Implementing a 15-week AI-education program with under-resourced families across 13 global communities

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Abstract

The AI Family Challenge (AIFC) was a 15-week program implemented with ∼7500 3rd-8th grade students and their families in under-resourced communities across 13 countries. Families learned to develop AI-based prototypes that solved problems in their communities. The goal of the program was to determine whether AI was of interest to such communities and what the impact of such an experience was on them. Pre and post surveys were conducted, as well as interviews with participants in the US, Bolivia and Cameroon. Other data was collected through student projects and online student responses to multiple choice questions.

Results show that 95% of the sites completed the 15-week program. This, as well as the survey and interview data show that under-resourced communities are curious to learn about AI and what role their children can play in an AI-powered future. After AIFC, 92% of parents believed their child was able to explain AI to others and 89% believed their child was capable of producing an AI application. Findings indicate the need to improve parent training materials, connect technical mentors to sites, and improve the curriculum to be more hands-on and engaging, and better illustrative of the concepts.

1 Introduction

As AI is rapidly integrated into our society and workplace, this change is increasingly being called the 4th Industrial Revolution. Characterized by exponential rates of discovery and adoption, this revolution combines digital, physical, and biological systems. And, like the revolutions of the steam engine, electricity, and computers that preceded it, AI will unlock tremendous growth and productivity.

At the same time, it threatens to accelerate existing income and access gaps [Frey and Osborne, 2015]. Low income and under-resourced communities are already being left behind by the technology revolution [Google, 2016; Iridescent, 2018]. In a technology-dominant future, these communities are at an even greater risk of failure.

There are three drivers of this risk. First, there is a greater demand in occupations that require problem-solving, intuition, persuasion, and creativity, and there isn't enough supply of these skills. Second, the interest to learn new skills required for higher wage jobs isn't enough. Third, there is a widespread fear of AI fueled by media stories around errant self-driving cars and "robots taking over jobs" [Winick, 2018]. Fear dampens curiosity and the willingness to learn.

A survey of 1,500 parents of elementary and middle school students, commissioned by Iridescent [Iridescent, 2018], found 80% of parents in the United States believe AI will replace too many jobs (not just low-skilled jobs), less than 20% understand where and how AI technologies are currently used, ∼60% of low-income parents have no interest in learning about AI, and less than 25% of children from low-income families have access to technology programs.

Workforce readiness requires increasing cognitive capacity through education and job training – both slow-moving processes, that create a race between technology and education [Goldin and Katz, 2007]. Education organizations need to implement grass-roots programs that immediately help under-resourced communities change their attitudes towards AI and support development of skills such as problem identification, problem solving, collaboration and lifelong learning.

The authors launched and implemented the AI Family Challenge in 2018 across 71 sites in 13 countries, engaging ∼7500 under-resourced 3rd-8th grade students and their parents. This study outlines the research questions, curriculum, findings from pre-and post surveys and interviews conducted with parents across the global cohort, as well as insights from implementations in Bolivia and Cameroon.

2 Background

Hidi and Renninger's research describes four phases in the development and deepening of learner interest: triggered situational interest (temporary interest that arises spontaneously due to environmental factors), maintained situational interest, emerging (less-developed) self-driven interest, and well-developed, self-driven interest [Hidi and Renninger, 2006]. Research conducted by [Ericsson, 2006] has shown that after ∼50 hours of training and experience people attain an acceptable level of performance for most everyday activities such as

