girls' experience of the program, particularly filmmaking skills, STEM identities, leadership competencies, and interest in coding careers and cultures. Discussion about filmmaking covered the storyboarding, filming, and editing process. Questions about STEM identities focused specifically on interest in and attitudes toward coding. Leadership outcomes covered in these interviews were: sense of self, advocacy, problem solving as it relates to working in a team, teamwork, critical thinking, project management, and reflection. Questions about coding careers and culture explored girls' site visits to coding companies.

In the fall, we planned the group discussions to take place during the 20 minutes after class with the entire group of girls at each site. We found that larger groups of more than 6-8 girls had difficulty sustaining conversation and encouraging quiet students to participate. Additionally, girls were working in small groups on different projects and it was difficult for them to generalize about their learning and experiences. In the spring, we adapted our strategy and conducted smaller and shorter group interviews of 2-4 girls during the session, which helped to increase participation. This approach enabled more detailed discussions about their specific projects, their approaches to filming, and the coding skills they were learning.

We conducted group discussions with 20 students in the fall, and with 21 in the spring.

Instructor Interviews

At the end of each semester, NewKnowledge invited instructors to participate in phone interviews to explore their perspectives on how the curriculum was working, girls' progress towards target outcomes, and suggestions for improving the program. Questions were designed to broadly address coding skills and knowledge, STEM identities, filmmaking skills, leadership competencies, coding careers and culture, rather than specific aspects of these target outcomes. This approach helped us obtain more nuanced and unconstrained reflections from the instructors.

Participation in the interviews was not required and everyone who participated received a gift card as a thank you. All four instructors participated in the interviews in the fall, and two of the three instructors participated in the spring.

Video Review & Coding Quizzes

Across the seven sites, students produced and coded 19 personal identity videos in the fall and 16 PSA videos in the spring. We reviewed the PSA films to capture the community issue topics and types of code students used.

Instructors also administered a coding assessment designed by Vidcode at the beginning of the fall semester, in January, and in the spring. The assessment included multiple-choice questions to measure girls' understanding of critical concepts covered in coding lessons, such as variables, loops, and conditional statements. We provide an overview of these results.

Results

The Results section describes findings from the evaluation of Breaking the Code during the 2016 – 2017 school year. The evaluation focused on measuring progress toward the intended outcomes identified in the program logic model: leadership competencies, STEM identity, coding knowledge and skills, and coding career knowledge and interest.

LEADERSHIP DEVELOPMENT

The Breaking the Code curriculum placed strong emphasis on advancing girls' leadership identities, a central Girl Scout competency. Our evaluation indicated gains in several leadership areas:

- Sense of self, including self confidence;
- Teamwork and conflict resolution;
- Advocacy;
- Public speaking;
- Critical thinking; and
- Reflection.

Additionally, two aspects of leadership competencies emerged as uniquely related to the filmmaking process:

- Project management; and
- Problem solving.

Students built a strong **sense of self** over the course of the program, where they became more aware of their strengths and other capabilities, particularly in relation to others. Some girls were able to articulate general aptitudes, seemingly based on differences they observe between themselves and their peers. During group interviews, one girl remarked, *I feel more confident as a result of this program because most people can't do this work and I can*. Another added, *I feel like I'm improving because I'm helping others out and working together.* For a few girls, growth in their sense of self related specifically to coding. *What I learned about myself was, I thought I was going to be really bad at coding. I didn't think I was going to learn it fast. But I like it a lot. I guess I'm learning it really quick.* These comments illustrate how the program developed girls' sense of self.

Many girls gained **confidence in their abilities**, another aspect of a strong sense of self. They became more confident with working with other students and taking on leadership roles in their group projects. One instructor commented, *I watched super quiet girls come out of their shells. For example, two girls at one site were really, really shy ... At the beginning, they didn't even want to be in their own films, but by the end they were volunteering to be in everyone's films*. Similarly, we observed one girl who did not want to appear in the film as an actor. Instead, she assumed the role of film director. She confidently and respectfully gave instructions and suggestions and in return, her teammates listened to her input.

The Breaking the Code curriculum featured team-based project work, where multiple students collaborated on the personal identity or PSA videos over the course of the semester. As a result, **teamwork and conflict resolution** became an area of focus for both instructors and girls. Instructors organized students into teams of two to four, deliberately combining outgoing and shy girls, as well as girls who had not previously known each other. On reflecting at the end of each semester, instructors felt that the team-based structure of the project work helped girls get to know each other and become more respectful of each other. In group interviews, girls described how they divided the work among team members so they could accomplish more of the goals set for each class period. Some even noted that collaboration was their favorite part of the program, one writing, *My favorite part of Breaking the Code is meeting new people and working with them.* Another appreciated the opportunity to be *closer to other girls.* For many girls, the program provided a meaningful opportunity for collaboration with peers, which instructors recognized as well.

A number of girls at some sites were more ambivalent about the conflict resolution aspects of the program. Many girls said they never disagreed when planning their projects, so resolving disagreements appeared to be a non-issue for them. Meanwhile, group interviews showed that at least at

one site, girls felt unsure about their ability to resolve conflict when working in teams. For instance, several girls said they simply gave in when there was a disagreement, rather than finding a compromise. We observed that this difficulty with conflict resolution occurred at a site that also experienced behavioral disruptions during the first semester, so it may be unlikely that curricular changes would affect conflict resolution outcomes. However, while a minority of girls in the program seemed to experience negative feelings about conflict resolution and others did not seem to think much about conflict, girls' comments suggest there be may an opportunity to incorporate additional activities about resolving team issues in ways that girls can be proud of. In conclusion, teamwork was a strong aspect of the program, and there may be opportunities to enhance conflict resolution aspects of the program, particularly when girls are getting to know each other early in the first semester.

