Summative External Evaluation Report

for

An Informal Learning Model of Genetic and Genomic Education for Adult, Bilingual Learners Project

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Executive Summary

The NSF-funded project titled *An Informal Learning Model of Genetic and Genomic Education for Adult Bilingual Learners*, was led by Joanne Sandberg, PhD. The project included three phases:

- Phase I: Investigation of knowledge and beliefs about transmission of traits, genetic and genomic concepts, gene-environment interactions, and environmental exposures in Latinx adults born in Mexico or Central America and who have limited literacy.
- Phase II: Development of two educational interventions in Spanish that address:
    1. Information about environmental exposures that can be detrimental to health plus information about genetics/genomics
    2. Information about environmental exposures that can be detrimental to health only
- Phase III: Delivery of the educational interventions in Spanish by Lay Community Educators who are Latinas born in Mexico or Central America. Participants in each arm of the study received one of the interventions.

A critical contributor to the project's success was the team's use of a community-informed approach throughout. This included a Community Advisory Committee, interviews with community members that informed development of the intervention, focus groups with

community members during intervention development to obtain feedback on the materials, and employing Lay Community Educators to deliver the intervention.

The project was carried out as outlined in the Logic Model with a few modifications. Primary among these was a change in the partner for developing the animated videos that are part of the educational intervention, and modifications to the hands-on activities due to the pandemic.

Despite the pandemic, the Lay Community Educators were successful in recruiting and retaining 202 participants, who completed all intervention and survey components. The project thus met its goal of 200 participants.

Data analysis showed mixed results in terms of participants in the two arms reporting increased interest in science and in internal and external motivation for learning science. The data also showed mixed results in terms of participants' science self-efficacy and genetic self-efficacy in the two arms. However, participants in the genomics + environmental arm showed significant increases in their genomics knowledge. A post-hoc analysis showed significant differences between the two arms in participants' scores on three concept clusters—inheritance, gene-environment interactions, and molecular.

As they reflected on the project, team members noted a number of factors that contributed to its success, including the PI's inclusive leadership style, the Program Coordinator's knowledge of and skillful translation between the Latinx and research communities, the respect shown among team members and their acknowledgement of each other's expertise, and the Lay Community Educators' ability to recruit and retain members of their community in the study, among others.

Introduction

The overall goal of this project was to develop and evaluate a community model of informal genomic education that is culturally and educationally appropriate for Latino adults born in Mexico and Central America (MCA) who have limited literacy. The community engagement strategy and materials the project created were designed to lead to three learning outcomes:

- Increased interest and engagement with genomics
- Change in science, technology, engineering, and mathematics (STEM) attitudes and self-identity
- Increased understanding about gene function and the human genome.

Specific Aims

The project was designed to achieve the following Specific Aims, stated in the grant proposal:

AIM 1: Delineate beliefs and knowledge about genetic concepts, including "gene," "heredity," "DNA," and transmission of traits to subsequent generations among Latinos in order to identify common misconceptions and barriers in genetic and genomic education.

AIM 2: Delineate Latinos' understanding of common environmental exposures that can affect the expression of physical traits and cognition. These exposures include lead, pesticides, environmental tobacco smoke, dietary exposures (e.g., phthalates), and toxicants created through use of residential burning (e.g., polycyclic aromatic hydrocarbons).

AIM 3: Develop and test procedures for meaningful community-based education about the effect of gene-environment interaction, including but not limited to epigenetic factors, on health among Latinos.

AIM 4: Delineate how Latino lay heath advisors (promotoras) and Latino non-promotoras conceptualize health and illness after they have learned about concepts relevant to genetics and genomics, including gene-environment interactions.

Project Phases and Research Questions

The project was divided into three phases.

Phase I: Investigation of MCA Latinx adults' knowledge and beliefs

Semi-structured in-depth interviews were conducted in Spanish with 60 MCA Latinos with limited formal education to identify their beliefs and knowledge about transmission of traits, genetic and genomic concepts, gene-environment interactions, and environmental exposures. The interview transcripts were analyzed with an eye to identifying information that could inform the Phase II development of an educational intervention.

The research questions for this phase, which addresses Aims 1 and 2 were:

Research Question 1: What are the sets of beliefs held by adult Latinos born in Mexico and Central America (MCA) about how traits are transmitted to subsequent generations and how environmental exposures influence the transmission and expression of these traits?

> *Research Question 1a:* What are the *commonly* held beliefs among MCA adult Latinos about how traits are transmitted to subsequent generations and how environmental exposures influence the transmission and expression of these traits?
>
> *Research Question 1b:* What are *less commonly* held beliefs among MCA adult Latinos about how traits are transmitted to subsequent generations and how environmental exposures influence the transmission and expression of these traits?

Research Question 2: How do beliefs held among MCA adult Latinos about how traits are transmitted to subsequent generations and how environmental exposures influence the

transmission and expression of these traits vary by participant characteristics (region of birth, education, etc.)?

Phase II: Development of two educational interventions

Knowledge gained from Phase I and input from a Community Advisory Board were used to iteratively develop two educational interventions:

1. Information about environmental exposures that can be detrimental to health plus information about genetics/genomics
2. Information about environmental exposures that can be detrimental to health only

Both interventions consisted of 5 modules or lessons and included practical strategies that individuals and families could use to maintain their health. The information and strategies were used as the "hook" to interest, engage and retain study participants.

This phase addressed Aim 3.

Phase III: Lay Community Educators delivered the educational interventions

Lay Community Educators (LCEs) from the focal communities were trained to deliver the educational interventions to community participants. To reduce chances for "contamination" in the data, each LCE only presented one of the interventions and mostly recruited participants from an assigned area in the vicinity of their home. One hundred participants were recruited for each arm of the study. The implicit hypotheses for Phase III were:

Hypothesis 2.a.: At least 70% of MCA Latino adults who participate in the first module of the set of informal learning opportunities will participate in all five modules.

Hypothesis 2.b.: MCA Latino adults who are involved in the set of informal learning opportunities that integrate genetic and genomic content will demonstrate significantly greater increased *interest in and engagement with genetics and genomics, and science more generally,* than MCA Latinos who are involved in the informal learning opportunities that exclude genomic content.