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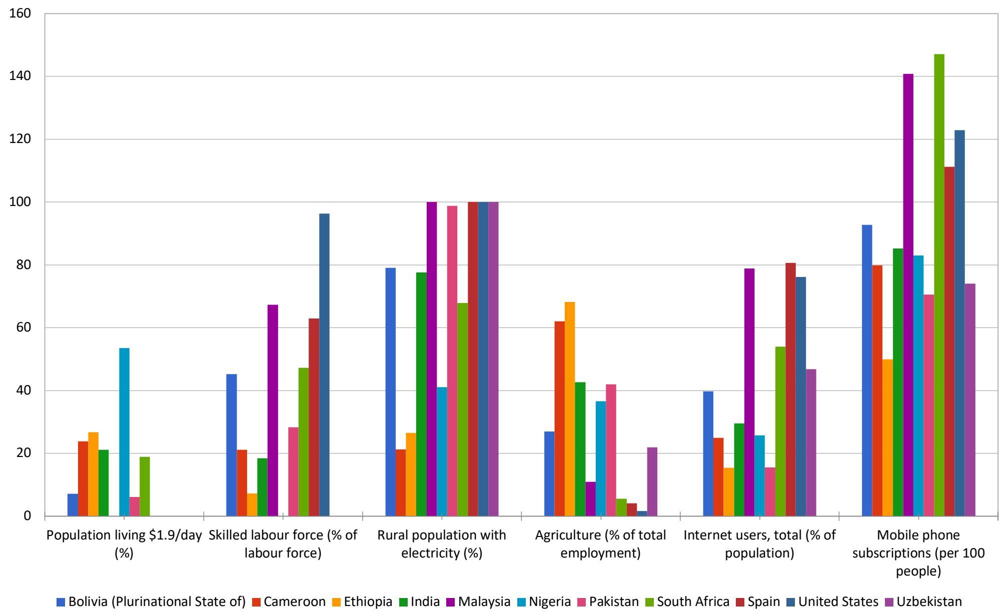

Figure 1: Poverty and Employment, 2018 Human Development Index data, UNDP.

typing, playing tennis, or driving a car.

Areas for exploration are determining the level of performance achieved after 40-50 hours of problem solving and identifying the length of training needed to achieve a well-developed, self-driven interest in solving real-world problems using engineering and technology. Engineering and technology programs such as FIRST Robotics and Technovation have shown that it is possible to retain a student's interest over a sustained period of time (6-12 weeks) if the program is team-based, part of a global competition, and supported by a mentor [Melchior *et al.*, 2018]. Technovation in particular has been effective in engaging girls in technology by presenting the challenge - "Solve a problem in your community by developing a mobile app" [Hubbard *et al.*, 2018].

Finally, there is a significant body of research demonstrating the long-term positive impact of parental engagement on student academic and career performance. An area for exploration is around family co-learning models that go beyond short-duration activities in museums and science centers.

Building on this research, the AI Family Challenge sought to answer the following questions:

- *Research Question 1:* Are under-resourced families interested and willing to participate in an AI-Education program?
- *Research Question 2:* What elements of an AI-Education program enable families to apply their new found AI-awareness and interest to real problems?
- *Research Question 3:* What elements of an AI-Education program enable families to deepen curiosity and interest in AI technologies?
- *Research Question 4:* How do under-resourced families perceive AI and what is their understanding of AI? How does it change through participation in such a program?

3 Methods

The AI Family Challenge was implemented by Iridescent, a global education nonprofit, in partnership with community partners in 13 countries. The following section outlines the recruitment, adoption, curriculum, training, methods of implementation, data collection, and analysis.

3.1 Recruitment

Iridescent recruited participants through its network of global partners and by offering a financial incentive ($5000 USD). Funds covered materials for activities, internet hotspots, t-shirts, and dinner for the families. 74 sites (out of 80 applicants) across 13 countries (Bolivia, Cameroon, Ethiopia, India, Malaysia, Nigeria, Pakistan, Palestine, Somalia, South Africa, Spain, USA and Uzbekistan) were invited to participate. Most of these sites were schools, libraries, or community organizations offering after-school programs. Selection criterion required that the sites engage under-resourced communities, engage parents (not just students), had access to computers, and 1-2 staff members who could spend 60+ hours training for and leading the program.

3.2 Adoption

Three sites dropped out from the 74 sites that started. 30 sites were in the United States, 2 in Spain, and 39 from countries that had an average Human Development Index (HDI) of 0.63. The United Nations Development Programme (UNDP) defines HDI as the ability of an individual to lead a long, healthy life and have access to education that enables them to have a decent standard of living. Participating country indices are as follows (Figure 1): Ethiopia = 0.46, Nigeria = 0.53, Pakistan = 0.56, Cameroon = 0.58, India = 0.64, Bolivia = 0.69, South Africa = 0.70, Uzbekistan = 0.71, Malaysia =

Figure 2
Families in Bolivia learning about parallel systems processing through a hands-on challenge

Figure 3
Families in Cameroon learning about control in a robot

0.80, Spain = 0.89, United States = 0.92. Somalia and Palestine do not have an HDI.