Advocacy was an important aspect of the curriculum design and an area of students' development during the program. Girls developed film projects on a wide range of issues that affect them personally and also influence their communities (Table 1). In the fall semester, girls created Personal Identity videos that explored issues related to perceptions of people on the basis of gender, race, and culture. In the spring, girls created Public Service Announcement (PSA) videos, which addressed issues related to the wellbeing of girls and their communities.

Table 1. Topics addressed by girls' video projects.

Personal Identity Videos	
Gender Roles & Stereotypes (6)	Girl Friendships (3)
Gender Expression (3)	Self-confidence (3)
Judging Others (3)	Bullying (2)
PSA Videos	
Community Centers	Immigrant Rights (2)
Littering	Global Warming
Bullying	Gendered Street Harassment
Black Lives Matter	Homelessness
Gun Control	Smoking (3)
Healthy Eating	School Rules on Cellphones

Group interviews with girls showed they had become deeply interested in both the personal identity and PSA topics. In the fall, girls spoke about the value of their personal identity videos for other people. Nearly all girls asserted that their projects could teach others about identity and assumptions based on race, nationality, and gender. Girls mentioned younger students and people who are misled by erroneous political rhetoric as ideal audiences for their videos. For example, one girl explained the videos would benefit *girls who don't think they have a voice...If they think they're too weak to stand up for themselves, maybe these videos will inspire them to... go step by step and stand up for themselves to whoever is keeping them down. They should still try no matter what anyone else says*. However, observations and group interviews showed that some girls did not yet see themselves as role models or advocates because they did not think others would listen to them.

In the spring, girls' confidence appeared to rise with the production of the PSAs. Many of the PSA stories were inspired by personal experiences (e.g., immigration, gendered street harassment), while other topics were not perceived as personal (e.g., climate change, gun control). Regardless of how closely they personally related to the issue, all girls could articulate the videos' importance for their community. During a group discussion, one girl asserted, *[Gun control] is not personally important to me, but I want to help the people out there that use a lot of guns and get hurt a lot.* Many girls had goals for what they wanted their audiences to learn from the videos. We observed girls enthusiastically explaining their PSA topics during group interviews and site visits. In one case, we observed two girls describe their video and its goals to a representative of a municipal leader. These observations, combined with girls' increase in confidence and sense of self, demonstrate how Breaking the Code strengthened girls' advocacy on their own behalf and for others.

We also observed positive changes in the **public speaking and presentation** aspects of Breaking the Code. The summer pilot program demonstrated that many girls had difficult speaking in front of others, especially unfamiliar adults. As such, program leaders adapted the curriculum to feature more emphasis on presenting skills. In the fall, we observed girls planning as a team and using a template to

develop their presentations, then practicing their talks in front of the class. At the film festival in the spring, we watched twelve teams from six sites present their work by introducing themselves, their topic, and the code they used. While some spoke quietly and appeared to be nervous, we observed the majority were able to effectively speak in front of the large audience, using a microphone to project their voices and displaying confident body language. These observations provide evidence for Breaking the Code's contribution to girls' presentation skills.

Breaking the Code's supported girls' use of **critical thinking** by considering a variety of feedback from different sources, particularly instructors, visitors, and mentors. Girls asked for and received regular feedback from their instructors, and we observed some take the opportunity to discuss ideas for their projects with visitors to the sessions. Meanwhile, girls also met with a mentor via Skype at least once per semester to discuss their projects and ideas for improving the videos. Overall, girls appeared to enjoy discussing the code, content, and filmmaking aspects of their projects. At one site, we observed a team of girls explain their video about guns to a representative of a municipal leader. He asked if the film was about gun control or gun safety, and one girl responded that they are the same thing. The representative then had a conversation about the difference between the two concepts. Without the representative telling them the answer, the girls reflected on the difference and edited the code to display *gun control* instead of *gun safety* in the video. Observations showed that the use of feedback as an integral part of the curriculum strengthened most girls' ability to think critically, particularly considering their projects from different angles and perspectives.

Finally, **reflection** was a regular component of the program, as both the curriculum and evaluation activities encouraged girls to consider a variety of program aspects, including their goals and how their skills could be used in the future. Nearly everyone who had parental consent participated in the group interviews and surveys. Many girls thoughtfully shared stories of their experiences and their ideas about the program, and some were forthcoming about critique. A small number of girls, particularly at the site with behavioral problems, appeared to struggle with reflection in a group discussion

setting. Across all sites, we observed many girls had difficulty sustaining engagement with the full survey. Overall, the program and the evaluation appeared to support most girls' reflection, particularly in a discussion format. We further address the reflection formats that were adapted in Appendix B.

LEADERSHIP DEVELOPMENT THROUGH FILMMAKING

While coding and leadership skills were the focal points of the curriculum, filmmaking was a third component that figured prominently in Breaking the Code. Filmmaking activities supported girls' production of original films, and they also appeared to overlap with other program priorities, particularly leadership.

Filmmaking was an opportunity for leadership skill development as the process entailed a number of social activities that promoted collaboration and **project management**: girls negotiated the assignment of roles and often recruited girls from other teams, planned the details of each scene, engaged in roleplaying, and responded to feedback. To be successful in these activities, girls had to work collaboratively. **Problem solving** was also an intrinsic part of building a product and learning new skills in a team-based format. As mentioned above, in interviews instructors noted that the Breaking the Code process helped girls who were otherwise unlikely to interact get to know and work with each other in a productive ways. Group interviews corroborated these results. At one site, two girls explained how they adapted their roles and work assignments when another girl was absent, so they could still meet the deadline for finishing the PSA. We also observed girls both collaboratively and independently work through coding challenges, which we explore more in the section about Coding Knowledge & Skills. These data show how the project-based filmmaking curriculum supported the development and use of project management and problem solving skills.