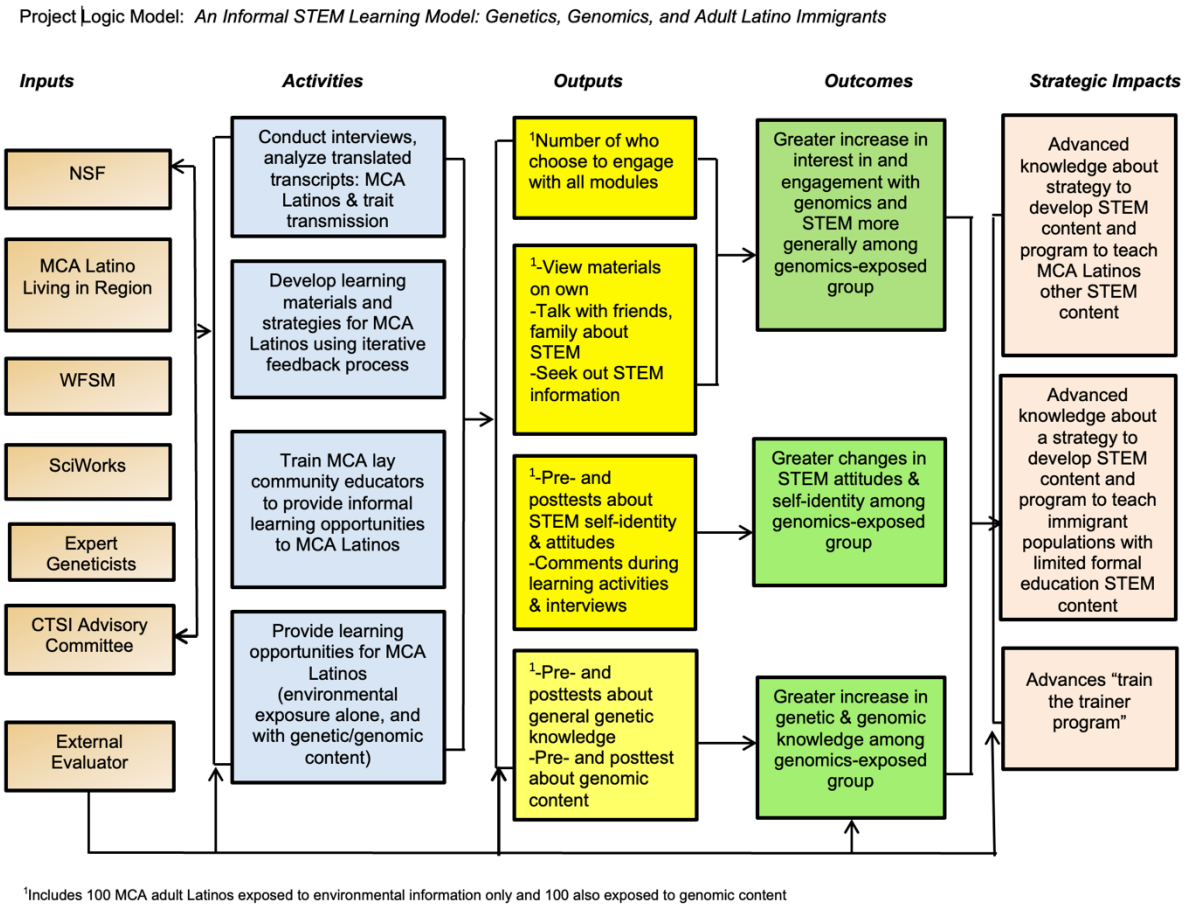
Hypothesis 2.c.: MCA Latino adults who are involved in the set of informal learning opportunities that integrate genetic and genomic content will demonstrate a significantly greater increase in *their self-perception as science learners* than MCA Latino adults who are involved in the set of informal learning opportunities that exclude genomic content.

Hypothesis 2.d.: MCA Latino adults who are involved in the set of learning opportunities that integrate genetic and genomic content will demonstrate a significantly greater increased interest in *genetic and genomic knowledge* than MCA Latino adults who are involved in the set of informal learning opportunities that exclude genomic content.

Project Logic Model

The logic model that was submitted with the grant proposal is shown on the next page (Figure 1). The following sections compare the extent to which the project was carried out in accordance with this logic model and places where the project differed, either due to unexpected changes or unanticipated opportunities.

Figure 1: Project Logic Model



[1]Includes 100 MCA adult Latinos exposed to environmental information only and 100 also exposed to genomic content

Project Inputs

Most of the project inputs remained as planned throughout the project, although there were several important changes and additions:

- *NSF* funding was essential to conducting the project.
- *MCA Latinos Living in the Region* participated in the interviews and informal learning opportunities (educational interventions).
- *Wake Forest School of Medicine* faculty and staff remained the same, with the addition of a Public Health Sciences Analyst, who joined the team late in the project to assist with

data cleaning and analysis. (Appendix A, Table A.1 includes a list of project team members, their areas of expertise, and contributions to the project).
    - The project originally planned to collaborate with the WFSM Communications Office on developing the videos and did so during script development and early storyboarding. However, the institution decided that it wanted this Office to focus on other priorities and it became apparent that the videos would take more time than originally expected. Therefore the Office recommended Out of Our Minds Animation Studios to replace them, providing initial coordination during the transition (see Additions, below). The Communications Office staff member who was most closely involved with the project also contributed to the project by recording the audio from their own infant/toddler, which was used as the voice of Juanito, the baby in the video.
- *Dr. DaKysha Moore*, who has expertise in health communication, also was a member of the project team. She was a faculty member at Johnson C. Smith University when the project began and subsequently moved to North Carolina Agricultural and Technical State University; both institutions are historically black colleges and universities (HBCUs).
- *SciWorks* museum and science center (now Kaleideum). The key person in this collaboration was Dr. Paul Kortenaar, who was Executive Director when the project began.
    - The Kaleideum team was involved in developing interview questions related to visitation and interest in science museums.
    - Dr. Kortenaar remained a member of the project team throughout subsequent moves to two other informal science education institutions (see Appendix A, Table A.1).
- *Expert Geneticists* ensured that the genetics and genomics information in the educational interventions were accurate. They included one member of the project team (Dr. Howard) and two external consultants (see Appendix A, Table A.2).
- *CTSI Advisory Committee* provided recommendations for two of the Community Advisory Committee members; this committee may have been less involved than originally planned.
- *External Evaluator* provided expertise as a "critical friend" during educational materials development and served as the project evaluator (Dr. Stark, see Appendix A, Table A.3).

Additions:

- *Out of Our Minds Animation Studios* (OOOMAS), an independent multimedia company, collaborated in producing the animated videos that are an important part of the educational interventions. The project team iteratively developed the video scripts with input from the Community Advisory Committee, and OOOMAS produced the videos.
- *Community Advisory Committee (CAC).* The seven CAC members (see Community-Based Participatory Research section below and Appendix B, Table B.1) brought expertise in working with the Latinx community, particularly in health and education/learning; all were bilingual in Spanish and English.

- While the CAC is not listed in the Inputs, this group provided important input and feedback as well as community connections throughout the project.

Community-Informed Approach

A critical contributor to the project's success was the project team's use of a community-informed approach throughout. While this is only hinted at in the Logic Model, this was an essential component of the project. Therefore, it is worth describing these components at this point in this report before discussing other components of the Logic Model. The community-informed approach included:

- A Community Advisory Committee that met 2-4 times/year throughout the project to provide input and feedback on the project's work.
- Semi-structured interviews with 60 community members to learn their thoughts and beliefs related to the project's focal topics; this information was used to inform development of the educational interventions.
- Four focus groups with Latinx community members who are similar to individuals who would be recruited to participate in the study. In two focus groups held in the first half of intervention development, participants provided feedback on video story lines and storyboard imagery, and science concepts, including cultural appropriateness. Two focus groups also were held near the end of the development process to gather feedback on the near-final materials. For both sets of focus groups, women and men met in separate groups.
- Hiring and training immigrant Latinx community members to serve as Lay Community Educators (LCEs). These five women recruited participants and delivered the educational interventions to them.

Community Advisory Committee (CAC)
Early in the project, the team recruited a 7-member Community Advisory Committee (CAC; see list of members in Appendix B, Table B.1). All are members of the Latinx community or closely involved with this community. Four women have expertise in health education and health communication. Another has expertise in formal and informal learning in immigrant families. One is the director of a non-profit organization that serves the local Latinx community and another is a retired director. All are engaged in the Latinx community and have multiple connections. While it might have been preferable to include several men on the CAC, family health is considered to be part of women's "domain" in Latinx communities. Men may have felt less comfortable serving on a CAC that focused on family health.

The CAC met 12 times during the 4.75 years of the project (see Appendix B, Table B.2), with an additional email update and request for input provided in May 2020, two months into the pandemic. While attendance was not as consistent as might be wished, four or more CAC members participated in 8 of the 11 meetings held before the pandemic (67%); 3 members participated in 82-91% of the meetings, 2 participated in 55% of the meetings; and 2

participated in 27-36%. Four project team members and the external evaluator also participated in 82% or more of the meetings.

The CAC meeting topics and focus changed throughout the project (see Appendix B, Table B.3). During Phase I activities, the CAC provided input and feedback on the Semi-Structured Interview Guide, assisted with identifying and recruiting participants, and later discussed the codebook used for data analysis and the analysis of interview data. For Phase II activities, the CAC reviewed and provided input on key concepts to include in the educational materials, module outlines, video scripts and storyboards, lesson plans, hands-on activities, draft videos, and flipcharts. They also provided input on naming the project and the educational intervention: *Nuestra Familia Sana* (Our Healthy Family). During all phases, the CAC provided suggestions for places to recruit participants. Findings from the Phase III data were reported and discussed at a final meeting. The project team was responsive to the CAC input and feedback, carefully considering their suggestions and implementing those that were feasible.

