Ruff Family Science
Prototype Development and Formative Research Report
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Prepared by Education Development Center, Inc. (EDC)

Introduction

Ruff Family Science is a project funded by the National Science Foundation (NSF) that aims to foster joint media engagement and hands-on science exploration among diverse, low-income parents and their 4- to 8-year-old children. Building on the success of the PBS series *FETCH! with Ruff Ruffman*, the project leverages *FETCH*'s funny and charismatic animated host, along with its proven approach to teaching science, to inspire educationally disadvantaged families to explore science together. The project is utilizing a research and design process to create resources that meet the needs of families with a parent enrolled in an adult education program, addressing parents as both adult learners *and* as caregivers who can nurture their children's development in science. In doing so, the project's ultimate aim is to build new knowledge about the potential for digital media to inspire and support intergenerational science learning among vulnerable families.

WGBH and Education Development Center, Inc. (EDC) are collaborating on three phases of research and development: a Needs Assessment Phase, a Prototype Development Phase, and a Prototype Testing Phase. **This report summarizes the findings from the Prototype Development Phase**, which seeks to investigate the extent to which new prototype resources meet the priorities and needs of families and educators involved in intergenerational education settings, while identifying successful engagement strategies and areas for improvement.

The Prototype Development Phase comprised four rounds of formative research. The first three rounds elicited feedback on individual components of a prototype "Activity Set," consisting of an introductory video, hands-on activity, online game, follow-up video, and related educator supports. Various preexisting and newly developed resources were tested for their ability to promote enthusiasm and interest in science, promote science knowledge and practices, and support further science exploration in adult learners and their children. Educators also were consulted to gather their opinions on the resources and their ability to promote joint engagement and intergenerational science learning in their program contexts. In addition, educators were asked to reflect on the resources' ability to promote comfort and confidence in their own abilities to facilitate science exploration. During the fourth round of testing, research focused on testing the revised Activity Set as a whole, using an implementation model that incorporates science exploration in adult education settings, in family education settings, and in family homes.

Multiple sources of data (observations, focus groups, pilot parent surveys, and educator interviews) were used to assess the promise of the Activity Set resources and implementation model.

The project team intends to use the feedback to make modifications to the prototype Activity Set, to develop a second Activity Set, and to make adjustments to the implementation model.

Both Activity Sets and a revised implementation model will be tested in the Prototype Testing Phase.

Resources and Model

The main objective of this phase of work is to develop prototype resources and an accompanying implementation model that adult and family educational programs can use to engage adult learners and their children in intergenerational science learning.

Resources

The project team developed one set of resources, collectively known as an "Activity Set," that could form the basis for joint parent/child engagement in science. The prototype Activity Set focuses on the scientific concepts (or "Big Ideas") of force and motion, and contains the following components.

- *Introductory video.* Intended to capitalize on the appeal of a popular PBS animated character, Ruff Ruffman, this video serves as an introduction to a particular science topic. In the animated portion, Ruff attempts to solve a problem or accomplish a goal; in the live-action portion, real families engage in a related science exploration in order to help him out.
- *Hands-on activity.* Intended as a follow-up to the video, the activity consists of simple instructions for a hands-on science exploration that adult learners and/or families can do together with minimal materials and preparation.
- *Online game.* Intended to deepen the learning from the hands-on activity, the online game consists of an intergenerational two-player game, accessible via computers or mobile devices.
- *Follow-up video.* Intended to inspire families to continue exploring the featured science idea at home, the follow up video provides a call to action and offers ideas on how families can extend the hands-on exploration.
- *Educator supports.* Intended to support facilitation of the Activity Set in various settings, educator supports consist of an educator video that provides support for leading hands-on science activities, and a set of Educator Guides that contain suggestions for using the materials in three different educational settings: a high school equivalency class, an English language or adult basic education class, and a family education class.

Model

Because our initial research showed that intergenerational learning programs require both resources *and* structure in order to effectively engage families in science learning, the project team created an implementation model that provides direction on how to implement the above resources in a way that addresses adult learners' lack of confidence in doing science with their children. In the model, parents are first introduced to the Ruff resources in an adult education class and then given the opportunity to explore them again with their children in a facilitated family workshop, which also promotes ways for families to continue exploring at home. Participating programs were encouraged to use this model during our final round of testing.

Methodology

Participants

A total of 20 program observations were conducted across four rounds of testing. WGBH and their project partners at National Center for Families Learning, Kentucky Educational Television, and Alabama Public Television coordinated these observation sessions through local existing program partnerships. These programs included community schools in Las Vegas, Nevada, and Okolona, Kentucky; adult education programs in urban and rural Kentucky and Massachusetts; poverty reduction programs in Huntsville, Alabama, and Sylacauga, Alabama; advocacy and education programs for immigrants, refugees, and marginalized populations in Providence, Rhode Island, and Louisville, Kentucky; and an urban ministry in South Birmingham, Alabama.