Finally, it seemed that filmmaking offered girls the opportunity to be creative in a different way as a form of "play." In the survey, 7 out of 29 girls reported that filmmaking was their favorite aspect of the program. When reflecting on their favorite parts of Breaking the Code in group discussions,

many girls enthusiastically described their filmmaking experiences. They recounted the process of practicing their lines, messing up, and perfecting each scene. Some girls also characterized filmmaking as the hardest part of the program, on account of the need to re-do scenes multiple times. We also point out that filmmaking was also the most physically active part of the curriculum, which may have given girls an outlet for their energy.

CODING KNOWLEDGE & SKILLS

To support Breaking the Code's focus on exploration and collaborative learning, the evaluation focused on indicators or proxies for coding knowledge and skills in the group learning format. We did not prioritize assessing individual knowledge in order to avoid creating a pass / fail testing atmosphere. The results presented below describe indicators of gains in knowledge and skills, along with an explanation of factors that seem to influence growth in this area. Finally, we include summary results from the coding quizzes built into the Vidcode platform

We found that girls who consistently attended Breaking the Code built their coding skills and knowledge over the course of the program. One indicator of coding knowledge was understanding and use of vocabulary. Girls' coding-specific vocabulary expanded as they progressed through their Breaking the Code projects and we observed them using *JavaScript* terms when discussing their effects with each other and their instructors. For example, we watched girls discuss the x and y coordinates of an emoji to perfect the location on the screen. Survey results corroborated these observations, with the number of girls who were able to correctly define a key term nearly tripling from pre to post surveys: 14% of girls (7 of 49) could correctly explain *JavaScript* in the pre-program survey, while in post-program surveys, 45% of girls (14 of 31) could correctly define the term (Figure 4). Girls also gained an understanding of key coding principles, such as syntax. We also observed one girl remind another about the syntax for a particular function, advising, *We always need to have the parentheses*. Combined, these results from observations and the survey indicate girls' knowledge of coding terms and principles increased.
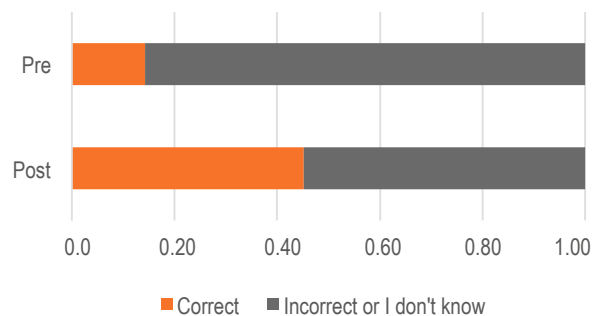

Figure 4. Proportion of girls providing correct and incorrect answers or indicating that they do not know when asked What is *JavaScript?* on the pre and post-BtC surveys.
Note. Pre N = 49, Post N = 31.

Similarly, coding quiz results in the Vidcode platform indicated marked improvement in coding knowledge. Girls took these quizzes at three points in time: program start in October, program midpoint in January, and program end in April. There were 32 cases in which girls with the same username responded to quizzes in at least two points in time, which we considered "matched" cases. There was an increase in correct scores in 25 matched cases. Meanwhile, one matched case showed no change and six matched cases showed a decrease in correct responses. Unfortunately, we were unable to discern whether any of the usernames in the matched cases represented individuals, pairs, or groups of girls. But the positive effect corroborates the results of the evaluation surveys and observations, which also showed growth in coding knowledge and skills, as described above.

An indicator of building both coding knowledge and skills was an increase in girls' ability to apply code by selecting, inputting, and adjusting code to achieve desired special effects. Across all sites, we consistently observed girls accomplishing this objective, most commonly in adding and customizing filters, emojis, and text. Most importantly, although the Vidcode platform offers the ability to drag and drop code, both instructor interviews and our observations showed that girls often wrote code from memory. For instance, teams of girls remembered the function and syntax of code for adding text and filters. In addition to their ability to recall lines of code, we also observed that girls, particularly during the spring semester, confidently used the Vidcode platform and glossary to find and select code for more

complicated functions that were difficult to memorize, such as scrolling text. Girls' ability to recall familiar code and use resources to access unfamiliar code demonstrate their coding knowledge and skills grew as a result of the program.

Girls' skills in applying code grew over the course of their participation in the program, though they appeared to reach different levels of fluency. Almost all teams had ambitious plans for customizing their projects: throughout the school year, we observed girls discussing effects they aspired to use in their videos. About half of the groups (8 of 15 in the spring semester) relied exclusively on simple *JavaScript* functions that required one or two lines of code each, such as emojis or text, or applying vignette or tint effects. A few of these groups made these functions slightly more complicated after inserting them in their projects, by changing the color of the text or the location of the emoji, modifications that required an extra line or two of code.