Project Activities

The four Activities listed in the Logic Model were carried out, although modifications in one were made due to the SARS-CoV-2 pandemic.

Conduct interviews with MCA Latinos

As planned, semi-structured interviews were conducted in Spanish with 60 Latinx immigrant adults who were born in Mexico or Central America (MCA); 30 men and 30 women participated, with 45% having less than a seventh grade education. Each interview lasted 40-80 minutes and participants received a $25 incentive. The interviews were completed before the pandemic, so were not disrupted by it.

The interviews explored participants' thinking and beliefs in two topic areas. One set of questions focuses on how traits are transmitted between family members, participants' familiarity with genes and DNA, the role of blood in trait transmission, the basis of similarities in different types of twins, and the location and relative sizes of genes and DNA in the body. Another set of questions explored participants' knowledge about environmental risks (pesticide exposure, lead exposure, secondhand tobacco smoke, dietary exposure, plastic exposure (Bisphenol A; BPA) and their impacts on health. Note that in the grant proposal, Aim 2 listed "toxicants created through the use of residential burning (e.g., polycyclic aromatic hydrocarbons)" as one of the environmental exposures that would be used in the intervention. However, early in the project the team decided that given the restrictions on "barrel burning" in urban environments, it would be better to change the focus to BPA. This had the benefit of BPA being a good exposure in the context of educating participants about epigenetics. This decision was made before the team conducted the Phase I interviews, so questions related to BPA and its health effects were included in these questions. The interview findings are briefly summarized below; the numbers for relevant citations in Appendix C are in square brackets.

Heredity and traits: Data analysis revealed that participants were aware of trait transmission from parents to children. However, researchers identified five mental models related to heredity. While four of the models include genes, only 1 model links DNA to heredity. Most of the models include blood as a component of trait transmission. The findings elucidated that educational materials for this population would need to assume that individuals had no prior knowledge of cells, DNA, genes or inheritance and/or that knowledge about these terms may be inaccurate. This means that all visual images and terms need clear explanations. In addition, references to blood and use of the color red should be avoided, if possible; if it is necessary to refer to blood, it is important to be very specific and address potential assumptions. [2, 10, 15, 16, 17, 18, 25].

Environmental exposures. The interviews also explored participants' knowledge and beliefs about five environmental exposures that can impact health [1, 4, 15].

- *Secondhand smoke*. A key finding was that most people believed that secondhand smoke was more harmful than primary smoke [1].
- *Lead*. There was widespread awareness that exposure to lead is harmful and that one source is old paint. However, fewer individuals were knowledgeable about the health effects of lead exposure.
- *Bisphenol A (BPA)*. Few participants were familiar with BPA.
- *Diet.* Participants were aware that both diet and family history can influence one's health, such as in diabetes. Most were aware that a healthy diet includes vegetables and is low fat.
- *Pesticides.* Participants were aware that exposure to pesticides is harmful. They primarily discussed this within the context of crop production and comestibles. Exposure to pesticides used in the home was not mentioned as often.

These findings provided information for developing the environmental exposures portion of the educational materials, identifying misconceptions (e.g., secondhand smoke) and topics with low awareness that would need more information (e.g., BPA).

These activities were carried out as planned and—as anticipated—provided a rich set of information for developing the educational interventions. The findings from Phase I were reported in two published papers [1, 2], one manuscript [4], and seven presentations (oral or poster) [10, 15, 16, 17, 25, 26, 27]

Develop learning activities and strategies using an iterative feedback process

During grant proposal planning, the project team decided that teaching people about environmental exposures that can impact health and ways to mitigate or avoid these exposures would provide the "hook" to engage participants in learning science concepts. This approach was designed to overcome potential barriers to participation such as limited science background, the perception that science is "not for me," and competing time demands. The team engaged in a multi-iteration process to develop the learning activities and materials,

which included videos, flip charts for the Lay Community Educators to use, and hands-on activities.

The team identified potential genetics and genomics concepts to include in the materials and carefully considered how these could be integrated with educational materials on environmental exposures that impact health. They also identified hands-on activities related to each module topic that would be culturally appropriate and relevant. In addition, the activities needed to be easy to both transport and carry out in home settings. From this work, they identified the topic/activity combinations and learning sequence shown in Table 1.

Table 1: Module topics and hands-on activities for the intervention

Module	Environmental Exposures	Genetics/Genomics	Hands-on Activities
1	Secondhand smoke	Cells, genes, DNA and mutations	• Microscope with cheek cells and neurons slides • DNA model and bases • DNA mutation demonstration
2	Lead	Inherited traits, cell communication, and fertility	• Identifying safe and unsafe dishes • Marshmallow and bowl model of cell communication with and without lead present
3	BPA	Epigenetics	• Pipe cleaner model of DNA and epigenetic changes • Sorting containers by safety level
4	Nutrition	Gene-Environment interactions	• Identifying amount of sugar in sweet food items • Puzzle with risk factors for disease
5	Pesticides	Genetics review	• Identifying ways the environment and behavior can cause changes and harm

The team developed learning objectives for each module and then created a storyline for a set of videos (1/module) that would serve as a key component of delivering the educational content. The 5-part, animated series uses a telenovela style to engage viewers' interest in the story while also incorporating health and science content. The team sought to develop a story in which each of the adult characters brings information to share with the others (modeling life-long learning) and no one is the "fall guy." In the final project team interview, the PI noted that "we were very conscious of being respectful of the characters and showing that they can learn." Video script and storyboard development as well as flipchart development were a collaborative process with the Out of Our Minds Animation Studio (OOOMAS) team members assigned to the project, with weekly meetings and other communication. Additional input and feedback were provided by the Community Advisory Committee and the external evaluator. The OOOMAS and script-writing project team developed a creative way to provide genetics/genomics content for the videos in that study arm, while enabling the video content to also be used for the

environmental exposures only arm: the genetics/genomics content was shown on a tablet by characters in the story. This made it relatively easy to cut these parts of the videos out for the environmental exposures only study arm.

Four focus groups were held with MCA individuals who have similar demographics to those who were recruited to participate in the study. These focus groups are not included in the Logic Model. However, this addition provided important feedback during the development process. Approximately halfway through development, two focus groups were held to solicit feedback on the video story lines and storyboard imagery, as well as the science concepts; participants also were asked to comment on cultural appropriateness of the images and story. Two focus groups also were held near the end of the development process to gather feedback on the near-final materials. For both sets of focus groups, women and men met in separate groups, which is culturally appropriate.

Storyline for the videos, each 6-9 minutes long [text taken from 21]:
Note: The videos for the "environmental exposures only" arm of the study did not include the genetics/genomics content described below.

A family prepares for Juanito's first birthday and learns new ways to keep its family healthy in each episode

1. Secondhand smoke, DNA and cancer.
The family is preparing for Juanito's first birthday. The family learns what secondhand smoke is and how to protect their family. They also learn about cells, genes, DNA and how secondhand smoke can cause mutations in DNA that can increase one's risk of cancer.

2. Lead causes harm independent of impact on genes.
As the family prepares the backyard for the party, they learn that lead is an environmental exposure that causes harm through a mechanism that does not involve genes. They also learn about the health effects of lead exposure, how to reduce lead exposure, and about conception and how twins are formed.

3. Bisphenol A (BPA) and epigenetic changes to genes.
While Juanito's mom makes a piñata, she learns about BPA and how it can affect genes through epigenetic changes. They learn how to limit use of plastics to reduce negative health effects of BPA.