Across all four rounds of testing, most classes were conducted in English (13 out of 17); however, some educators conducted their classes using a mixture of English and Spanish. In most cases, materials were tested in adult-only education settings. In some settings, particularly in the fourth round of testing, adults were asked to bring their children to test Activity Set materials during a joint engagement/family event. Each round of testing is summarized in Appendix A.

Procedure

During the first three rounds of testing, field researchers from WGBH and their project partners conducted observations in local adult education and family education settings, using observation protocols developed by EDC in consultation with advisors. Field teams used the protocols to collect observation data on the use of individual Activity Set components, and to conduct debrief interviews with participating educators. The EDC research team analyzed this field data by examining observer notes and coding excerpts of educator interviews to establish major themes related to interest, appeal, and usability for each of the tested Activity Set components.

In round four, two program sites tested the prototype Activity Set as a whole. Educators were asked to first use the Activity Set in an adult education setting, and then use the materials again with the same adult students and their children in a family workshop setting. In addition to conducting observations, the research team engaged adult learners in focus groups to discuss their experiences with the Activity Set. A small number of participants also were asked to provide feedback using either English or Spanish language surveys[1]. EDC examined data from researcher-led observations, participant surveys, focus groups, and educator interviews, coding for themes as they related to the research questions of interest, to create a series of key findings as they relate to the prototyped Activity Set.

[1] EDC developed a survey for participants to reflect on their Activity Set experiences. This survey was pilot-tested with the two programs that participated in round four of testing. The results of this pilot test will inform survey revisions prior to use in the next phase of research

Results

The findings have been summarized to respond to the project's research questions of interest, which investigate the promise of the Activity Set and model in promoting intergenerational science learning. Key findings (in bold) have been assembled across implementation sessions that tested prototypes at various stages of development.

RQ1: To what extent does the prototype Activity Set and implementation model promote enthusiasm for and interest in science exploration among parents and children?

Participants in both adult education and family education learning environments were enthusiastic about and interested in each of the Activity Set components (videos, hands-on activities, online games). They also enjoyed the Activity Set model as a more complete facilitated experience. Key findings, as they relate to learners' enthusiasm for an interest in each type of resource as a mechanism for exploring science content, are presented below.

Videos

- *Children and adult learners responded enthusiastically to videos that mixed humor and science learning and that depicted real families exploring science in ways that feel natural and authentic.* Adult learners and their children often were observed to quietly attend to the videos, periodically smiling or laughing at comedic aspects of the animation or endearing interactions between families shown during live-action segments.
- *Adult learners liked the educational messages of the videos.* They appreciated the opportunity for children to learn about things such as making a hypothesis, building ramps, and the scientific concept of force.
- *Adults learners also liked how the animated videos periodically integrated footage of real children and families working together to solve problems.* Several participants said that they would like to see even more children and families representative of their ethnic backgrounds endorsing and enjoying science in future videos.
- *Participants appreciated when the families in the videos used both English and Spanish phrases.* Adult learners thought that this piece could be expanded to help emphasize English and Spanish vocabulary highlighted in the video.
- *Adult learners also liked how the science investigations were presented in the videos.* Participants liked that the projects were broken down in a step-by-step way that still felt like an authentic science experience.
- *Very few dislikes were reported about the animated videos; the only criticism heard more than once was related to the speed of Ruff Ruffman's dialogue.* Small numbers of participants reported that Ruff talks very fast, which can make him hard to understand at times.
- *Adult learners commented that the videos shown before and after the hands-on activity supported their enthusiasm and engagement.* Watching an introductory video before the activity served as a preview of the day's hands-on activity. Some learners also reflected on how nice it was to see a follow-up video at the end of the event because it inspired ideas on how they could do more to build on the activity that they did in the session.

- *The majority of adult learners from both adult and family education learning contexts said that they would watch videos like this with their children on their own.* Further, participants also thought that videos like these would make them want to talk about or do science activities as a family.
- *Most of the educators that participated in the Activity Set testing reported that they would utilize videos like those tested with their students.* Educators thought that the animated videos would help adult learners with language learning in that they expose them to different voices and accents to help them pick up the English language. Multiple educators reported that they liked how the Ruff animated videos also wove in live-action segments with children and their families. They thought that this aspect would help keep adult learners from dismissing the animation as a cartoon meant only for children.
- *Despite this common enthusiasm, one educator said that she likely would not use the videos with her students because they are all adults.* This response from a high-school equivalency exam instructor, while unique, may signal that some educators may not explicitly perceive the value of the videos as part of the Activity Set experience, as they may see them as being geared more toward child audiences.