In contrast, 7 of the 15 groups in the spring semester used more complicated functions that required several lines of code to make the visual effect operate correctly. These groups most frequently used current.time to make text or an emoji appear at a certain point in the video or the repeat function to make a scrolling headline, operations that were covered in later Vidcode lessons. Despite some previous exposure to the function through a Vidcode lesson, observations and instructor interviews indicated that several of the groups that used advanced code relied on instructors to help them find the solution. Meanwhile, other teams independently problem solved with the advanced code and were successful. More practice with the complex functions would likely enable the girls to become more fluent. Through interviews with instructors and girls, we learned that several girls used the Vidcode platform outside of program time. These individuals were more able to incorporate complex code without or with minimal instructor support.
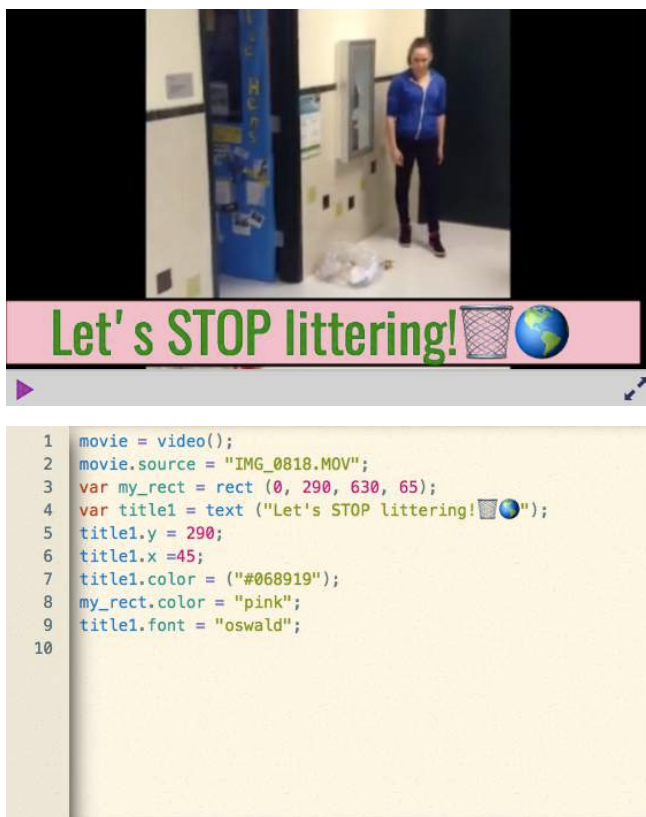

Figure 5. Screenshots of a film and code with emojis and a filter.

Figure 6. Screenshots of a film and code with timed text.

These data show that the Breaking the Code curriculum and design supports a range of coding aptitudes and interests. Most girls could independently realize their objectives for coding effects with little or no guidance from instructors. Those students who needed guidance felt comfortable working with instructors. Overall, coding skills increased across all girls and sites.

Considerations for Building Coding Knowledge & Skills

Several circumstances likely affected outcomes in coding skills and knowledge. Some of the sites had two one-hour sessions each week, whereas other sites had one two-hour block. Interviews with instructors and project leaders, as well as our own observations, showed that it was difficult to achieve the goals of each session in one hour, as the logistics of set-up and technology trouble-shooting often left very little time to work on the coding lessons. Two-hour sessions offered girls and instructors more concentrated learning time after working through tech or other common challenges.

Additionally, learning coding was often hampered by girls' level of computer literacy. We observed and instructors confirmed that many girls had poor typing skills or were unfamiliar with punctuation marks that are common in *JavaScript*, such as parentheses or semicolons. To meet this challenge, instructors built computer skills instruction into the lessons as needed.

CODING & STEM IDENTITIES

To understand how girls identified with coding specifically and STEM more broadly, we assessed their interest and attitudes toward coding, self-efficacy with coding activities, and their coding and STEM identities. In this section, we prioritize data from observations, interviews, and some survey indicators, as survey data specifically about coding and STEM identities appear skewed due to low survey participation rates and potential response bias. At the end of this section we include the survey data to describe the issues and contribute to a discussion about how evaluation strategies and instruments might be improved in the future.

Survey results showed that coding was an important and positive part of the program for participants. Unprompted, open-ended responses indicated that coding was one of the highlights of the Breaking the Code curriculum, with 17 of 29 girls indicating that it was their favorite part of the program in the post-program survey. Some girls highlighted specific functions that they liked using, one writing, *I liked learning coding and using the filters we learned* and another writing, *Using coding to add special effects and words and color*. Others appreciated the opportunity to express themselves that coding offered, one writing, *I can show what I can do with coding and show my creative side*. These results showed that, for just over half of the survey responders, the program strengthened girls' interest and positive attitudes toward coding.

Breaking the Code appeared to increase girls' coding self-efficacy, where they felt confident they could achieve their objectives in coding activities. In the fall semester group interviews, some girls shared that they were pleasantly surprised that the program enabled them to do coding themselves – they seemed to have expected they would only listen to lectures and demonstrations. Observations showed many girls were happy with their newfound coding abilities and enjoyed fluently navigating the Vidcode platform. In a group interview, one girl remarked, *I like playing around and thinking about what I can change to make the video better*. Moreover on the post-program survey, 19 out of 23 girls agreed or strongly agreed with the statement *I am sure that I can do well on activities that involve coding*. These results indicate that girls became more likely to consider themselves "coding people" after participating in Breaking the Code.

Overall, paired t-tests assessing significant changes over time indicated that girls did not self-report a significantly different level of coding and STEM identities after participating in Breaking the Code. We suspect this lack of significance may be related to the small sample size – and possibly other factors, as explained below – rather than diagnostic of program outcomes.

Strength of coding identity was similar in the pre- and post-test. Despite many of the girls having little or no experience with coding when starting the program, on the pre-test,15 of the 23 girls indicated that they agreed or strongly agreed that

they were coders. Similarly, on the post-test, 16 girls agreed or strongly agreed that they were coders. There are several possible explanations for the similar values on the pre- and post-tests. Girls taking the pre-test may not have had a strong idea of what coding was and therefore overestimated their coding identity. It is also possible that social desirability bias skewed girls' pre-test responses to be more favorable, perhaps because they anticipated that being a coder was a prerequisite for the program. Participating in Breaking the Code likely affected their perceptions of what coding entails, and the observations combined with post-program data may be a more accurate reflection of their coding identity.

For STEM identity, on the pre-program test, 13 girls reported that they either agreed or strongly agreed that they thought of themselves as STEM people. Results were similar on the post-test, with 11 girls selecting agree or strongly agree. Although the number decreased between the pre- and post-test, the decrease was not statistically significant. Given that STEM involves more disciplines than programming or coding, participation in Breaking the Code alone may have been unlikely to change girls' overall STEM identity.