4. Food choices and gene-environment interactions.
While cooking for the party, the family learns about food choices such as sugar, salt, and fats, and how they can modify genetic health risks.

5. Pesticides and summary of mechanisms, including genomic, through which environmental exposures can influence health.

The family celebrates Juanito's first birthday and learn about safer alternatives to pesticides to get rid of pests. The family talks about how life choices, behaviors, and environmental exposures can affect their health.

In addition to the videos, a flip chart was developed for each module, to be used by the Lay Community Educators during the session with participants. The front of each "card" had images and brief text for participants while the back provided details about content to present, questions to stimulate discussion, and hands-on activity instructions. This type of flip chart has been successfully used in other educational interventions taught by Lay Community Educators.

The project team sought out multiple sources of stakeholder input at each major stage during development of the educational materials, modeling best practices for stakeholder-informed educational materials design. This was a real strength of the project.

The processes used in Phase II of the project were reported in one manuscript [3], and four presentations (oral and poster) [11, 14, 18, 21].

Train MCA Lay Community Educators (LCEs)

The Project Coordinator, who is bilingual in Spanish and English, provided training for the LCEs. The LCEs for each of the two study arms met separately and were not informed about the other arm. This approach was selected in order to reduce the possibility of "contamination" between the two arms and seemed to achieve this aim.

The Project Coordinator held two 5-hour close-spaced training sessions with the LCEs for each study arm. In addition to content that was specific to the curriculum the LCEs would be teaching, the trainings included content on professionalism, reporting suspected child or drug abuse, and domestic violence. The team geneticist, Dr. Howard, participated in the relevant sections of training for the genomics arm of the study. In a third session for each arm, the LCE's practiced teaching a lesson to the Coordinator and received feedback. The Coordinator also taught a lesson to the LCEs to model best practices in teaching. The LCEs were then asked to further practice by teaching 1-2 lessons to a family member or someone who would not qualify as a study participant.

Following the training, the Project Coordinator conducted in-person observations of each LCE teaching each of the five lessons and provided feedback to them; she conducted 5-10 observations for each LCE. The observations were conducted using an observation record sheet that she developed for each lesson on which she recorded the LCE's fidelity of implementation and participants' reactions/behaviors. These observations served as a "quality control" component for the intervention. The Project Coordinator and LCE met immediately after each observation so that the Coordinator could provide them personalized feedback on the teaching strategies they were using as well as suggestions for ways to improve their strategies and interactions with participants. The observation and feedback component of the project's work with the LCE's is a best practice that can be shared with others conducting similar types of interventions.

The LCE's received additional formal training after the initial training, including a 4-hour training mid-way through the study and a 3-hour safety training. The latter took place after new Covid-19 project safety measures were approved by the IRB. The LCE's learned about the new procedures and how to provide online and in-person lessons using the modified hands-on activities. Taken together, the training program seems comprehensive and appropriate for the LCEs.

In order to share their training processes, the project team developed an educator training manual [30] and a "train-the-trainer" manual [31] which are freely available on the *Nuestra Familia Sana* project website (https://school.wakehealth.edu/departments/family-and-community-medicine/nuestra-familia-sana).

The project had an excellent LCE retention rate. Three of the four original LCE's stayed throughout the study. The fourth one did not continue due to fears about Covid-19 infection after the pandemic began.

The project's LCE compensation approach provides a model for similar interventions. LCE's received $300 for the initial training and $150 for the mid-year training. Their compensation for teaching the lessons was tiered, in order to encourage them to retain participants through the study. LCEs received $55/lesson for sessions 1-3, $60 for lesson 4, and $70 for lesson 5; this averages to $59/lesson. The LCE's were also reimbursed for their mileage at the federal rate. When recruitment became more challenging toward the end of the study, LCE's were paid $10 if they recruited a participant for the other LCE in their study arm (LCE's were assigned a specific area in which to recruit). In order to receive payment, the LCE's submitted an invoice, activity sheets and participant lesson information.

Provide learning opportunities for MCA Latinos

Individuals were eligible to participate in the study if they were adults who were born in Mexico or Central America, speak Spanish, and have a child aged 13 years or younger. The goal for participant education levels were: at least 30% have a sixth grade education or less, 60% have less than a high school education, and no more than 10% have a high school education or equivalent (e.g., GED).

Despite the pandemic and the resulting challenges to participant recruitment, the study met its goal of 100 participants in each of the two study arms (102 in the genomics + environmental arm and 100 in the environmental-only arm). These individuals each completed the pre-test, all five educational sessions, and the post-test. Only 10.6% (24 individuals) did not complete all study component. This speaks to the high interest level the intervention generated and participants' commitment, despite challenges posed by the pandemic, work conflicts, illness and school. In addition to participant numbers, the study met its goals for participant educational levels; 39% have a sixth grade education or less, 11% completed grades 7 or 8, 41% completed grades 9-11, and 9% completed 12th grade or equivalent, such as a GED. Most participants were born in Mexico (72%) and were female (81%).

Each lesson lasted approximately 30-60 minutes, depending on the number of questions participants asked. The first lesson for the genomics arm took 50-60 minutes due to teaching more genetic science and setting up the microscope. After the pandemic began, children were not in school so households were busier and more chaotic, making the lessons more challenging to complete. Participants received incentives of $30 for the pre-test/survey and $30 for the post-test/survey; they were not provided with an incentive for participating in the educational sessions. However, those who completed the sessions were given two family passes to Kaleideum, which were donated by the museum. Since Kaleideum has two locations, the passes provided the opportunity for participants to visit both museums. Those who participated in the 6-month follow-up survey received $35.

The study took place over a 15-month period. Most participants completed their sessions during a 4-week period, with approximately 1 lesson/week; five participants took longer at the beginning of the SARS-CoV-2 pandemic.

Modifications due to the pandemic

The Lay Community Educators had begun working with participants when the SARS-CoV-2 pandemic hit. Approximately 14-16 participants were in the middle of their series of five lessons in March 2020. The pandemic ended in-person meetings until safety protocols could be established and approved by the Wake Forest School of Medicine IRB. The Program Coordinator modified the hands-on activities so that each participant could have an individual set of materials that were not touched by others. For example, instead of using a microscope, there were pictures of cells on slides in which participants could point to the nucleus; chenille stem models replaced the large DNA model. Guidelines were established for the Lay Community Educators to meet outdoors and only with individuals from the same household. The project purchased iPads so that individuals could have the option of participating remotely. However, only a few participants took advantage of this option. The Educators began meeting with participants again in October 2020.

The project is to be congratulated on how well it was able to adapt the intervention and intervention processes to the constraints imposed by the pandemic. At a time when many clinical trials were stopped and many research studies had difficulty recruiting participants, this study succeeded in meeting its study participant completion goals. This accomplishment was due to excellent facilitation and support by the study team as well as the creativity and persistence of the Lay Community Educators.

Project Outputs

The project outputs in the Logic Model focus on data that were collected from study participants. All of these data were collected and thus the project accomplished these outputs. The first implicit hypothesis is relevant to the Project Outputs:

Hypothesis 2.a.: At least 70% of MCA Latino adults who participate in the first module of the set of informal learning opportunities will participate in all five modules.

This hypothesis was supported; 89.4% of participants completed all five lessons in addition to the pre and post-tests.

Project Outcomes

The project outcomes are related to three of the implicit hypotheses. The findings related to these hypotheses are summarized below.

Hypothesis 2.b.: MCA Latino adults who are involved in the set of informal learning opportunities that integrate genetic and genomic content will demonstrate significantly greater increased *interest in and engagement with genetics and genomics, and science more generally,* than MCA Latinos who are involved in the informal learning opportunities that exclude genomic content.

Note: This measure focused on interest in science as well as internal and external motivation to learn science. The Cornell Laboratory of Ornithology, which developed the measures, suggested conducting separate analyses for participants with initial lower and higher scores. Therefore the team decided to group the data by participants who scored less than the median score on the pre-test and those whose scores were equal to or higher than the median score.