<u>Hands-on Activities</u>

- *Adult learners enjoyed the hands-on activities as an opportunity to engage with science content.* Participants who tried an activity in which they built a model "sail car" liked constructing the model and making predictions. They liked learning about the type of force used and how different "pushes" can affect how far their car travels. They also enjoyed working collaboratively during the hands-on activity time. Participants in family education environments liked that activities were a hands-on way to learn about scientific concepts such as force and motion, and that the activities used materials that could be found at home.
- *Most participants liked the format of the activity instructions.* Participants thought they were easy to follow and thought that it would be exciting to end up with a big book of activities like this that they could do at home with their children.
- *During follow-up focus groups that reflected on hands-on activity experiences in later rounds of testing, none of the participants discussed any dislikes about the activity.* Responses during feedback sessions were overwhelmingly positive.
- *When asked what they most liked about the activity, learners from the family education program said that it was fun to do together and gave them a chance to get involved in their child's learning*. Participants in this class also mentioned that they really enjoyed seeing the reaction of children as they worked on the activity, and that they appreciated how well the experience would help to build children' self-confidence.
- *Educators also were enthusiastic about the hands-on activities, reporting that these resources could be leveraged to meet the educational goals of their classes.* One GED instructor thought that the activities could be helpful for learners to understand scientific concepts such as force and motion. An ESL program educator thought that the activities would be helpful specifically by providing opportunities to teach listening skills and comprehension. One family learning educator thought the activities could be

helpful because they build academic vocabulary and the foundational skills of math and science for participating parents.

Multiplayer Games

- *Digital gameplay was a popular activity with adult learners, and they enjoyed the chance to explore various online games.* Most adult learners found the games easy to use, though some adult learners experienced difficulty due to varying levels of comfort with technology (e.g., mouse use) and with the English language (e.g., the labeling of some game buttons was not intuitive for non-native English speakers).
- *Learners favored gameplay styles that allowed them to take turns completing levels or challenges or working collaborative to complete each round of play.* Early rounds of testing asked adult learners to pair up and play two games in different ways: competing against each other, collaborating as a team, and letting one person give the instructions while the other person worked the controls. When asked to reflect on gameplay, adult learners enjoyed engaging in the challenges presented by both games. Adult learners thought that tackling the science challenges collaboratively was the type of gameplay that they enjoyed the most.
- *Learners across education contexts were seen talking with each other, smiling and/or laughing, and discussing the games' objective as they played.* Consistent with feedback from adult students themselves, observers in multiple adult education contexts reported that they thought adult learners were less animated or less engaged in discussion when they were asked to compete against each other.
- *When discussing aspects of the various games, adult learners were able to see connections between gameplay and scientific investigations.* Observers documented that adults were able to highlight specific aspects of the games that got them to make predictions, experiment with solutions, and engage in processes of trial and error, such as experimenting with and using various shapes to build hamster pathways or taking guesses as to how far an object would slide on the ice and adjusting the amount of force needed to reach the target.

Activity Set model

Beyond the unique reflections collected about videos, hands-on activities, and multiplayer games, adult learners across experiences expressed enthusiasm for the Activity Set model.

- *Nearly all adult learners reported that the Activity Set helped support a positive experience for engaging in science learning.* Several participants mentioned that trying things out in an adult education setting allowed them to experiment and play like they did when they were children. For example, one adult education student eloquently said that the experience "took (her) back to (her) childhood when (she) didn't have to worry about anything." One parent said, "It just brought me back to be a child again!" Another said, "It was like going back in time and remember(ing) when I was a little girl and did (these) type of activities with my parents."
- *One of the enjoyable aspects for adult learners who experienced the Activity Set materials in an adult education class was trying out science activities collaboratively with others.* During the last round of testing, a small group of participants was surveyed to ask what they liked most about their learning experience with other

adults; participants reported that they liked working together and learning from each other. Others liked learning more about science with others (making predictions, building the sail car, using tools).

RQ2: To what extent does the prototype Activity Set and implementation model promote parents' comfort and confidence in exploring science with their children?

Adult learners frequently expressed that the Activity Set materials and model increased their confidence in exploring science as a family. Participants reported that the specific act of using the materials in the adult-only setting helped them be aware of the content before leading the activity for their child. One parent said that the model worked well because "they [the educator] can teach us, and then we [the parents] can teach them [the children]." One of the educators for a family education event emphasized that she saw this experience paying off while working with her participants. She thought that adult learners' confidence increased after their first trial with the activity. Adult learners thought that it was helpful to have their own ideas about what was going to work so that they could help explain to their child when things go right or wrong.