Although the survey data are inconclusive, observation and interview results show that the program positively contributes to girls' coding identity. We are less certain about the relationship between Breaking the Code and STEM identity. In the future, we aim to increase response rates to the survey, as explained in the chapter about the evaluation methods. We may also explore designing retrospective pre- / post-program questions to help girls answer more accurately at the end of the program.

CODING CAREERS & CULTURE

In the survey, we included an open-ended question asking girls to report how knowing how to code might be useful. Responses on both the pre- and post- surveys varied in specificity and accuracy. Many focused on particular coding applications, such as making or understanding websites or building games or apps. For example, one girl responding to the pre-program survey wrote, *if I get bored at using a filter on Snapchat, I can just make my own*. Other girls spoke to functional advantages of knowing how to code, such as the competitive advantage of mastering an unusual skill,

improving their job options, or making the world a better place. Some also alluded to the abstract or conceptual value of coding. One girl wrote, *knowing how to code can be useful because most of the world is run by technology and by knowing how to do this we can help the world have better technology and help people be safer*.

Additionally, responses to close-ended questions about the skills needed to excel at coding (coding competencies) and the uses for coding (coding applications) further suggested that girls starting the program already had an appreciation for the real-world use of coding skills (Figure 7). Paired t-tests indicated that the change in coding competencies and coding applications was not statistically significant. The range and depth of responses on both the pre- and post-program measures indicated that girls may have come to the program with a general understanding of coding applications, they may have been drawn to the program to explore these applications, and they likely deepened their understanding of ways to functionally and conceptually apply coding skills.
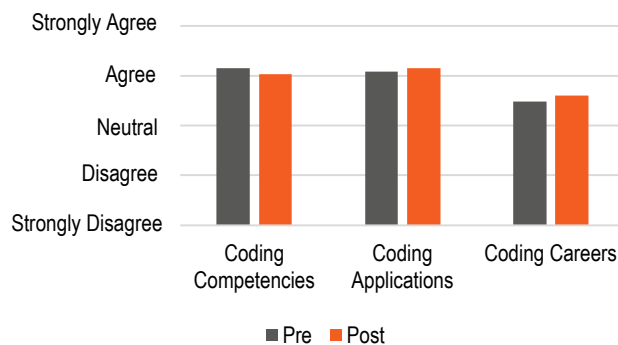

Figure 7. Girls' agreement with statements about coding competencies, coding applications, and interest in coding careers before and after participating in the program.

Note. *N* = 23. Bars represent the mean values for scale items.

Some evaluation results showed strong indicators of growth in coding career interest and awareness, while other data were inconclusive. Discussions with girls at the end of Breaking the Code suggested that they had a better appreciation for what a coding-related career might entail. For example, several girls at one site vividly described what they learned during their workplace visit, where they met women who worked in technology fields. The instructors similarly felt that the workplace visits were transformative and girls benefited from exposure to professional coders. In the spring, one remarked, *Site visits really opened their minds to what they can do in the future – gave them some power. The girls were surprised that things they were doing in the classroom were happening at companies right in New York City!* In spite of this apparent growth in career awareness and interest, survey data showed interest in coding careers increased very slightly between the pre- and the post-program surveys, but the difference was not statistically significant. While there was inconsistency between interview and survey data, the exposure to quality coding learning and professional applications in coding seemed to shift the needle for girls' awareness of opportunities in this field.

STAFF CAPACITY

While we did not formally measure Breaking the Code staff growth, we made several informal observations that address this outcome. A variety of staff played important roles in implementing the program in its first year. The program director, manager, and associate at GSGNY were highly involved in the life of the program. They co-designed the curriculum, recruited sites and maintained connections with site representatives, supported program implementation in the classroom, facilitated portions of the evaluation, provided technical assistance and resources to sites, trained and checked in with instructors, facilitated partnerships with STEM-focused companies and individual STEM mentors, facilitated classroom visits by potential funders, and planned film festivals.

Instructors led each session with girls and managed the classroom, prepared curriculum and technology details in advance of each session, checked in with GSGNY personnel on a regular basis, supported girls' learning in and outside of the sessions, and assisted with film festivals. Vidcode staff

co-designed the curriculum, prepared and troubleshot the coding platform, and assisted with film festivals.

NewKnowledge researchers focused on supporting and implementing the evaluation process over the course of the year. We designed and adapted instruments, helped facilitate or led data collection in the sessions, and provided written and verbal reports of the evaluation results.

On an iterative basis throughout the year, the staff made improvements to the program. Instructors made on-the-ground adjustments to their pedagogical approach to meet the needs of each site and student. GSGNY and Vidcode collected feedback about the curriculum and program design and accordingly made changes over the course of each semester. After delivering the program in its intended environment, an afterschool setting, with participants whose motivations and readiness for participating substantially varied, they made revisions to the curriculum before the beginning of the spring semester to address what they learned in the fall. Refer to Appendix B for an overview of these curriculum updates.

The leadership team's responsiveness to data and input from members of the evaluation team and the rest of the project team resulted in effective changes to the program and demonstrated the team's growth in capacity to implement the program. This culture of reflection and revision will serve Breaking the Code well as it plans expansion in the future.

Discussion

IMPRESSIONS FROM YEAR 1

The Breaking the Code Team pursued an ambitious goal of developing a new leadership and coding curriculum, pilot testing the program during the summer, and undertaking implementation in a full academic year. To capture evidence of outcomes for this new program, we conducted an exploratory evaluation of Breaking the Code. The program experienced many successes and some challenges.

Program Successes & Challenges

The most notable success was engaging middle school girls in a range of leadership and coding activities. Much of the Breaking the Code programming provided experiences that were novel and exciting for many students. The evaluation showed that some girls recognized the opportunity to develop new skills and became confident they could master these skills. They thrived in a project-based group work setting where they could try different roles and interact with new people. Conversations with mentors and workplace visits helped girls understand they could become women who use leadership and coding skills to earn a living. For these reasons, we conclude the program design was effective and met its objectives.