3.3 Curriculum and Training

Sites were given access to an online curriculum (https://www.curiositymachine.org/aichallenge) consisting of 8 initial, hands-on challenges that used simple materials (Figures 2 and 3). Families learned to work with open-ended prompts and do rapid prototyping, troubleshooting and redesign. These units introduced AI concepts such as Neural Networks, parallel processing, algorithms used in self-driving cars and industrial robots. Families watched videos of an expert explaining the concept, following which they applied their understanding in a hands-on way. For instance, in the self-driving car design challenge, families learned that the computer onboard the car collects data through sensors. The algorithm (created by the engineer) uses this data to make the car act in a particular way. The family was then challenged to "engineer" an "algorithm" that takes specific actions on an electrical game-board circuit, based on certain inputs. Through this experience, families realized that an algorithm can be improved if it is not working well, and that the process of improvement is iterative and continuous. Following the 8 initial design challenges, the families went through 10 lessons introducing concepts of data, machine learning and training models to recognize images, text and emotions through an IBM-Watson based platform Machine Learning for Kids. The 10 units also introduced strategies of identifying meaningful community problems and creating AI-based prototypes to address these problems.

The Iridescent team trained site staff members on the curriculum through online webinars (10 hrs/6 months), while providing access to detailed lesson plans and customizable slide-decks. Following the training, site educators and facilitators recruited ~7500 3rd-8th grade students and their families, and engaged them in the AI Family Challenge program, meeting once a week for two hours over 15 weeks. Educators were able to adapt the curriculum to suit their local audiences and learning abilities.

3.4 Data Collection and Analysis

Four types of quantitative and qualitative data was collected to assess program impact - pre and post surveys with parents, 34 interviews with participants from the US (12), Bolivia (11) and Cameroon (11), student responses to multiple choice questions, and judges' scores on families' prototypes. The US, Bolivia and Cameroon were chosen as regions representative of a large number of sites (US = 30) and of countries with similar income, education and employment indicators. All program participants signed consent forms which explained in simple language why and what type of data was being collected. The sign test was used to determine the statistical difference of survey results taken before and after the program for each family.

4 Results and Findings

4.1 Pre and Post Surveys

Each site conducted pre and post surveys with the families. 2398 pre-surveys and 534 post-surveys were collected and analyzed. 464 surveys were paired and findings are presented below. 6% of guardians that came with the students were mothers, grandmothers, aunts and older sisters. 30% of respondents were South Asians, 20% Latin American or Hispanic, 18% White, 9% Central Asian, and 8% Middle Eastern.

Parents were positively inclined in almost all survey measures before AIFC, suggesting that participants were already predisposed to AIFC's program objectives. For instance, 90% of parents already believed that STEM could make the world a better place, and this increased to 96% after AIFC. In addition 97% of parents believed that new technology would change the jobs their children had (Figure 4).

Parents responded favorably to their child's knowledge, curiosity and ability around AI after AIFC. 92% believed their child was able to explain AI to others and curious to continue learning. And 89% believed their child was capable of producing an AI app in the future (Figure 5).

Parents showed gains in their own confidence to learn new technologies after AIFC, especially in their feelings and attitudes (Figure 6). However, they did not feel capable of supporting their child's learning of technological content at home (Figure 7).