In a follow-up survey completed by a small sample of participating parents, six of eight parents who responded to questions about their comfort level reported that they were comfortable with each of the science practices in the activities (building a model, making predictions, describing tests, measuring results, comparing predictions to results, and drawing conclusions). Only one participant reported that they were uncomfortable with certain practices (building models, watching and describing what happened, redesigning car) but did not elaborate on the reasons for this discomfort. Five participants said that the activity helped them become more comfortable with science, citing that it was helpful to work on an activity with very clear, explicit explanations.

Despite this preparatory experience in their adult education setting, some parents still expressed some anxiety about exploring the materials with their children. One participant mentioned that she was concerned that something about the activity would not work and it would discourage her child, so she felt the urge to "cheat a little bit." According to this parent: "I realized that, with kids, especially if you're doing activities with kids, you don't want to hurt their feelings and sometimes you get to cheat a little bit as a parent. Maybe (the car is) not moving, maybe push it a little bit so that they can see it move." Another parent in the group expressed a similar feeling of anxiety: "In the second activity I was worried the car wouldn't roll. If it doesn't roll, I'm leaving." From these comments, it can be inferred that parents benefit from the experience of trying things out ahead of time but feel a desire to make that second experience with their child go smoothly the first time they try it.

RQ3: What evidence exists that the prototype Activity Set and implementation model promote science knowledge in both parents and children?

Throughout prototype testing, adult learners reported learning new things about gravity, force, motion, and measurement. Across testing rounds, adult learners from both adult and family education programs reported that they learned about science concepts as part of their prototype testing involvement, and that they liked that the hands-on activities and games built upon the scientific concepts introduced in the introductory videos. Adult learners

mentioned that they learned about gravity, force, motion, and measurement. In the small follow-up survey, eight out of nine parents surveyed reported that they learned a great deal about the concepts of force and motion.

Observers corroborated these reports from adult learners, supplying evidence that adult learners and children engaged with learning around the Big Idea of the Activity Set (force and motion). Observers reported that adult learners and their children talked about how the force of wind can cause objects to move. Adult learners and children explored how different sources of wind would impact the sail car, and were observed to be forceful with their breath to try to get the car to go further. Educators in several locations were observed to effectively scaffold the experience for adult learners and families.

Beyond learning about the specific science concepts addressed in the prototype materials, some participants said they learned more about the nature of science. In the follow-up survey, six of nine parents reported that they have a different idea about what it means to learn or do science after experiencing the Activity Set. While these results are drawn from a small sample of participants, the results are promising evidence to suggest that the approach of the Activity Set has the potential to enhance adult learners' understanding of science.

RQ4: What evidence exists that prototype Activity Set and implementation model promote adults' and children's engagement in science practices?

Across rounds of testing, observers reported that adult learners and their children were often engaged in many of the targeted science learning practices, such as making predictions, building models, and recording data about their observations. The ways in which they did so looked somewhat different across locations. For example, in one class, parents were reported to take the lead on testing the model and helping children as they colored in parts of their data collection charts to record results. In another class, adults and children took turns testing their model and recording results.

Adult learners reported enthusiasm and interest in engaging with science practices such as conducting observations and working collaboratively with others. Adult learners said that they learned more about how these practices work—for example, that predictions can be right or wrong.

In the final round of testing, observers tallied the frequency with which participants engaged in the specific science practices targeted in the Activity Set. The most frequently observed practices were building models, making predictions, observing and describing, and measuring and organizing. The least consistently applied practices were drawing conclusions and summarizing results, with observers noting the omission of these practices in both observation sessions. Below is a table that documents examples of children's and families' engagement with science practices.

Science Practice	Observations
Building models	• Participants worked collaboratively with their child to build a sail car. They followed the directions on the activity sheet together. • One mother helped guide her son but did not take over the project. The child seemed to enjoy the activity. He smiled as he hammered the pencil into the tires to make the hole. He really enjoyed the hammering and was focused on the task. He smiled and said "Yea!" when they got all the wheels on the car.
Making predictions	• One mother placed a ruler on the table so her child could measure how far he could get the car to go. The facilitator suggested making a starting line on the floor so he could test out his car. The child was excited to try out his car and blew on it before he made his prediction. Afterward, he predicted that it would go 12 inches. The mother had to step outside for a phone call while the facilitator helped the child reset. She prompted him to "try with one breath" and then helped him fill in his prediction chart. • Parents explained predictions and wind to their children. Children blew on their cars to test them. He didn't want to stop, kept blowing on the car on the table. Moms made sure their children made predictions before the tests.
Observing and describing	• One parent-child pair made predictions with the prompting of the facilitator and observed their tests. At one point, the little girl made the car move using the paper. "Wow, amazing wind!" she said. • One child tested his car. His mom asked him what they used. He said wind, and his sister added, 'A fan.' Another child's car got stuck and did not move. She recognized that this was because she used larger wheels than the other children. "See, Daddy, I told you the small wheels were better."
Measuring and organizing	• A parent-child pair measured the distance their car went. The teacher recorded their predictions and actual results in the Windy Wheels chart. • Children tested their cars and their parents helped them record the information on the prediction chart.
Drawing conclusions	Was not observed in either location.
Summarizing results	Was not observed in either location.

