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Agriculture & Nutrition for Girls While Encouraging Leadership & Stem-Enrichment (ANGELS) Program

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Dr. Sandra C. Affare is an Adjunct Professor in the Engineering Management and Technology Department at the University of Tennessee at Chattanooga (UTC). Teaching at UTC is a surreal opportunity as she obtained a B.S. in Engineering and MBA with a concentration in Production and Operations Management there. She earned a doctorate in Industrial and Systems Engineering with a concentration in Engineering Management from the University of Tennessee-Knoxville. Dr. Affare served as a Project Engineer and Project Manager at Tennessee Valley Authority (TVA) where she managed research and development projects for TVA's Transmission Technologies and eventually became a Senior Compliance Analyst until retirement in July 2014. After retirement, Dr. Affare was a project management consultant in transportation and logistics for a few years until she began her second career in higher education. As an engineering professor, her research focuses on increasing the number of women in STEM with an emphasis in minorities in Engineering. Over the past 3 years at UTC, Dr. Affare has established the reputation as the go to person with respect to multidisciplinary and interdisciplinary grant collaborator as it relates to STEM. Dr. Affare served as the Co-PD on the USDA Grant mentioned. The Program Director is UTC Biology Professor and Agronomist, Jose Barbosa. Her fellow Co-PDs were Drs. Angelique Ramnarine (Math Professor), Melissa Powell (Nutrition Professor), and Marissa McElrone (external evaluator).

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Abstract

Funded by the US Department of Agriculture's Women and Minorities in STEM (WAMS) program (Award #2022-04279), the Agriculture & Nutrition for Girls While Encouraging Leadership & Stem-Enrichment (ANGELS) Program was piloted in the Summer of 2023. The goal of the program is to complement traditional and non-traditional science, technology, engineering, and mathematics (STEM) education with experiential agricultural, and nutritional activities to help create a successful middle school to college pathway leading to STEM-related careers. Project Directors accomplished these goals by delivering an interactive STEM curriculum complementing experiential agricultural, nutrition, and problem-solving activities for six weeks during the ***ANGELS Summer Pilot***.

To evaluate the impact of the program's ability to develop middle school girls' interest in STEM-related fields, the effectiveness, feasibility, and acceptability of the ***ANGELS Summer Pilot*** was assessed through summative and process evaluations by an external evaluator using both quantitative and qualitative methods. Summative evaluation results showed an increase in ANGELS participant's feelings of being in an environment that is supportive of science careers. The ***ANGELS Summer Pilot*** provided opportunities for adults and students to improve their communication skills and deploy conflict resolution techniques. There were a number of parent and participant requests during the Summer Pilot's closing ceremony for the project directors to conduct an ANGELS Summer Camp again. Additional lessons learned and recommendations for future summer bridge programs were developed while navigating the day-to- day interactions with fifteen middle school girls.

As a result, project directors repeated the pilot but on a smaller (4-week) scale and with a broader emphasis on STEM education by introducing the ***ANGELS Beta Summer Camp***. This Summer Camp, held in June of 2024, aimed to encourage proper social interactions as educators during the teaching and learning processes while adhering to the ANGELS Program's original goals. During the ANGELS Beta Camp, we aimed to expand participants' social interactions and mentor networks. We included an emphasis on technology through coding and computer science, various engineering fields, and included a mental health focus. More pre- and post-assessments were provided to help decide ANGELS participants' engineering identity and engineering communal values. This CoNECD paper will lead to a discussion on the importance of connecting academia and the community as it relates to diversity in education, as modeled in the ANGELS Programs.

Keywords: girls in STEM, Summer Program, Networks, non-traditional STEM education

Introduction

While many STEM fields (e.g., Biology) have made significant strides in supporting the recruitment and retention of some underrepresented groups [**1**], women, particularly women of color, continue to be grossly underrepresented in engineering and agrisciences [**2**], [**3**]. The ANGELS Education/ Teaching Programs were designed to support increased participation of women and underrepresented minorities in STEM, with a unique focus on broadening participation through motivational impact for middle school girls.