This hypothesis was not supported, but there are some caveats.

Participants who had pre-test scores less than the median score:

- Participants in the genomics arm reported a statistically significant increase in interest in science at $p = 0.003$. However, the increase was not greater in the genomic arm than the environmental only arm.
- Participants in the genomics arm reported a statistically significant increase in both internal and external motivation ($p < 0.001$ and $p = 0.006$, respectively). Furthermore, the change in both internal and external motivation was greater among those in the genomics than the non-genomics arm ($p < 0.01$ and $p = 0.01$ respectively).

Participants who had pre-test scores greater than or equal to the median score:

- Interest in science in the genomics arm did not increase.
- Participants in the genomics arm reported a significant decrease in external motivation ($p = 0.01$), and participants in the environmental only arm reported a significant decrease in internal motivation ($p < 0.01$). However, the changes in internal or external motivation did not vary significantly across arms.

It appears that participants in the environmental only arm perceived that they were learning about science. While this is true, they were not learning science at the same level of complexity as those in the genomics arm. It therefore is not surprising that there were not more differences in magnitude in changes in attitudes between those in the genomics and environmental only arms.

Hypothesis 2.c.: MCA Latino adults who are involved in the set of informal learning opportunities that integrate genetic and genomic content will demonstrate a significantly greater increase in *their self-perception as science learners* than MCA Latino adults who are involved in the set of informal learning opportunities that exclude genomic content.

Note: These measures focused on science self-efficacy and genetics self-efficacy.

This hypothesis was partially supported.

Participants who had pre-test scores less than the median score:

- Participants in both arms reported significantly higher post-test than pre-tests scores for general science self-efficacy and genetic self-efficacy at $p < 0.001$. However, the size of the change was not significantly greater between the genomics arm and the environmental only arm.
    - The increase in genetic self-efficacy among the environmental only group may be due, in part, to a halo effect – they may have perceived that they could learn about all science topics, including those to which they had limited exposure.

Participants who had pre-test scores greater than or equal to the median score:

- The increases in science and genetic self-efficacy among those in the genomics arm were not statistically significant. Although not statistically significant, the science and genetic self-efficacy scores decreased in the environmental only arm. As are result, the genomics arm reported a statistically significant greater increase in genetics self-efficacy ($p = 0.01$).

Hypothesis 2.d.: MCA Latino adults who are involved in the set of learning opportunities that integrate genetic and genomic content will demonstrate a significantly greater increased interest in *genetic and genomic knowledge* than MCA Latino adults who are involved in the set of informal learning opportunities that exclude genomic content.

This hypothesis was supported.

Comparisons between answers on the pre- and post-intervention genetic/genomic assessment items revealed an improvement in both the genomic and environmental only groups.

- In the combined groups, participants provided correct responses 35.81% of the time for the pre-intervention genetics/genomics items, and 58.05% of the time for the post-intervention items.
- To test our hypothesis that the genomics information provided additional learning, we evaluated the pre- and post-intervention scores stratified by intervention group. While the

environmental only group's correct response scores improved after the intervention (from 37.2% to 52.4%), a much greater improvement was observed in the genomics group (from 34.4% to 63.6%); the difference between the improved scores was highly significant (p = 0.0002). The difference in correct responses between intervention groups appeared to be due to the intervention itself, since the pre-intervention assessment scores were not significantly different between groups (p = 0.34).

Not all of the hypotheses were fully supported by the data. However, this was a research study so these types of outcomes are within the expected range of possible findings.

An additional data analysis was carried out after looking at the data. The project team noticed that the improvement in correct responses to the knowledge assessment items varied considerably among items for the genomics group. To better understand which genomic/genetic concepts were more easily learned by participants, they performed a post-hoc analysis, combining multiple questions into three genetic concept clusters: "Inheritance" (3 questions), "Gene Environment Interaction" (5 questions), and "Molecular" (6 questions). The genomics participants showed significantly higher pre/post knowledge gains than the environmental only participants (p = 0.01 - 0.0007; Table 2). This analysis provided a thoughtful, additional way to look at the data.

Table 2: Differences between pre-test and post-test for the two study arms, based on genomic/genetic concept clusters

Concept cluster	Environmental only (mean + SD)	Genomics + Environmental (mean + SD)	P-value
Inheritance	20.3 (35.4)	35.9 (38.6)	0.003
Gene-Environment Interaction	19.2 (33.7)	31.0 (31.7)	0.01
Molecular	8.7 (32.2)	23.9 (30.4)	0.0007

Strategic Impacts

The Logic Model includes three strategic impacts that the project team anticipated would result from this project. The first two impacts are very closely related, particularly since the project focused on MCA Latinos, many of whom are immigrants from Mexico with limited formal education.

Advanced knowledge about strategy to develop STEM content and program to teach MCA Latinos other STEM content

Advanced knowledge about a strategy to develop STEM content and program to teach immigrant populations with limited formal education STEM content

The strategy the project team used to develop the intervention is described above in the "Develop learning activities and strategies using an iterative feedback process" section of the Project Activities. The team used community-informed processes to iteratively develop the intervention so that it was culturally and linguistically appropriate for the MCA community, as well as being at an appropriate science and health content level. The fact that 89% of initially-enrolled participants completed all intervention components (even in the midst of a pandemic) speaks to the high interest generated by the project's educational materials. Thus, the processes the project team used provide a model that can inform others' work.

Advances "train the trainer program"

The project team's training manuals are freely available on the *Nuestra Familia Sana* project website (https://school.wakehealth.edu/departments/family-and-community-medicine/nuestra-familia-sana). The manuals, along with the training procedures and compensation model for Lay Community Educators provide models that can inform others' work. This will be important as the roles of Community Health Workers continue to expand.

Factors Supporting Project Success

The external evaluator held a series of conversations with project staff in August 2022, near the end of the project. The following two sections summarize these conversations.

The Principal Investigator, Dr. Joanne Sandberg, set the tone for a collaborative team in which each person's expertise and contributions were respected. As one team member said, "A lot of things start at the top with the PI. A lot of times if you're not as senior as they are, you feel that your suggestions are ignored." They went on to say that the project PI solicited input from each team member.

The bilingual (Spanish and English) Program Coordinator was essential to the project's success. She is a member of the Latinx community, is familiar with the local community, developed the Spanish version of the intervention, was able to train the Lay Health Educators in Spanish and to observe the lessons they presented in Spanish, etc.

Most team members are not part of the Latinx community. The Project Coordinator, who is part of this community, said "people didn't go into stereotypes, they didn't assume things, they were open to what I had to say." She also noted that employing Lay Health Educators from the community demonstrated respect and sensitivity to the community's needs.

Employing Lay Community Educators who were members of the focal communities was very important to the project's success and its ability to meet its recruitment goals, even during a pandemic.

All members of the project team felt that they demonstrated a great deal of respect for each other and recognized each other's expertise. For example, one team member said "I could share questions I had and felt that people would respond in a way that respected me as a person while bringing their expertise to the conversation. People could express differing perspectives without feeling judged." Another team member said "When I had something to say that was important, it wasn't dismissed."

Team members worked together collaboratively. For example, Grisel, Tim and Joanne were the primary team members working on the videos. Joanne said "It was astounding how much back and forth there was. Grisel knew what was appropriate for the audience, Tim provided the genetics content, and I became the person who emphasized short sentences and limiting pronouns."

The team was very conscious of being respectful of all characters when developing the videos. As one team member said "We didn't want to have a fall guy. We wanted everyone to be respected in the videos and be shown as someone who could learn. Each person throughout the videos had an opportunity to share information."

The project team worked very closely with the video team in a multi-iteration process. When reviewing the video scripts and drafts they "asked how many different ways could people misconstrue or misunderstand what is being presented?" The video team did not have a genetics background, which also helped the project team see how something could be misunderstood."