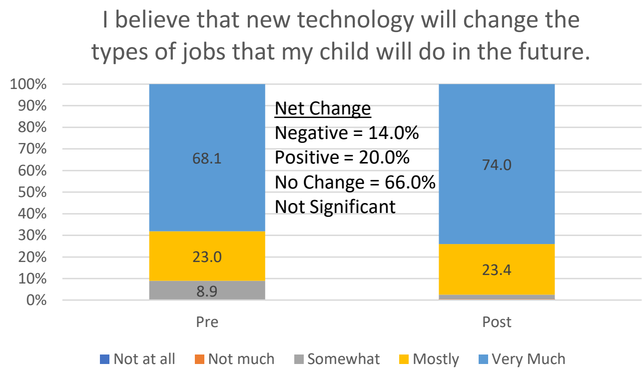

Figure 4
Parents' attitudes towards technology's impact on jobs

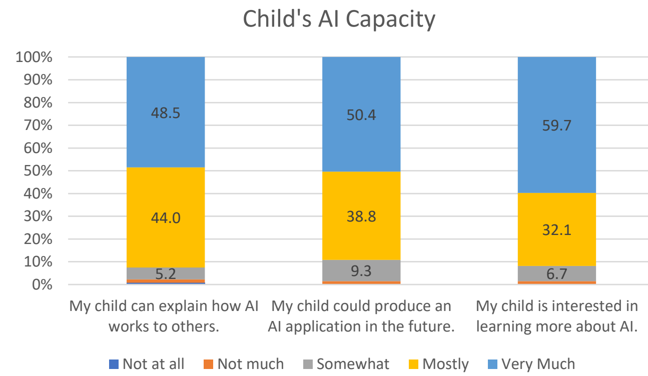

Figure 5
Parents' evaluation of their child's changes in AI knowledge

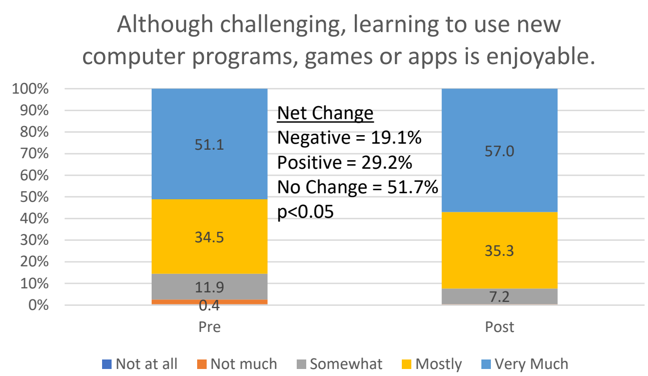

Figure 6
Parents' attitudes towards learning new technologies themselves

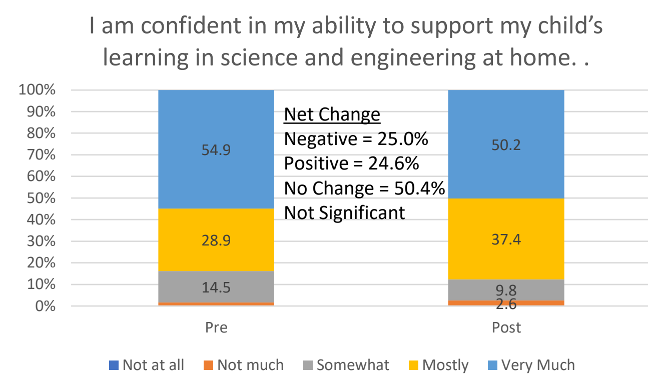

Figure 7
Parents' evaluation of their own abilities to support their childs learning at home