Motivation, such as personal-professional identity, self-efficacy, and belonging, has long been shown to play a role in interest and integration in STEM fields, particularly for women and underrepresented minorities [**4**], [**5**]. According to a 2018 Confidence Code poll, self-confidence levels drop by thirty percent (30%) for girls between the ages of 8 and 14 [**6**]. According to the Journal of Research in Education, within the STEM domain, female and racial/ethnic minority students often report lower levels of self-efficacy in their STEM capabilities [**7**]. Furthermore, during middle school, girls have been reported to lose more interest in math and science compared to boys. Microsoft-sponsored research investigated why girls lose interest in STEM in middle school [**8**]. Female engagement in science has been attributed to several factors, including 1) the way they perceive themselves and 2) their attitudes towards science and engineering, including if they perceive science as being important and useful [**9**]. Research on informal learning experiences, such as summer camp programs, highlights the effectiveness of STEM-focused programming on increasing motivational factors that have downstream impacts on intentions and persistence in STEM fields, particularly for women and underrepresented minorities [**10**], [**11**]. However, many of these programs, while important, focus broadly on STEM. With these motivational factors in mind and a goal to specifically support broadening participation in engineering and agrisciences, we see the ANGELS program as a unique opportunity to address education equity in STEM and promote the development of a confident and qualified female workforce in engineering and agricultural sciences.

The programs exposed fifteen (15) female, middle school girls per year to accomplished females and minorities in STEM-related fields through speaker workshops, STEM activities, and industry fieldtrips. One major goal of the ANGELS program was to promote self-efficacy, interest, and a sense of belonging for the young girls. Throughout the summer experience, we encouraged the student participants to imagine themselves as engineers or agricultural scientists and had students engage in reflective processes (e.g., journaling) to foster their sense of connection to STEM.

A secondary focus was on ‘soft’ skills such as teamwork and problem-solving through project-based learning using the Project Management Institute Education Foundation’s *PM Skills for Life* curriculum. The ***ANGELS Enrichment Program*** began in the Fall of 2023 providing project management tools and techniques that encouraged a participant-developed project that addressed food security issues. This project-based learning program provided a unique environment for participants to identify food deserts, examine the evidence, ask questions, and propose solutions to the problems they encountered during the summer pilot activities and beyond. The participants met twice per month on a weekend at a participating high school. Teams worked together to identify areas in need, determine the most practical items to place in meal kits, and successfully deployed the *ANGELS Thanksgiving Meal Project*. As a result of this and similar project-based exercises, the participants learned to become early adopters of solving problems.

Enhancements to the ANGELS Program broadened our impact by offering more diverse ways to stimulate middle school girls’ interest in STEM by pairing STEM with the arts. The ***ANGELS Beta Program*** extended the arts with cultural cooking, more visual arts, and by offering guitar lessons. In addition, the ***ANGELS Beta Program*** introduced Scratch Coding and participants designed and built their own garden in Roblox. These classes created alternate avenues to stimulate middle school girls’ interest in STEM.

Methods

Participants & Procedures

ANGELS participants were selected from different schools in the local school system and in coordination with teachers from underrepresented schools. In March 2023, project directors observed STEM classes at a local elementary school and provided recruitment flyers for the STEM teacher to give to rising 6th graders' parents. Project directors also took part in a STEM Night at a local middle school. A recruitment poster was developed, and the recruitment flyers were given to parents who visited our table. Participants were selected on a first-come, first-serve basis upon submitting a complete application. Fifteen (15) participants were admitted and successfully concluded the summer activities. The demographic information on the participants is:

- 12 participants identify as Black or African American
- 3 participants identify as mixed race with one being Pacific Islander

Forty percent (40%) of the ANGELS Summer Pilot participants will be first-generation college students, if they choose to earn a bachelor's degree. Two-thirds of the 2023 ANGELS Summer Pilot participants continued with the ANGELS Enrichment Program in the Fall of 2023. Two of the summer pilot participants enrolled in high school the following school year and were therefore unable to return for the 2024 ANGELS Beta Summer Camp. Project directors were not able to successfully connect with the parents of the remaining students. Sixty-nine percent (69%) of the eligible summer pilot participants returned for the ***ANGELS Beta Summer Camp***. All (100%) of the ***ANGELS Beta Summer Camp*** participants identify as Black and were rising 6^{th} - 9^{th} graders.

The primary outcome of the ANGELS Programs was evaluated through participant pre/post Qualtrics assessments measuring interest in STEM content and careers [**12**]. Process evaluations were conducted with participants at each session (including the art and dance sessions) to capture the participants' perceptions of session implementation, participant satisfaction, and participant engagement (behavioral and cognitive engagement) in each session [**13**]. In addition, student engagement was captured via a self-evaluation at the end of enrichment activities. Evaluation and attendance data was monitored continuously throughout the programs to inform planning, quality improvement, operational decisions, and to measure impact. In addition to the academic evaluations, we tracked the community impact over time to measure our progress, including the number of new organizational and community partnerships developed.