Project team members brought experiences from prior projects that worked with Latinx populations, particularly a video about epigenetics that was part of a prior grant. This prior work also showed the importance of participants recalling information themselves.

Project team members felt that they "learned a lot" and "had a lot of fun."

Project Team Members' Learnings

After holding the trainings for the Lay Community Educators, the Program Coordinator realized that it would be helpful to break the content training sessions into three sessions, instead of two sessions, so that the Educators have less new content to absorb in each session.

The project provided opportunities for individuals who had not done so previously, to engage with and learn from community members. For example, the geneticist said "…the interaction with the participants was phenomenal. We learned things I never imagined." "For example, people thought that breathing second hand smoke was worse than smoking."

Working on a team with differing areas of expertise expanded each member's understanding of community engagement and research. For example:

- The geneticist learned that it is very important to be culturally sensitive and appropriate when explaining genetics to community members.
- The statistician learned about qualitative analysis and gained an appreciation for it.

The interviews with MCA individuals in Phase I were critical to developing the educational materials. As one team member said "We found that we really had to start at ground zero for teaching about genetics. We couldn't assume that people knew what a cell is. We realized that a lot of things out there for genetics [education] assume an awful lot."

Including the environmental information was an important component for study participants. As one team member reported: In the interviews with participants after they completed the educational materials, "people said that this information was something I had no idea about." "The intervention showed small changes that people could [reasonably] do; it was information that they could potentially achieve."

One team member remarked that based on the pre-/post-tests, some genetics concepts were more difficult. However, it is not clear if this is due to the questions or understanding the information. Are there other ways to assess participants' understanding of these concepts? For example, when the interviewer asked participants after the intervention "What did you learn about epigenetics?" almost everyone showed the DNA model, illustrating that their knowledge was tied to the activity they had carried out.

Another team member noted that they may have asked more generic questions in the pre-and post-test when they should have been more direct in asking what they specifically wanted to know.

The team had hoped that observations of the Lay Community Educators teaching would provide information about the types of questions and (mis)understandings that participants had. However, this did not turn out to be a fruitful way to collect data.

Dissemination of Project Processes and Findings

The project has and is in the process of disseminating project processes and findings (see Appendix B). Project dissemination metrics as of August 31, 2022 are:

- Papers published in peer-reviewed journals – 2
- Manuscripts under review – 2
- Manuscripts in preparation – 5
- Paper presentations at professional meetings – 4
- Scheduled presentation at a professional meeting – 1

- Invited presentation at an external academic institution – 1
- Poster presentations at professional meetings – 9
- Poster presentations at Wake Forest School of Medicine – 3
- Community presentations – 2
- Project training materials – 2

Additional dissemination opportunities suggested by the Community Advisory Committee

Community Advisory Committee members recommended using the educational materials in a community clinic, Migrant Education Programs, and with the parents of children who participate in these programs. They also suggested presenting at the annual meeting of the National Association of State Directors of Migrant Education.

Recommendations for Future Work

Continue to use Community-Based Participatory Research approaches for community-based projects. More clearly indicate community co-creation and/or iterative input/feedback in the project Logic Model.

Include Community Advisory Committee members, Lay Community Educators or other appropriate community members as authors on papers, posters and presentations. Provide opportunities for them to orally co-present posters and presentations. Include travel funds in grant budgets to they can attend professional meetings with project team members to give presentations.

Be aware that providing opportunities for community members to be trained as Lay Community Educators can have a strong impact on their self-efficacy and educational goals. Keep this in mind when developing train-the-trainer programs and materials, providing resources to support additional education.

- For example: Due to her experience, one of the Lay Community Educators felt empowered to go back to school, despite facing many obstacles. She graduated in August 2022.

Appendix A: Project Personnel and Contributors

Table A.1. Project Team Members
All at Wake Forest University School of Medicine unless otherwise noted

Name/Training	Title/Organization	Project Role/Areas of Expertise
Joanne C. Sandberg, Ph.D. Principal Investigator Sociologist	Associate Professor, Family and Community Medicine	• Overall responsibility for conducting the project, communicating with NSF, etc. • One of 4 coders of qualitative data • One of 3 team members who worked closely together and with animators to produce high quality videos and associated materials • Wrote/writing manuscripts (first author and co-author) • Expertise in informal STEM learning, Latinx health, including beliefs and behaviors; qualitative and quantitative research methods
Grisel Trejo, M.P.H. Project Coordinator	Research Associate, Family and Community Medicine	• Trained and supervised lay educators and interviewers, conducted in-depth interviews, contributed to material development • One of 4 coders of qualitative data • One of 3 team members who worked closely together and with animators to produce high quality videos and associated materials • Wrote/writing manuscripts (first author and co-author) • Expertise in working effectively with Latinx community members from Mexico and Central America on health-related issues and managing projects • Bilingual in Spanish and English
Thomas A. Arcury, Ph.D. Anthropologist	Professor, Family and Community Medicine	• Contributed to all phases of project • Wrote/writing manuscripts (first author and co-author) • Environmental health expertise, with particular focus on pesticide exposure; experience developing educational interventions and working with lay educators to deliver educational interventions • Expertise in Latinx health, including beliefs and behaviors and qualitative and quantitative research methods

Timothy D. Howard, Ph.D. Molecular Geneticist	Professor, Biochemistry	• Responsible for determining genomic content to be included in learning materials and ensuring accuracy of genomic content. • One of 4 coders of qualitative data • One of 3 team members who worked closely together and with animators to produce high quality videos and associated materials • Wrote/writing manuscript (first author and co-author)
Edward Hak-Sing Ip, Ph.D. Statistician	Professor, Biostatistics and Data Science	• Responsible for ensuring statistical analyses were conducted appropriately and accurately • Wrote/writing manuscript (first author and co-author) • Expertise in educational research and evaluation
Paul Kortenaar, Ph.D. Education	Chief Executive Officer, Ontario Science Centre Previously: Founding Executive Director, El Paso Children's Museum (2017-2020) Executive Director, SciWorks, Winston-Salem, NC (2013-2017)	• Contributed knowledge about effective informal science learning, including in the context of genomics, as well as useful knowledge about informal STEM learning community, and avenues for dissemination • Contributed to manuscript preparation
DaKysha Moore, Ph.D. Communication Studies	Associate Professor, College of Health & Human Sciences, Speech Program, North Carolina Agricultural and Technical State University	• One of 4 coders of qualitative data. • Wrote/writing manuscript (first author and co-author) • Expertise in health communication Previously: Assistant Professor, Visual, Performing & Communication Arts, Johnson C. Smith University (2016-2021)
Sara A. Quandt, Ph.D. Anthropologist	Professor, Epidemiology and Prevention	• Contributed to all phases of project • Wrote/writing manuscript (co-author, including 2nd author) • Environmental health expertise, with particular focus on diet; experience developing educational

		interventions and working with lay educators to deliver educational interventions. • Expertise in Latinx health, including beliefs and behaviors, and qualitative and quantitative research methods
Santiago Saldana, M.S.	Analyst, Public Health Sciences	• Responsible for cleaning and analyzing quantitative analysis under the supervision of Dr. Ip • Contributed to data analysis for manuscripts and manuscript preparation • Joined team as evaluation data was in final stage of being collected

Table A.2. External Expert Geneticists
Reviewed genomic content, including content in videos

Name	Title/Organization	Areas of Expertise
James Hickson, Ph.D.	Professor, University of Texas Health Science Center, Houston	• Expertise in the genetics of complex diseases
Vandana Shashi, M.D.	Professor, Duke University School of Medicine	• Expertise and experience in communicating genetic information to disadvantaged populations