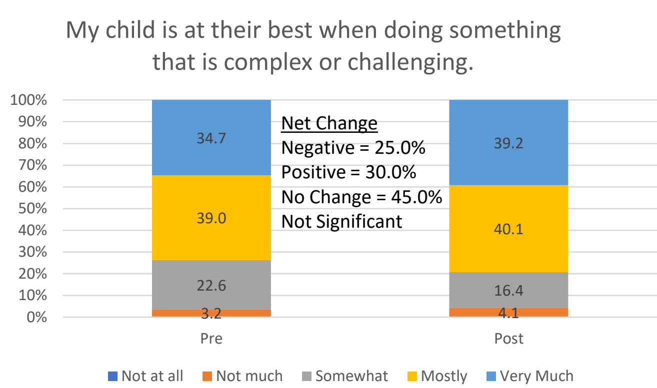

Figure 8
Parents' evaluation of child's persistence

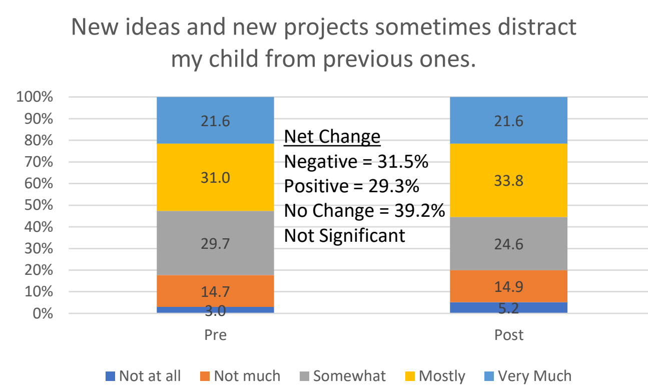

Figure 9
Parents' evaluation of their child's focus

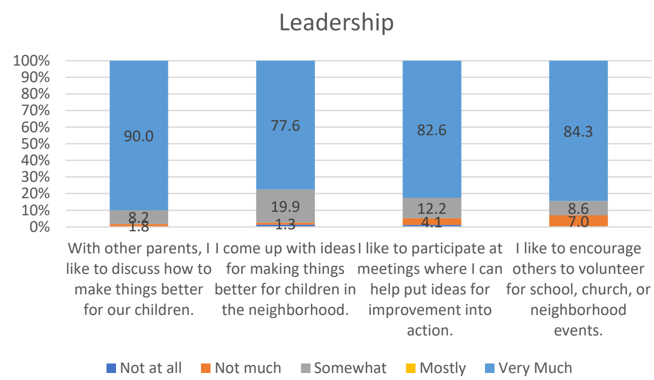

Figure 10
Parents' interest in community

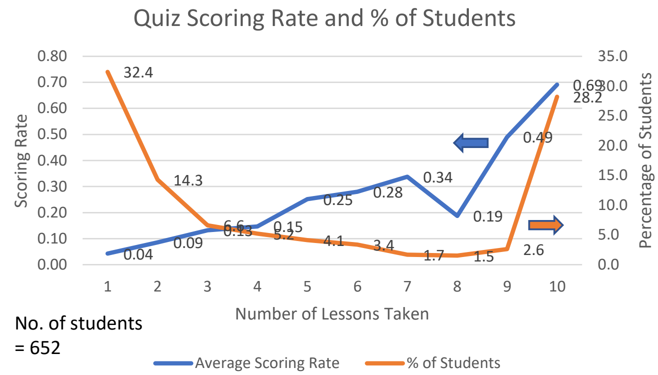

Figure 11
Students' scores vs number of completed lessons engagement

Although parents felt that their children responded well to challenges, they did feel that their children got distracted (Figures 8 and 9). This could be due to the subject matter not being age-appropriate, program execution, curriculum delivery, or insufficient training for parents to help them keep their children engaged.

After AIFC, parents appeared to be strongly positive about community engagement – galvanizing support to improve the environment for their children (84%), implementing solutions (83%) or developing new solutions (78%) (Figure 10).

Of particular interest is that Bolivian parents expressed stronger interest (96%, $n = 8$) in community leadership in comparison to Cameroon (58%, $n = 7$).

4.2 Interviews

The authors conducted 34 interviews with families in the US, Cameroon, and Bolivia. There were three types of families that were interviewed - those who completed the program, those who submitted prototypes for judging and those who dropped out. Families who submitted had much higher competitive drive compared to those who didn't. The families who submitted wanted to win the global competition.

Universal themes across the three countries and socio-economic groups were that parents wanted their children to work on something that they were passionate about, leading them to happiness and success; AIFC was a way for parents to learn more about their children as well as themselves; and parents appreciated increasing their own problem-solving and technological abilities at the same time as their child. For all, the biggest barrier to participation was time.