Program Development Context

The ANGELS Program faculty-led curriculum development cohort met monthly during the Fall 2022 and Spring 2023 semesters to develop the nutrition and food science curricula for the target population. The cohort completed activities needed to develop necessary aspects of the ANGELS Program prior to the summer pilot in 2023. During the meetings, a weekly curricular program was developed, which included 23 summer activities lasting six weeks in June and July and included:

a. Diverse agricultural activities in different sites include a University *Teaching & Learning Garden* and weekly visits to different nearby farms, and
b. Nutrition lessons and health cooking were oriented by a nutritionist, a home chef, and a chemist, which include the value of food as medicine and the use of alternatives to salt and sugar.

The ***ANGELS Summer Pilot's*** activities were planned and executed over two blocks of three weeks scheduled with a one-week interruption in between for reorganization and preparation of material necessary to successfully conduct the program. A special theme was appointed each week to enrich and broaden the agriculture curriculum, as well as promote STEM self-efficacy and interest in participants:

Week	Date 2023	Theme	Observations
1	06-12 / 06-16	**L**eadership	The highlight of this week was the activities that helped the Campers, Mentors, and Coordinators get to know each other.
2	06-19 / 06-23	**N**utrition	We focused on eating whole food and drinking plenty of water.
3	06-26 / 06-30	**E**ngineering	The goal of the Engineering Week was similar to its national component, to introduce girls to a variety of engineering disciplines.
4	07-10 / 07-14	**G**irl-Centered	We focused on the girls' mental health, self-care, and personal character.
5	07-17 / 07-21	**A**griculture	Despite agriculture being assigned a specific week, agricultural activities occurred at least once per week. During this specific week, agricultural lessons were taught at least once per day.
6	07-24 / 07-28	**S**ocial Science	ANGELS participants made social connections between food security and the social justice issues discussed throughout the camp.

Table 1: ANGELS Pilot Summer Experience Weekly Structure

Experts in different fields, according to each week's theme, were invited and took part in the program sharing their experiences in STEM. Among the many experts invited were engineers, nutritionists, physicians, scientists, artists, pharmacists, human and health performance professors, a counselor, and a dance instructor. Enhancements* to the ANGELS Summer Pilot broadened our impact by offering more diverse ways to stimulate middle school girls' interest in STEM by pairing STEM with the arts. We hosted a *STEM from Dance* Workshop called "Breathe" that included building a lung model and introduced a participant-led, choreographed dance routine that was performed for parents during the ***ANGELS Summer Pilot's*** closing ceremony. *STEM from Dance* is a proven 10-year program, started in New York, which empowers minority females with coding knowledge and confidence to dream big.

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The ***ANGELS Beta Summer Camp's*** activities were planned and executed over four weeks. Each week was designed to broaden participants' social connections and experiences with engineering, agriculture and technology:

Week	Date 2024	Theme	Observations
1	June 2nd – 7th	**B**elieve in Yourself	We focused on the girls' mental health, self-care, and personal character through social/ emotional learning workshops.
2	June 10th – 14th	**E**nrichment	The highlight of the ANGELS Beta experience was the cultural enrichment brought by *Cooking Up Learning* and the introduction of STEM games from unfamiliar cultures.
3	June 17th – 21st	**T**echnology	The highlight of this week was the non-formal educational enhancements using technology. This week also consisted of science and engineering mini labs - all purposed to encourage the participants to see (imagine) themselves as a scientist or engineer.
4	June 24th – 28th	**A**chievement	The purpose of this week was to celebrate their achievement throughout the ANGELS Programs.

Table 2: ANGELS Beta Summer Experience Weekly Structure

Measures & Analysis

The ANGELS Summer Pilot measures included weekly participant process evaluations (11-items) that explored opportunities for program improvement, participant satisfaction and engagement; pre/post program evaluations (38-items) explored interest in STEM content and careers; and post-intervention ripple effect mapping (REM) focus groups to explore participant perceptions of the impact of the program on themselves, their families, and their communities. Additionally, 5-items were used to evaluate participant's belief of their identification with and belonging to a STEM field (i.e., STEM Identity) at the beginning and end of the summer program [**14**]. Participants rated on a scale of 1 (strongly disagree) to 5 (strongly agree) on items such as "I have a strong sense of belonging to the community of those in STEM," and a composite score was created.