Table A.3. External Evaluator

Name	Title/Organization	Areas of Expertise
Louisa A. Stark, Ph.D. Evolutionary Genetics Science and Health Education, Evaluation & Research	Professor of Human Genetics, and Director, Genetic Science Learning Center, University of Utah	• Expertise in developing multimedia, hands-on and print-based educational materials for K-12 and lay audiences, including Spanish-speaking and other members of diverse communities; conducting research and evaluation studies to evaluate the efficacy of educational interventions

Appendix B: Community Advisory Committee

Table B.1. Community Advisory Committee Members

Name	Title/Organization	Areas of Expertise
Keren Griselle Ferris	Clinical Research Manager, Pediatrics, Wake Forest University Baptist Medical Center	• Expertise in issues related to health equity and quality of health and wellness systems, procedures, and policies with underserved populations • Bilingual in Spanish and English
Anna Jensen	Student Action with Farmworkers, Program Director Previously: Executive Director, NC Farmworkers' Project	• Expertise related to health of Latinx farmworkers, including immigrant and migrant farmworkers; works closely with Latinx farmworkers and people who conduct outreach to farmworkers • Bilingual in Spanish and English
Maria Luna	Interpreter Supervisor, Internal Health Services, Forsyth County, NC	• Works closely with Latinx/Hispanic community members in the context of health communication • Bilingual in Spanish and English
Rachel Mooneyham	Public Health Educator, Forsyth County Dept of Public Health Coalitions & Community Engagement	• Works closely with Latinx/Hispanic populations and has skills as a public health educator. • Bilingual in Spanish and English
Odette Sanchez	Executive Director, Latino Community Services (Formerly, El Buen Pastor LCS)	• Leader in community service organizations that provide resources for Latinx adults, families and youth, with attention to providing adult education and leadership development, family-life enhancement opportunities • Bilingual in Spanish and English
Marta Rhodes	Community Member	• Knowledge about and connections with the local Latinx community, including local organizations serving the Latinx population • Bilingual in Spanish and English

Sonja Williams	Migrant Education Program Administrator, Program Monitoring Section, NC Department of Public Instruction (retired)	• Expertise in formal and informal learning among Latinx immigrant families • Bilingual in Spanish and English

Table B.2. Community Advisory Committee (CAC) Meetings: Participation

	2016	2017				2018		2019			2020		2022
Individual	12/13	3/23	6/14	9/25	12/11	3/20	9/24	3/12	7/17	10/22	1/30	5/6 email	8/17
CAC Members													
Keren Ferris	x	x	x		x	x	x	x	x		x	x	x
Anna Jensen	x	x	x	x	x	x	x	x	x		x	x	
Maria Luna	x			x			x			x			
Rachel Mooneyham	x	x	x										
Odette Sanchez	x	x		x			x	x			x	x	
Marta Rhodes	x	x	x	x	x	x	x	x	x	x		x	x
Sonja Williams	x			x	x			x		x	x	x	x
Project Personnel													
Joanne Sandberg	x	x	x	x	x	x	x	x	x	x	x	x	x
Grisel Trejo	x	x	x	x	x	x	x	x	x	x	x	x	x
Thomas Arcury	x	x	x										
Timothy Howard	x	x	x	x	x	x		x		x	x	x	x
Edward Hak-Sing Ip	x	x					x						
Paul Kortenaar	x		x	x		x	x	x	x	x		x	
DaKysha Moore	x	x	x	x	x	x	x	x	x	x	x	x	
Sara Quandt	x												
External Evaluator													
Louisa Stark	x		x	x	x	x	x		x	x	x	x	x

Table B.3. Community Advisory Committee Meetings: Dates and Topics

Date	Meeting Focus
December 13, 2016	• Introduction to the project, project overview, CAC role • Discussion and feedback on Semi-Structured Interview Guide questions
March 23, 2017	• Reported on progress with recruiting individuals for interviews and conducting interviews ○ CAC members discussed possible ways/places for recruiting participants, particularly men • Discussed 3 case-based summaries from interviews. Each included:

	○ Gender and highest educational level ○ Summary of their understanding of heredity ○ How they think traits are passed between generations ○ How they think environmental exposures affect people ○ Whether they think instructions in genes, blood and DNA can be changed/mutated ○ How they gain knowledge
June 14, 2017	• Reported enrollment and demographics of participants • Discussed Phase I analysis (translation and transcription) • Discussed Phase 1 recruiting and issues with finding remaining male participants
September 25, 2017	• Reported demographics of interview participants • Discussed examples of case-based summaries for DNA, blood, genes and heredity (6 women; 5 men) • Discussed and provided input on key concepts related to cell biology, genes, traits and blood that will be tied to 5 environmental exposures in the educational materials
December 11, 2017	• Reported on findings from ongoing analysis of Phase I interview data • Reviewed and provided feedback/input on a document outlining a possible topic sequence as well as environmental and genomic content, and hands-on activities for each of 5 modules
March 20, 2018	• Provided project updates • Reviewed and provided input on outlines and storyboards for 5 modules • Reviewed and provided feedback/input on draft script for secondhand smoke video • Discussed name and logo for project
September 24, 2018	• Discussed material development for module 1 (lesson plans, videos, storyboards, plotlines, and genetic concepts) • Discussed conducting focus groups for modules 3, 4, and 5
March 12, 2019	• Presented and discussed materials for modules 1-4 for environmental exposures as well as genetic content (imagery, concepts, story, etc.) • Presented first renderings of videos
July 17, 2019	• Presented near-final drafts of flipcharts and videos • Discussed hands-on activities • Discussed educator recruitment and training materials and topics • Discussed content for FAQ documents (environmental and genetic topics)
October 22, 2019	• Reported on recruitment and intervention completion to date as well as observations of intervention enactment • Discussed possible places for lay educators to recruit that go beyond their personal networks, and who has connections with these
January 30, 2020	• Reported update on recruitment and intervention completion to date • Discussed ways CAC members could help with recruitment issues

	• Presented and discussed preliminary pre-test data
May 6, 2020	• Provided email update in place of meeting (this was 2 months into the pandemic) • Reported on recruitment and plans for participants who were mid-intervention to complete it using iPads • Requested suggestions on recruitment and transitioning to virtual lessons (email replies received from Keren Ferris and Marta Rhodes)
August 17, 2022	• Reported final findings from analysis of Phase III data • Shared dissemination materials and efforts • Encouraged members to disseminate materials within their networks • Solicited suggestions for how to expand dissemination efforts

Appendix C: Published Papers, Manuscripts & Presentations

The following information is accurate as of August 31, 2022.

Papers Published in Peer-Reviewed Journals (2)

1. Arcury TA, Trejo G, Moore D, Howard D, Quandt SA, Ip EH, Sandberg JC. It's worse to breathe it than to smoke it: Secondhand smoke beliefs in a group of Mexican and Central American immigrants in the United States. Int J Environ Res Public Health. 2020 Nov 20;17(22): E8630. doi:10.3390/ijerph17228630. PMID: 33233697.

2. Sandberg JC, Trejo G, Howard TD, Moore D, Arcury TA, Quandt SA, Kortenaar P, Ip EH. Mental Models about Heredity among Immigrant Latinx Adults with Limited Education from Mexico and Central America. J Genet Counsel. 25 April 2022. Online ahead of print doi: 10.1002/jgc4.1580 PMID: 35468233.

Manuscripts under Review (2)

3. Trejo G, Quandt SA, Howard TD, Arcury TA, Moore D, Kortenaar P, Ip EH, Sandberg JC. Using partnerships to develop a genomics informal learning program for Latinx adults in the US. Under Review.

4. Arcury TA, Trejo G, Moore D, Howard TD, Quandt SA, Ip EH, Sandberg JC. Pesticide Exposure Knowledge and Beliefs of Urban Latinx Immigrants. Under Review.

Manuscripts in Preparation (5)

5. Moore D, Trejo G, Howard TD, Arcury TA, Quandt SA, Ip EH, Sandberg JC. Genes and DNA: Sources of information in the Latinx community: Implications for developing teaching materials. (Finalizing manuscript for submission)

6. Ip EH, et al. Matched-pair binary item response analysis using Bayesian adaptive Lasso factor model (working title).

7. Howard TD, et al. Improvement in genetics knowledge following a culturally and educationally appropriate learning intervention in a Latinx population (working title).