Breaking the Code did not interest some students, as they did not enjoy or struggled with the coding activities. As coding lessons required girls to sit at desks with computers, we believe that some saw the program as an unwelcome extension of the school day. Some girls also experienced social challenges within their groups or sites, which may have complicated their ability to thrive in the program. While a substantial proportion of girls experienced these barriers, we believe they are not entirely unique to Breaking the Code. Middle school students often struggle socially. And many students dislike what they perceive as desk or computer work.

Unexpectedly, we found many girls struggling with basic computer skills, which may have affected engagement in the program. We observed students having difficulty with the following skills: typing with two hands, saving and retrieving files, recalling the location and purpose of punctuation keys, and copying and pasting. Coding activities and parts of the evaluation (i.e., the survey) in this program relied on many of these basic computer skills. These skills, which many adults developed as part of their formal education, appear to be lacking in this student demographic. In future evaluation activities, we plan to systematically assess computer literacy so that the program may be optimized to address students with differing levels of computer literacy.

Filmmaking, while not a central outcome area, was an important aspect of engaging girls in Breaking the Code. We believe that nearly all girls, whether or not they thrived in the program, found the filming process interesting, exciting, and fun. While evaluation did not focus on filming, we believe several factors made it appealing: filming offered students the opportunity for physical activity, experimentation, and play. Storytelling in film format also supported leadership development, particularly in critical thinking and advocacy competencies. Program leaders may want to experiment further with ways to integrate leadership competency development with filmmaking activities.

POTENTIAL FOR BROAD IMPLEMENTATION

The Year 1 achievements point to strong prospects for broadening the program to more sites in Year 2 and beyond. At this point, the program is building momentum through establishing a solid curriculum, as well as generating enthusiasm for the program via word of mouth and a portfolio of student work. The recent emphasis on strengthening technology skills among youth makes Breaking the Code timely and the curriculum's flexibility suggests that it could be implemented not only in afterschool programs, but also in formal school settings. Additionally, the Girl Scouts brand appears to be a compelling factor in generating interest in Breaking the Code.

News of Breaking the Code and the girls' videos are piquing interest among community members, afterschool program

leadership, government officials, and potential funders. Conversations with parents at the end-of-year film festival indicated enthusiasm for the opportunities afforded by the program and many had questions about how their daughters could participate next year. Buzz will continue to build in these networks in Year 2 as some girls return to the program as peer mentors.

CONCLUSION

In its first year, Breaking the Code addressed the critical need for engaging STEM learning opportunities across three boroughs of New York City. The program successfully engaged middle school girls in weekly activities that explored new technical skills, technology careers, and leadership development. The extensive external evaluation demonstrated that Breaking the Code achieved program outcomes, particularly in the areas of building girls' coding skills, coding interest, and leadership competencies. We support Girl Scouts of Greater New York and Vidcode's ongoing efforts to expand the program in the coming year.

Appendix A: Pilot Program Summary & Results

GSGNY and Vidcode led a pilot program in July 2016 to test the curriculum, evaluation tools, and general program design with a group of 25 middle school Girl Scouts. The weeklong, 40-hour pilot, hosted at GSGNY's headquarters in lower Manhattan, was designed to simulate the full program planned for the academic year. The primary difference between the pilot and full-scale program was that the pilot was conducted in full-day sessions for five consecutive days, whereas the regular afterschool program was offered in one or two-hour sessions on a weekly or bi-weekly basis for 20 weeks. We present a brief summary of results to demonstrate how the program worked with a small group of girls in a consolidated format, similar to a summer camp.

Here we summarize the methods and findings from the pilot. For the full description of results, see NewKnowledge Publication #NPO.144.301.02, which was an interim report on the evaluation of the program pilot and in-progress academic year program.

METHODS

Two NewKnowledge researchers conducted observations of the pilot program on three of the five program days, during which girls completed two video projects in small groups, one on personal identity and one public service announcement. To capture meaningful outcomes that emerged from the new program design, the observation protocol consisted of open-ended categories for recording descriptions of the space, activities, social dynamics among the girls and adults, learning outcomes, and how researchers interacted with participants. Girls completed an online survey on iPads before they began program activities on the first day and near the closing activities on the final day. The pre/post design enabled us to study changes connected to program outcomes. Survey questions explored leadership identity, STEM identity, and coding applications and career interest outcomes.

Summary results are presented here with the total number of respondents and frequencies (n). We do not use statistics (e.g., means) because the small sample size makes it possible for a single respondent to skew the findings.

Participants

All girls who attended were included in observations. We used written data from the 19 of the 25 girls who completed both the pre and post-program surveys and had parental consent to participate in the evaluation. All girls who attended the pilot were ages 10 to 13 and the largest number of them identified as Black or African American (n = 8). Three girls identified as Hispanic or Latina, three as White or Caucasian, two as Native American, two selected Other with one identifying as Egyptian and the other as Irish, and four chose not to respond. They were current Girl Scouts, representing troops from several boroughs.

RESULTS

This summary of the results describes outcomes from the survey and observations, particularly targeting specific program outcomes: leadership identity, STEM identity, and coding knowledge, applications, and career interest.

Leadership Identity Outcomes

To understand girls' leadership competencies, both the survey and observations measured changes in several aspects of leadership, as defined in the Introduction: sense of self, advocacy, teamwork, public speaking, and problem solving.

Survey results and observations demonstrated the biggest effect of the pilot program was teamwork and problem solving. On the survey, girls self-reported the biggest change in teamwork skills, with 11 girls agreeing or strongly agreeing they *work well with others, even if we don't agree about everything*, as compared to 16 who agreed or strongly agreed after with this statement after the program. Observations supported this result, as we saw instances of group problem solving, where girls discussed different methods to achieve similar visual effects for their stories and collaboratively made a selection as a group. They also identified challenges and

worked through new skills together that the curriculum had not yet introduced by using trial and error and referring to the Vidcode glossary.