For both datasets, descriptive statistics were calculated for quantitative process evaluation data and paired sample t-tests examined differences in pre/post program evaluations. An inductive analytical framework was applied to qualitative evaluation data and code frequencies were calculated to inform direct content analysis.

Preliminary Results

ANGELS Summer Pilot Results

Most participants were retained throughout the ANGELS Summer Pilot (n=15). Participants reported a mean score of 3.4/5 (±0.62) on the 8-item, 5-point Likert engagement scale. Qualitative process evaluation data indicated recommendations for programmatic improvement including the desire for more interactive activities and less traditional classroom sessions. Although not significant, data from pre/post-intervention showed increases in "interest in math content" (3.89±1.46 vs. 4.09±1.36, respectively) on 7-point Likert-type scale; "perceptions of being in an environment supportive of science careers" (3.16±0.52 vs. 3.25±0.50, respectively) on a 4-point Likert scale; and "intent to pursue STEM-related education" (3.15±0.33 vs. 3.23±0.35, respectively) on a 5-point Likert scale. Participants perceived that learning about nutrition and food security was the most important takeaway from the ***ANGELS Summer Pilot***, depicted in the REM results in Figure 1 below.

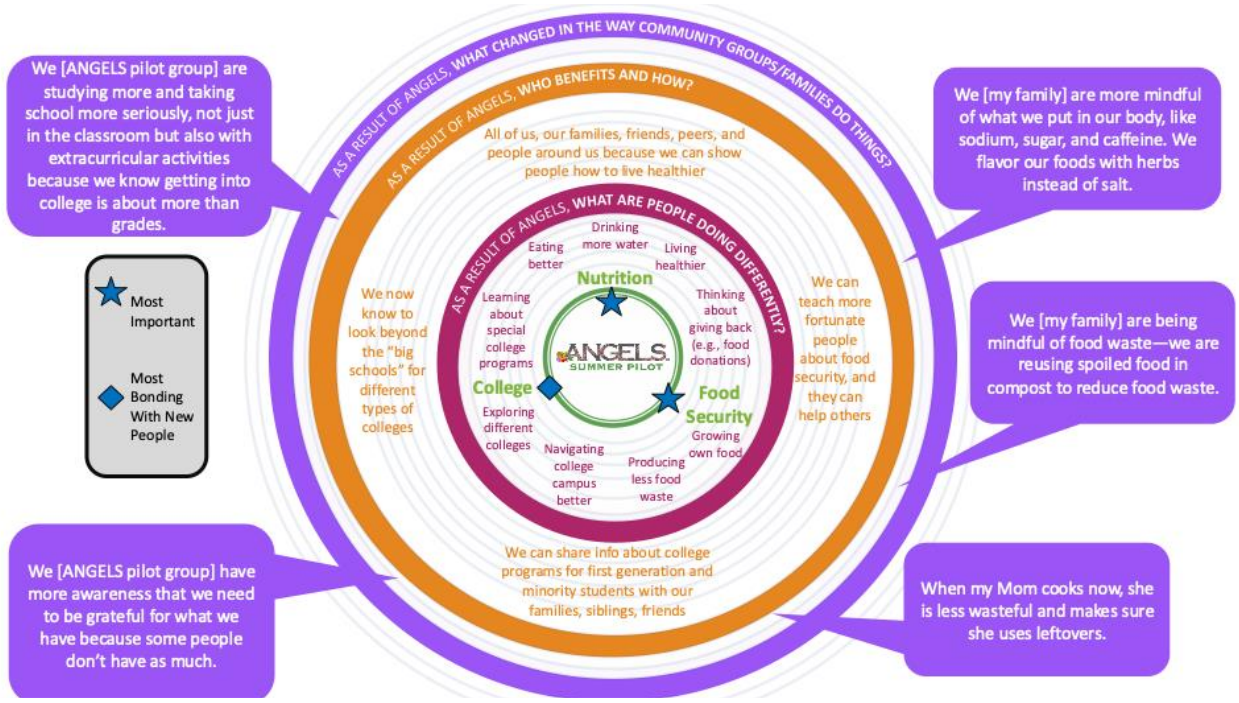

Figure 1: ANGELS Summer Pilot Ripple Effect Mapping (REM) Focus Group Results

ANGELS Beta Summer Camp Results

Most participants that started week 1 of the program were retained throughout the ***ANGELS Beta Summer Camp*** (n=12/13). Two additional participants joined the program in the last week or two of the camp and were excluded from the pre/post program evaluation analyses. Participants reported a mean score of 3.3/5 (±0.56) on the 8-item, 5-point Likert engagement scale. Similar to the ***ANGELS Summer Pilot***, the qualitative process evaluation data showed the desire to reduce lecture-style programming throughout the ***ANGELS Beta Summer Camp***. Although not significant, data from pre/post-intervention showed decreases in "perceptions of being in an environment supportive of STEM careers" (3.64±0.40 vs. 3.46±0.42, respectively) on a 4-point