8. Sandberg JC, et al. Changes in science attitudes among Latinx immigrants adult with limited education who engage in informal STEM learning program (working title).

9. Attitudes about science museums among immigrant adults from Mexico and Central American with limited education living in North Carolina (working title).

Paper Presentations at Professional Meetings (4)

10. Sandberg JC, Trejo G, Howard TD, Moore D, Arcury TA, Quandt SA, Kortenaar P, Ip I. Ways of Knowing: Genetic knowledge within the MCA immigrant adult population. Southern Sociological Society Annual Meeting in Atlanta, GA. April 11, 2019.

11. Sandberg JC. Strategy for engaging Latinx immigrant adults in informal learning opportunities: Nuestra Familia Sana. Session - Recognizing Realities: Explore Strategies for Serving the Immigrant, Migrant, and Refugee Communities. Association of Science-Technology Centers Annual Conference in Toronto, Canada. September 23, 2019.

12. Howard, TD, Ip EI, Trejo G, Kortenaar P, Moore D, Quandt SA, Arcury TA, Sandberg JC. Improvement in genetics knowledge following a culturally and educationally appropriate learning intervention in a Latinx population. American Society of Human Genetics Virtual Annual Meeting, October 28, 2020.

13. Ip EH, Sandberg JC, Zhang L, Pan J. "Matched-pair binary item response analysis using Bayesian adaptive Lasso factor model." International Meeting of the Psychometric Society. 2022. Bologna, Italy. July 13, 2022.

Scheduled Presentation at Professional Meeting (1)

14. Sandberg JC, Trejo G, Howard TD, Arcury TA, Quandt SA, Ip E, Moore D, Kortenaar P. Proyecto Nuestra Familia Sana (Our Healthy Family Project). American Public Health Association (APHA) Film Festival at the APHA 2022 Annual Meeting and Expo. Boston, MA. Nov. 7, 2022.

Invited Presentation at External Academic Institution (1)

15. Sandberg JC. Communicating Complex Health Information to Immigrant Latino Adults from Mexico and Central American: Genetics, Genomics, and Environmental Exposures. Department of Environmental Health, Eastern Tennessee State University. Johnson City, TN. November 16, 2018.

Poster Presentations at Professional Meetings (9)

16. Trejo G, Howard TD, Moore D; Arcury TA, Quandt SA, Kortenaar P, Ip E, Sandberg JC. Reaching into the Community: Immigrant Latino Adults from Mexico and Central America. Association of Science-Technology Centers Annual Conference in Hartford, CT. September 29, 2018.

17. Trejo G, Howard TD, Moore D; Arcury TA, Quandt SA, Kortenaar P, Ip E, Sandberg JC. Reaching into the Community and Returning Genetic and Genomic Results: Immigrant

Latino Adults from Mexico and Central America. Partnerships for Environmental Public Health Annual Meeting (NIEHS) at Research Triangle Park, NC. December 13, 2018.

18. Sandberg JC, Trejo G, Howard TD, Arcury TA, Quandt SA, Kortenaar P, Moore D, Ip E. Engaging Immigrant Adults in Learning about Genetics and Genomics in Their Communities. National Science Foundation (NSF) Advancing Informal STEM Learning (AISL) PI Meeting in Alexandria, MD. February 11, 2019.

19. Trejo G, Ip E, Howard TD, Moore D, Arcury TA, Quandt SA, Kortenaar P, Sandberg JC. Experiences and Perceptions of Science Museums among Latinx Adult Immigrants with Limited Education. Association of Science-Technology Centers Annual Conference, Virtual. October 20, 2020.

20. Moore D, Trejo G, Howard TD, Arcury TA, Quandt SA, Ip EH, Kortenaar P, Sandberg JC. Genes and DNA: Sources of Information in the Latinx Community: Implications for Developing Teaching Materials. 2021 D.C. Health Communication Conference. Virtual. April 23-24, 2021.

21. Sandberg JC, Trejo G, Howard TD, Arcury TA, Quandt SA, Kortenaar P, Moore D, Ip E. Creating a culturally and linguistically informal STEM learning program for Latinx immigrant adults: Association of Science-Technology Centers Annual Meeting. Virtual. October 6, 2021.

22. Trejo G, Sandberg JC, Howard TD, Arcury TA, Quandt SA, Kortenaar P, Moore D, Ip EH. Creación de un programa de aprendizaje informal de STEM que es cultural y lingüísticamente apropiado para adultos inmigrantes latinos: Genómica. Association of Science-Technology Centers Annual Conference 2021. Virtual. October 6, 2021.

23. Sandberg JC, Trejo G, Howard TD, Arcury TA, Quandt SA, Kortenaar P, Moore D, Ip E, Rhodes M. An informal learning model of genetic and genomic education: Insights from an interviewer. Virtual Poster presented at 2021 National Science Foundation Advancing Informal STEM Learning (AISL) Awardee Meeting. October 20, 2021.
(Marta Rhodes, who was an interviewer and CAC member, co-presented the poster)

24. Carreno D*, Trejo G, Sandberg JC. Diabetes Inheritance and Causation: Lay Beliefs among Latina Immigrants with Limited Education. Virtual poster presented at the Annual Biomedical Research Conference for Minority Students. November 2021. *(Ms. Carreno was named an awardee in the Sciences and Public Health Category for her poster presentation*.)

Poster Presentations at Wake Forest School of Medicine (3)

25. Trejo G, Howard TD, Moore D; Arcury TA, Quandt SA, Kortenaar P, Ip E, Sandberg JC. Reaching into the Community: Immigrant Latino Adults from Mexico and Central America. Family Medicine Annual Symposium, Wake Forest University Baptist Medical Center, Winston-Salem, NC. February 25, 2019.

26. Carreno D*, Trejo G, Sandberg JC. Diabetes Inheritance and Causation: Lay Beliefs among Latina Immigrants with Limited Education. Poster Symposium Day for Wake Forest School of Medicine, Winston-Salem, NC. July 30, 2021

27. Sandberg JC. An Informal STEM Learning Model: Genetics, Genomics, and Adult, Bilingual Learners. Family Medicine Annual Symposium, Wake Forest University Baptist Medical Center, Winston-Salem, NC. February 25, 2019.

*Undergraduate intern.

Community Presentations (2)

28. Sandberg JC, Trejo G, Howard TD, Arcury TA, Quandt SA, Ip E, Moore D, Kortenaar P. Informal learning about genetics. Oral presentation at the North Carolina Farmworkers Institute, Raleigh, NC. April 25, 2019.

29. Sandberg JC. How many ways can you confuse people? Presenting scientific information to individuals with a limited science background. Kaleideum Science Café, Winston-Salem, NC. May 7, 2019.

Project Training Materials

30. Trejo G, Howard TD, Quandt SA, Arcury TA, Moore D, Sandberg JC. Nuestra Familia Sana: Genomics Education Program. Educator Training Manual. Winston-Salem, NC: Wake Forest University School of Medicine, 2022. **

31. Trejo G, Howard TD, Quandt SA, Arcury TA, Moore D, Sandberg JC. Nuestra Familia Sana: Genomics Education Program. Train the Trainer Manual. Winston-Salem, NC: Wake Forest University School of Medicine, 2021. **

**Additional materials are available at https://school.wakehealth.edu/departments/family-and-community-medicine/nuestra-familia-sana, including flipcharts, lesson plans, participant handouts, video scripts, and Educator Lesson Manuals in both Spanish and English. The videos are available at the website in Spanish, and in Spanish with English subtitles. English versions of the *Train the Trainer Manual* and the *Educator's Training Manual* are currently available; Spanish-language versions will be added soon.