Other survey measures of leadership did not indicate substantial changes over the course of the program. Girls' survey responses demonstrated minor increases in measures of sense of self from before to after the program, with an increase in several girls who agreed or strongly agreed with statements like *I believe in myself and my abilities* (n = 16 pre; n = 19 post) and *I feel confident speaking up for myself* (n = 12 pre; n = 14 post). They also had a small increase in perceptions of their personal problem solving abilities (n = 12 pre; n = 15 post). Measures for advocacy and community service showed similarly small changes over time. These minimal changes may reflect the small sample size, the shortened time frame over which the pilot was implemented, or another factor we were unable to detect.

While the pilot survey results did not show strong gains in many leadership abilities, we gained additional insight into girls' expression of leadership abilities through program observations. Socially, girls appeared to gain confidence the more time they spent in the program. On the morning of the first day, there was limited conversation among most girls. Each day, girls began to talk to each other and adults more, asking questions and sharing ideas. Several older girls informally assumed the role of helper or guide for younger ones on specific tasks and group work.

Public speaking was a stumbling block for most of the girls. Survey data showed limited growth in this area, with 8 girls agreeing or strongly agreeing with *I am confident when I speak in front of others* before the program, compared to 9 who agreed or strongly agreed with the statement after the program. In spite of weak survey results in this leadership area, observations told a different story. At the beginning of the week, a few seemed to experience high levels of anxiety when asked to speak in front of the group or present their work. GSGNY facilitators noticed this reaction and adapted some activities to incorporate additional practice in public speaking and build confidence in girls' communication skills. At the closing ceremony, each girl introduced herself to the peer and parent audience before their videos were screened, reflecting increased comfort with their speaking roles.

STEM Identity Outcomes

Survey responses measured changes in girls' STEM identity by asking girls to rate their agreement with statements like *I think of myself as a science person*, *I think of myself as a technology person,* and so on. Students' sense of themselves as science, math, or general STEM people did not change noticeably over the course of the weeklong program. There was an increase in the number of girls who agreed or strongly agreed that they think of themselves as technology people before (n = 11) compared to after the program (n = 15).

Coding Knowledge, Applications, & Interest Outcomes

Most girls had no previous experience with coding at the beginning of the pilot program. We used surveys and observations to assess changes in their coding knowledge and skills, understanding of applications for coding, and interest in coding careers. In the curriculum, the focus on developing coding skills was not discussed as part of STEM identity, so we discuss these outcomes separately from the STEM identity results above. The evaluation did not focus on testing girls' knowledge, in order to avoid creating an exam-like atmosphere. Instead, we used other indicators, such as vocabulary and conversation, to understand changes in coding knowledge over time.

Using coding vocabulary as a proxy for coding knowledge, we found that girls' knowledge of coding increased during the pilot program. We asked girls to provide an explanation of programming and coding using open-ended questions on the pre- and post-program surveys. While responses on the pre-survey indicated confusion about the terms, with most girls providing vague and sometimes off-topic descriptions, responses on the post-survey were more accurate and precise. Additionally, before the program, only two girls knew the term *JavaScript*, the programming language commonly described as a core technology used to produce content on the Web. Fourteen students were able to accurately describe *JavaScript* as a computer language after the program.

The students also made substantial increases in their identities as programmers. Only eight girls thought of themselves as programmers prior to the pilot program, whereas seventeen identified as programmers afterwards (Table 2).

Girls in the pilot program seemed to gained confidence in their coding abilities, with only seven students agreeing or strongly agreeing with the statement *I am sure that I can do well on activities that involve coding* before the program, compared with seventeen girls who felt sure after the program (Table 2). Girls were given this question only if they said they previously had done coding, which explains the disparity in response rates to this question. Lastly, seventeen girls felt certain they could explain programming to their family and friends after the program, compared to only seven who felt confident before.

Table 2. Coding identity and self-efficacy results in the pilot program.

	-1-	-2-	-3-	-4-	-5-	*n*
I think of myself as a programmer.						
Pre	2	2	7	4	4	19
Post	0	0	2	9	8	19
I am sure that I can do well on activities that involve coding.						
Pre	0	1	0	2	5	8
Post	0	0	1	11	6	18
I can explain some aspects of programming to my family and friends.						
Pre	2	3	7	4	3	19
Post	0	1	1	11	6	19

Observations further emphasized girls' increased confidence with coding over the course of the pilot program. We observed that girls had many creative ideas for code they wanted to include in their personal identity and PSA videos. They sometimes tried code they had not yet formally learned from the curriculum, using trial and error to understand how they could achieve the desired effect. While working on activities, girls were able to describe to the evaluators the code they used and how they manipulated the variables to get a desired effect, such as various levels of pixilation. Combined with results from the survey, the pilot program showed solid increases in coding knowledge, skills, and self-efficacy.

The pilot program curriculum included discussions of coding careers and a visit to a workplace to expose girls to job options in fields related to coding. Survey results showed few changes in career interest and awareness among girls, with the number of girls who wanted to study programming in the future and learn more about jobs that use coding remaining consistent over time.

Conclusion

The evaluation of the pilot program showed positive initial results in the areas of leadership and coding abilities. The curriculum appeared to be a success in a consolidated, weeklong implementation in the carefully managed setting of GSGNY's headquarters. We supported the Breaking the Code leadership team to pursue implementation of the program in its intended afterschool setting. With NewKnowledge, GSGNY and Vidcode discussed program revisions and adaptations that would be used in the academic year program. These updates are detailed in Appendix B.

Appendix B: Program & Evaluation Adaptations

In this appendix, we document program and evaluation adaptations and plans for future adaptations. This information provides institutional memory of the initiative and demonstrates how the leadership team responded to program challenges and evaluation results throughout Year 1. Program leaders from GSGNY and Vidcode, the evaluation team, and the instructors made observations about challenges and then devised the adaptive strategies described below.