Likert scale; and "intent to pursue STEM-related education" (3.23±1.21 vs. 3.11±0.28, respectively) on a 5-point Likert scale; and no change in "perceptions of importance of STEM careers overall" (3.82±0.57) on a 4-point Likert scale, among the 7 participants with completed pre- and post-program evaluations. Additionally, there were no significant differences in pre to post STEM Identity scores for participants (M_{Pre}=3.65±0.22 vs. M_{Post}=3.23±0.16). The non-significant differences in STEM identity could be related to the fact that the original scale was written for undergraduate STEM students. Future generations of this work could be modified for middle school aptitude. Participants perceived that being aware of what they are eating now and having more self-discipline about what they eat was the most important takeaway from the ANGELS Beta Summer Program, depicted in the REM results in Figure 2 below.

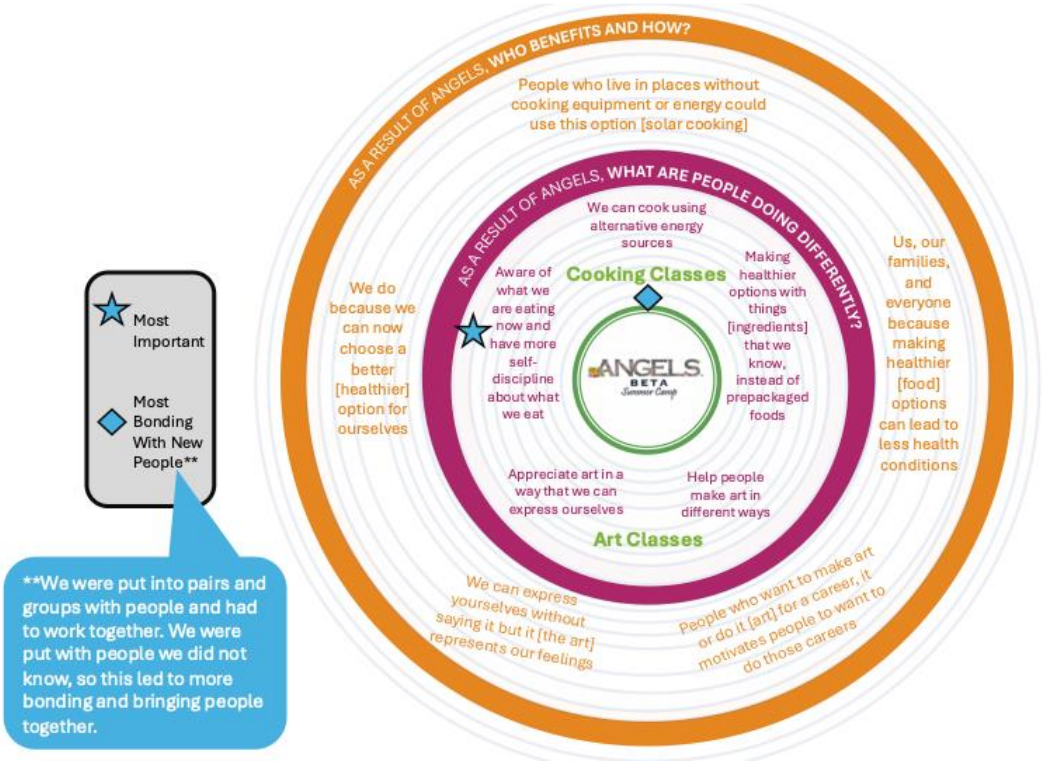

Figure 2: ANGELS Beta Summer Program Ripple Effect Mapping Focus Group Results

Future Work and Conclusion

As connections to the community and introductions of STEM role models, particularly those with shared demographics (i.e., same gender), have been shown to be significant mechanisms for increasing interest, self-efficacy, and identity in STEM for young students [**15**] and [**16**], we provided multiple opportunities throughout ***ANGELS Beta Summer Camp*** for students to meet with and hear from STEM professionals. Data on social networks formed throughout the ***ANGELS Beta Summer Camp*** were collected and will be analyzed in future work to determine the significance of these connections between the STEM professionals and the ANGELS campers.

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