In follow-up focus groups with adult learners, participants responded enthusiastically about their engagement with each of the described science practices, noting that each of these science practices was a skill that would be helpful for children's continued education.

Observers in both locations thought that educators did not spend much time helping adult learners or families with drawing conclusions about their test results, nor did they spend a great deal of time summarizing the results of the hands-on activity tests. Observers thought that the wrap-up segments of the sessions were fairly brief and sometimes rushed. The consensus was that the observed educators did not focus on bringing the evidence gathered across families' sail car tests together for group review as well as they highlighted the other science practices. Follow-up interviews with educators suggested that lack of time may have been one reason that this practice was not implemented consistently. In addition, one educator said the practice of summarizing is particularly difficult for ELL students; this may have been another reason why these practices were not observed.

RQ5: To what extent do the training materials and educator supports enhance adult and family educators' ability to engage adults and children in science learning?

Across multiple rounds of testing, observers reported that educators successfully facilitated hands-on learning experiences that introduced science ideas in simple terms, encouraged participants to work collaboratively, and incorporated clear and visual step-by-step directions. Observers reported that educators followed the recommended sequence for implementing the Activity Set, by first screening introductory videos and then introducing participants to a related hands-on activity. In adult education environments, participants were often asked to pair up for the activity or to work in small groups. In family education environments, parents were asked to work on the activity with their child or children. Below are some highlights from educators' facilitation strategies in each type of environment.

- *In adult education classes, educators often conducted a walkthrough of the activity for learners before allowing them to work on their own.* Educators gave participants a handout that contained a series of steps to follow for completing the hands-on activity. During the activity itself, pairs or groups of adult learners engaged with hands-on activities by building sail car models, discussing observations about the movement of their cars, and recording data. When activities called for model testing, adult learners occasionally established some friendly competition about which sail car model performed the best.
- *In family education classes, educators varied as to how they introduced the activity to participants; observers thought that the educators made adaptations based on their knowledge about their class participants*. Some educators read through the activity as a group, whereas others had adults read the directions themselves and to their children. Both of these approaches were seen to be successful in engaging families in science practices such as making predictions, building models, and recording data.

In reflecting on their implementation experiences, educators believed that the Activity Set instructional supports are well designed to help them promote science learning in a variety of learning environments. In the last round of testing, both of the educators who facilitated in-person events were very enthusiastic about the Activity Set as well as the educator supports. Both thought that the materials were easy to use with their students, which made them very comfortable in serving as a facilitator for the events. Both educators thought that

the materials that were used with participants were also well designed. In particular, one educator noted the value of the videos. She thought that the first video, which depicted three boys and a mom working on building a wind-powered car, was great because it generated excitement among the children to try the hands-on science activity themselves. This educator also thought that the video presented at the end of the activity, in which two families built and raced different wind-powered cars using materials they had on hand at home, was nice because it gave families ideas for additional science exploration they can do at home. She thought that families seemed excited to try other ideas, and she was happy to see families asking if they could take home the leftover materials from the event.

Educator supports that connect to commonly used standards, offer clear direction on leading science activities, and provide tips on how to support other program goals were deemed most helpful. When asked to reflect on how well the guide helped prepare them to lead the activity experience, educators thought that it was easy to follow, though some aspects could be simplified and streamlined. In particular, educators reported that the pictures and directions for the hands-on activity stood out as particularly beneficial. Another educator reported that the prompting questions and vocabulary connections were most useful, particularly for ESL students. Several educators thought that the guide was fairly lengthy. One thought that the included amount of detail would have been more useful at the beginning of her career. Rather than following the guide as a script, she felt more comfortable altering the way in which she introduced concepts using her own style to meet the needs of her program participants.

All of the educators said that the standards and curriculum connections made in the prototyped guide were consistent with those that guide their course content, and that the Activity Set materials were relevant to their program goals, even if they don't typically teach science. One adult educator said, "It covers reading and speaking and listening skills, and that is what our main concern is." Another adult educator said that she follows College and Career Readiness (CCR) standards and those are the first standards listed in the activity. She also said that she wished "every lesson was broken down like this." She mentioned how difficult it is to align lessons to CCR, so having an activity like this is helpful. The family educator noted that the guide was consistent with their content on "teambuilding, communication, problem-solving, and peer relations."