Curriculum

Public Speaking – Girls experienced stress and discomfort with public speaking during the pilot program. In the middle of the pilot, GSGNY staff improvised public speaking exercises to build girls' confidence and skills, which were successful within the pilot. In the academic year program, the curriculum included time specifically for girls to develop and practice their film presentations.

Retention – Instructors found that recalling new coding skills learned in previous weeks' sessions was difficult for many girls. During the academic year, the leadership team instituted quick review activities at the beginning of each session, asking girls to practice a skill they learned previously, then adding a new skill or extension of the skill onto it. This approach helped instructors identify girls' learning challenges and how to help them.

Additional Learning Support – Girls sometimes struggled to make connections between lessons and applied coding. During the academic year, the leadership team created visual tools to help girls understand the connection between code and video special effects, as well as vocabulary. Although the evaluation did not address this new approach, the leadership team reported this strategy was useful.

Writing – Girls struggled with and did not enjoy activities emphasizing writing. They seemed to find writing for curriculum activities (e.g., film scripts) and evaluation activities (e.g., open-ended survey questions) tedious, too much "like school," and difficult to master. While the leadership team hoped writing would become a good challenge for girls, it appeared that it became a barrier to engagement for many students. Curriculum and evaluation changes regarding writing requirements could not be made in the middle of the year, though the leadership team hopes to address this issue in Year 2.

Computer Literacy – To some extent in the pilot program and certainly in the academic year program, girls struggled with basic computer skills. The program required the use of many of these skills, including typing with two hands, saving and retrieving files, copying and pasting text, etc. When girls had trouble with these tasks, instructors improvised mini-lessons for a single girl or a small group of girls, which helped address the lack of a certain skill. However, girls were not uniformly provided with this training throughout Year 1. The evaluation team resolved to study computer literacy in the future, and the curriculum team hoped to incorporate introductory lessons on computer skills in Year 2.

Career & Future Study Interest – The pilot program discussed careers in coding activities and facilitated a workplace visit at a coding company, but the evaluation showed a lack of growth in career interest as a result of these activities. To address this problem, the leadership team incorporated more exposure to women in coding careers. These mentors were early-career coding experts who participated in a Skype call to review and provide feedback on the girls' projects. While workplace visits during the academic year were successful according to instructors and girls, survey data did not show an increased desire to pursue study or careers related to coding. The leadership team will continue to think about career exposure for the Year 2 curriculum.

Evaluation

Observations – We had initially used the Dimensions of Success (DoS) observation protocol, a National Science Foundation-funded tool for measuring informal STEM learning (The PEAR Institute, 2017). While the DoS tool captured

some aspects of the learning environment and general engagement, the protocol was highly focused on STEM learning. Meanwhile, the Breaking the Code curriculum did not make explicit ties to STEM learning, as half the curriculum focused on leadership. The curriculum did not discuss how coding fits within the STEM landscape, so students were unable to appreciate these connections. We did not consider the Breaking the Code emphasis to be a deficiency, but rather the nature of an afterschool program focused on two distinct areas of girls' development.

Focus Groups & Group Interviews – We used focus groups to gain insight into the experience of girls in Breaking the Code during the fall of the academic year. (Focus groups were not used during the pilot program due to time constraints.) The evaluation team found the focus groups difficult to administer with large groups of girls because they struggled to pay attention. In addition, the groups required girls to remain in the classrooms for about 20 minutes after the session finished. In the second semester, instead of focus groups, we conducted group interviews with the girls in their project teams during the session. Framed as a "quick chat break" to girls, this strategy helped girls remain focused and gave more girls an opportunity to speak.

Survey – Based on observations and survey results during the program pilot, NewKnowledge revised several aspects of the survey design to streamline the participation process, clarify terms, and remove questions that were redundant. We removed the term *programming* because it was not explained in the curriculum and seemed to cause confusion; instead we used only *coding* in the academic year surveys. As mentioned above, girls also had trouble writing open-ended responses. We also struggled with low response rates due to attrition, missed sessions, and lack of parental consent; these issues affected our ability to statistically test the outcomes. Strategies for improving the survey implementation in Year 2 might include shortening the survey, using retrospective pre/post questions, collecting surveys at more points throughout the year, and fielding the survey on iPads because girls find it more enjoyable.

Consent – As described above, gathering parental consent was a challenge. We suspect that the lack of consent represented a lack of awareness about the evaluation, rather than an intention to prevent girls from participating in the evaluation. The leadership team has discussed strategies to resolve this problem in Year 2, which may include adding the evaluation consent form to the packet of other program information and permission forms.

Implementation

Technology Access – Nearly all sites experienced many challenges with technology operations and access during the academic year. These problems included lack of or spotty Internet connections, computers that were not charged or failed to stay charged during sessions, being locked out of the technology storage spaces, and getting videos to play consistently in the Vidcode platform. The leadership team addressed as many of these issues as possible by supplying computers and tablets to some sites, bringing Internet hotspots, and troubleshooting the Vidcode site. While technology problems were frustrating for instructors and girls alike, they did not appear to seriously affect learning outcomes.

Mentors – The leadership team introduced mentors in fall of the academic year program and incorporated one call per semester per film project group. While girls said they enjoyed the call with the mentor, the leadership team felt the mentor role could be clarified. In particular, they hoped that mentors could better understand the opportunity and mentor recruitment could be scaled up so that mentors could be responsible for only one group of girls. The leadership team also discussed plans for a peer mentor component that could be added in Year 2.

Incentives – During the academic year program, the leadership team tried to increase enthusiasm for the program by offering incentives – movie tickets – to girls who consistently participated. While the evaluation did not address this aspect of the program, the leadership team felt it was successful and planned to continue this strategy during Year 2.

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