Educators' suggestions on improving the supports were focused on how best to support learners during the hands-on activities. For an activity that focuses on having participants build something, educators suggested that the guide direct the educator to build a sample prior to the activity experience. This would help them develop experience prior to facilitating the activity with participants, and would help them understand where participants may have difficulty. Another suggestion, particularly in environments where adult learners may be paired to work together, was to identify roles for each person in the pair for the hands-on activity. This would avoid having one participant do most of the work while the other remained fairly passive. Another suggestion was to encourage adult learners to write down a few sentences to answer questions and report out during the wrap-up phase to get participants involved in reading, writing, speaking, and listening.

Despite strong support for the Activity Set model, educators felt they would need to make modifications to the educator supports in order to more effectively work with families with

very low English proficiency and very limited science skills. For example, one educator did not ask families to summarize what they were doing as often as suggested in the educator supports, because she felt this would become onerous to the families, saying, "Sometimes you feel like you're torturing them because their language is so limited." Another educator was concerned about participants' lack of familiarity with making predictions and measuring. She made generalizations about her learner population suggesting that making predictions and engaging in measurement is not a cultural norm. She said that her students do not typically talk about what they think will happen, nor do they often measure (for example, "Cooking is done with pinches of this or that" and "Distances are simply labeled as close or far"). This educator felt that additional introductory lessons would help support her students to engage with these particular science practices.

RQ6: What factors work together to support or impede effective use of the prototype materials as part of existing adult education programs?

Over four rounds of testing, several factors emerged that supported or impeded effective use of the prototype Activity Set and implementation model. Obstacles included the following.

Time available

Some programs did not have enough time in a single class period to fully explore all the Activity Set materials. One family learning class ran out of time before finishing the hands-on activity. Observers reported that some parents had multiple children and it was difficult for them to keep going while also managing several children. Another adult education class ran short on time because the educator spent significant time addressing participants' questions and interests. Similarly, observers from another family education class mentioned that the educator spent a fair amount of time addressing questions about materials in the activity and the featured scientific concept.

Amount of text

Some participant felt that Activity Set materials were too text-heavy. Participants reported that they liked how activities are presented step-by-step, but some feedback indicated that, for some participants, the activities had too many steps. In several cases, educators were observed to try to break the activity down as a class, walking adult learners through the steps one at a time to make the whole process less overwhelming for learners. A later version of the activity, which replaced or supplemented some text with pictures, was deemed more helpful.

Concerns about supplies

Overall, educators and parents liked that the videos and hands-on activities featured science exploration that made use of commonly available supplies like straws, cardboard, and bottle caps. Other participants, particularly those from family education classes, expressed concerns about some of the activity materials (e.g., skewers, hammer, pushpins), particularly in that they are not easy for young children to use.

Technology issues

Although educators and adult students responded positively to the online games, differences in access to and proficiency with technology proved to be obstacles to effective use. First, many programs were equipped with technology that afford single-user experiences (i.e., desktop computer terminals with headphones). It appeared difficult for programs to adjust to gameplay that required individuals to work collaboratively using the same computer with audible sound for both players. Second, the technology proficiency level of adult learners was highly variable. When engaged in game testing, some participants were not confident with the desktop computer technology, particularly when having to operate a computer mouse. Some participants required a bit of time to become comfortable with how to operate the mouse and use it for gameplay. When asked to reflect on technology use, educators thought that adult learners are more accustomed to interacting with gaming technology on phones instead of desktops or laptop computers.

Language

As mentioned previously in this report, many adult and family educators serve ELL students, and appreciated that the Activity Set materials provided opportunities for their students to practice their English language skills. However, participants' limited English language proficiency appeared at times to impede their ability to fully engage in adult and family education sessions that made use of the materials. Some participants felt that the characters spoke too quickly during videos, making it hard to follow the dialogue. Some adult learners struggled with vocabulary used in hands-on activities (e.g., *skewer*, *pushpin*, *slide*, *lid*) and required clarification from their educator. Others ran into language-related roadblocks during online gameplay, especially with game instructions and with words such as *retry*, *push*, *hint*, and *undo*, which are key terms used to label buttons used during gameplay. Observers noted that some facilitators translated key words from English to Spanish to ensure that participants understood the activity handout as they went along. During the final implementation round, activity directions were made available in both English and Spanish. These materials were distributed in some programs, but they were not heavily consulted, even by primarily Spanish-speaking participants. Instead, participants seemed to look to the video and the educator for guidance, indicating that fully translated directions are not the only way that families get support for overcoming language barriers.

Across observations, members of the research team reported several factors that supported successful Activity Set implementation.

Educator experience and enthusiasm

In adult education classes, educators experienced some challenges around the logistics of facilitating a hands-on activity with a group of adult learners; however, many educators are well-versed at coming up with adaptations for their learners' needs. While the activities appeared to create excitement and enthusiasm, this concept of doing a hands-on project in pairs appeared to be a departure from the typical class activity for several participating programs. Because of this novelty, observers thought that activities were most successful when educators took the time to recognize the newness of what they would be doing that

day, discussed how they would be working together in pairs to help one another with the activity work, and gave their ideas on how to work collaboratively.

Educator approach

Variability in how adult and family educators set up and facilitated their class sessions appeared to make a significant difference in how successful the experience was for adult learners and families. Observers thought that hands-on activities worked best when educators walked participants through activities using a step-by-step process, rather than passing out handouts and letting adults and families follow the directions on their own. At the same time, once the overall purpose of the activity became clear, experiences were enhanced when educators encouraged the adult learners to revisit the activity handout, rereading instructions when any part of the process became unclear. In addition, as participants engaged in hands-on activity work, successful educators were frequently observed to circulate around the room, make suggestions on how to continue with the activity, provide one-on-one assistance to those who were struggling, and encourage perseverance to manage frustration in the face of a challenge.

At -home encouragement

Although observers were not able to follow up on whether families continued exploring science at home, they observed promising practices from some educators, who encouraged participants to do follow-up explorations on their own time. Some educators also allowed adult learners to take home extra materials to replicate the activity again at home.

Alignment with program goals

Across all four rounds of testing, educators were motivated to use Activity Set materials in large part because they addressed learning objectives and content that fit well within their program goals. One educator said that the materials aligned with her program goals regarding Common Core readiness skills—engagement with science practices such as making predictions, comparing and contrasting, and summarizing—and practices that help prepare parents become more involved in their child's education. Another educator said the Activity Set materials aligned with her family education program goals in that they showed parents how important it is to invest time in doing things with their child. She believed that her learners already knew a lot about science but that they did not realize how much they knew, and that the Activity Set materials helped her adult students recognize that so much of what they already understand is related to science. Another educator expressed a similar sentiment: "In family literacy, one of our biggest goals is to integrate parents into their child's educational lives, and not just have a parent who feeds them and bathes them but is involved with their schooling. In that way, it's very beneficial because it supports that goal."

Some program educators, particularly those who teach in courses that prepare students for high school equivalency (HSE) exams, found it more difficult to align the content of Ruff Family Science to their program goals. Many HSE courses are set up as self-paced programs where students consult with their instructors when required. Many of these courses are designed to align with the content of the exam. One educator reported that the exams are quite expensive for the students, so they try to focus as much course time as possible on helping students

achieve their test preparation goals. While these educators were more likely to report teaching science in general than were other adult educators, they felt that it would be more challenging to integrate the Activity Set materials than did their peers who teach other kinds of classes, a finding that bears further investigation.

Conclusion

Across the four rounds of testing, evidence suggests that the Activity Set and implementation model show promise in engaging parents as both adult learners and as facilitators of their children's learning, and in fostering intergenerational science learning. Both educators and adult learners were enthusiastic about the various kinds of learning assets that were part of the Activity Set. Videos were engaging for adult learners and children, stimulating interest in the hands-on activity. The hands-on activity was an opportunity to enact the Big Idea of science and to engage in science practices during an investigation. Educators found the support materials thorough and helpful in supporting implementation in a variety of learning environments. The adult and family-facing materials were well designed and easy to use.

In addition, the implementation model, in which parents are introduced to the Ruff Family Science resources in an adult education class, then given the opportunity to explore them again with their children in a facilitated family workshop, and then provided with additional opportunities for at-home exploration, showed promise for increasing parents' comfort and confidence in exploring science with their children and in fostering intergenerational science exploration.

Recommended takeaways

Several recommendations for the production of new Activity Set materials and refinement of the implementation model were supported by data collected from observations, interviews, focus groups, and parent surveys.

1. Continue to capitalize on the power of videos that show real families exploring science together. Activity Set videos were well received by participants, particularly in the ways that they support families in the exploration of science in a collaborative way.
2. Include some of the coaching from the parent education program educator guide in the preparation provided to other educators explaining the importance of investing time with their children's learning. This will help educators in all types of programs support this message.
3. Ensure that videos take the needs of EL learners into consideration. Some learners would benefit from Ruff talking more slowly to ensure comprehension.
4. Continue using English and Spanish dialogue in videos, as it is a powerful opportunity to connect with adults and children. Participants like the use of both English and Spanish in the dialogue.
5. Continue to make use of hands-on activities formatted in clear, step-by-step instructions that can be modeled and stepped through by educators. Hands-on activities were well received by participants, particularly because parents enjoy seeing their children's reactions and an increase in their children's self-confidence.

6. Find ways to emphasize how experiments or scientific tests that go wrong are a learning opportunity. Some parents reported that they worry about an activity not going smoothly when they do it with their children, and they start to become anxious if it doesn't. Find ways to mitigate this concern, helping parents recognize that mistakes and unexpected results can be a learning opportunity. In addition, consider providing supports that help parents manage their child's emotional reactions when mistakes or failures happen.
7. Digital games are popular with adults and children, but due to limits on time and access in educational settings, gameplay may be best poised for at-home use. Find ways to capitalize on multiplayer game strategies—particularly in ways that may leverage what children know and can do with technology—that support parent involvement at whatever technology or English-language proficiency they might have.
8. Educator guides are comprehensive and particularly valuable for early career educators or those who need the deeper dive into the supports required for science education. However, some educators found them text-heavy. Consider an "At a Glance" version of the Activity Set instructions that can be used by more experienced educators, or could serve as a checklist that can be reviewed quickly during the event.
9. Consider developing introductory lessons on concepts such as predicting and measuring before asking adult learners to engage in the hands-on activities. Some professional development for educators and introductory materials for adult learners may help participants engage more deeply with the science content.
10. Educators did not consistently include a wrap-up and summarization at the end of adult and family education sessions. Find ways to make these practices more accessible for educators to introduce and for adult learners to engage in.
11. The Activity Set experiences made adult learners feel like children again, an experience that they enjoyed and appreciated. Throughout, find ways to emphasize this particular angle for adult learners. It is worth communicating the value of child-like exploration and play as a part of science learning.

Appendix A—Phase 2 Research Design

Each round of testing was focused on testing different combinations of Activity Set assets. Below, we provide a brief description of each round of testing.

Round 1

Round 1 focused on testing the promise of using a combination of videos with a hands-on activity to introduce science concepts to adult learners. During this round of fieldwork, the resources were introduced to participants by a field researcher. Eight observations were conducted across project partner sites. Five programs were identified as having a family literacy/education focus, while three programs had an adult education focus. In family literacy/education-focused programs, testing groups ranged from 5 to 17 adult learners (predominantly female participants). In these classes, children were a part of each testing session (ranging from 2–9 children present). In adult education classes, testing sessions ranged from 4 to 12 adult learners (predominantly female participants). Children were not involved in these testing sessions. Six educators also were interviewed across project partner sites.

Round 2

Round 2 focused on gathering participant feedback on different styles of gameplay with two online multiplayer games. Four observations were conducted across project partner sites. One observation occurred during adult-only time in a family learning context, while the other three site observations were conducted during adult education contexts (ESOL/ESL and GED classes). The family learning program testing group comprised five adult learners who are parents of children ages 4–8. In adult education classes, testing session participants ranged from two to nine adult learners. Children were not involved in these testing sessions. Four educators also were interviewed across project partner sites.

Round 3

Round 3 was focused on observing how program educators facilitated a prototyped set of new and existing materials (videos and hands-on activities) with adult learners. Five observations were conducted across project partner sites. The family learning group comprised 15 parents of children ages 4–8; children were not present for the observation (conducted in an adult-only session of the program). The other four site observations were conducted during adult education contexts (ESOL/ESL and GED classes). In adult education classes, testing sessions participants ranged from two to 11 adult learners. The majority of these adult education participants were parents of children aged 4–8. Children were not involved in these testing sessions. Four educators also were interviewed across project sites.

Round 4

Round 4 focused on the chance to test the full in-person Activity Set experience: offering an adult-only session first and then a follow-up family session with the same set of adult learners. Two program partners were involved in testing sessions. The sole family learning class comprised nine parents and their children (ages 4–8). Parents first participated in the adult-

only session and subsequently completed a family session with their children. Two adult education programs were involved in testing the Activity Set model. One location (primarily a program serving ESL learners) offered an adult-only session with a follow-up family session. Below is a short description of implementation at each of the two Round 4 testing sites.

- *Massachusetts.*The Activity Set was implemented in a program that supports newly arrived immigrants by engaging in family education, particularly supporting parent involvement in education. The instructor has 23 years of teaching experience and had some prior knowledge of Ruff Ruffman learning programs. Her previous experience with teaching science was limited to a culinary science class for ESL students. The event was offered to program participants with children in the target age range. Two adult learners and their children attended this experience.

- *Rhode Island.* The Activity Set was implemented in a program that focuses on providing family education and adult education classes. The instructor has 11 years of teaching experience. This educator reported that she was initially intimidated by science early in her career, but became more engaged by facilitating science programming for children and, eventually, for adult learners. The event was offered to program participants with children in the target age range. Nine families (11 children) participated.