The interviews with Cameroonian families emphasized their interest and skills in doing hands-on activities, in contrast to the Bolivian and American families. The site leader from Cameroon reiterated how families had to rely on making things themselves, as they couldn't afford store-bought things. For instance, children learned to make their own toys, instead of purchasing. In addition, as a majority of the population depended on agriculture (62%), families (including children) needed to devote significant time collecting resources and ensuring meals for the next day. Children were a contributing part of the economy. Hence, family participation in the AI Family Challenge on the weekend was an indicator of the strong interest to learn about AI and to participate in new learning experiences. The site leader from Cameroon, a woman, indicated that seeing a female leading the group motivated more women and girls to participate.

4.3 Multiple-Choice Quiz Results

Students tested their understanding of concepts through multiple choice questions on the curriculum platform. If they selected the wrong answer, they were prompted to try again. Thus a high score indicated fewer attempts made to get the correct answer. Figure 11 shows that students who completed more lessons deepened their understanding of the concepts and scored higher ($n = 652$). The exception was for Lesson 8 where the question was "Which of the following tasks can a machine learning model be used for?" This suggests that the curriculum could be improved to help learners differentiate when machine learning models should be used. The scores were also low for Lesson 1, Q1: "Pick the best definition of artificial intelligence". Following this lesson, many students discontinued the program, or stopped answering the questions. This suggests that the curriculum could be enhanced to retain interest, as well as improving the question interface to encourage continued submissions.

4.4 Judges Scores

207 families submitted their prototypes and pitches for review. Each submission was virtually scored by 3 judges who went through a training on the rubric. Points were awarded for: the innovation in addressing a meaningful problem, the use of AI, prototype, quality of the pitch, creativity and feasibility. Some of the highest scoring submissions included image recognition systems: to find and eradicate an invasive species in Lake Titicaca, to analyze drawings to see if children were experiencing bullying, and to monitor public pools for signs of drowning. Figure 12 shows that judges awarded high scores to most of the projects (average score = 42, $n = 176$). Figure 13 shows the average change from pre to post survey for each family against the judges' score for their project. There is only a slight positive gain in how the families perceive their growth. This is consistent with the

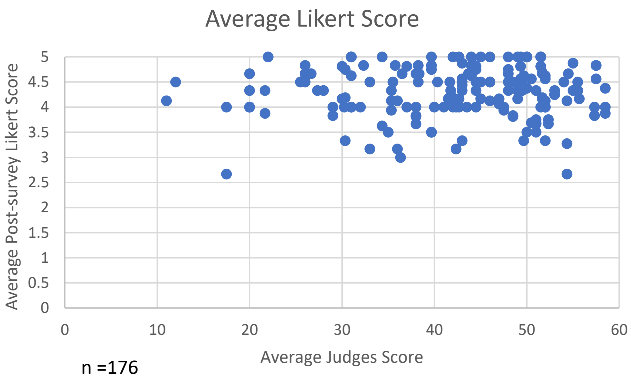

Figure 12
Post-survey Average Likert Score (self-assessment) vs. Judges' scores

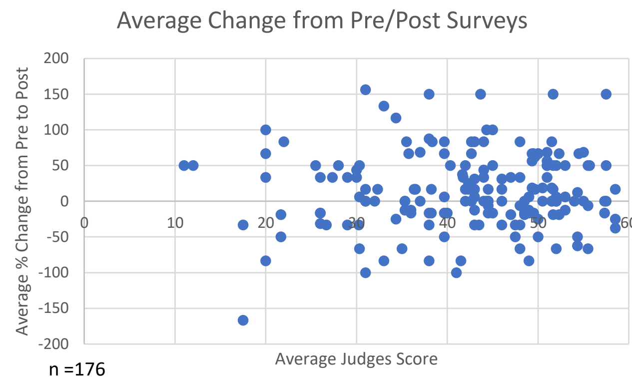

Figure 13
Post-survey Average Change (self-assessment) vs. Judges' scores

overall pre and post paired parent survey findings of the families being already strongly aligned with the program values.

5 Discussion

Analysis of the AI Family Challenge data shows that under-resourced communities are interested in learning about AI, and participating in a multi-week family education program, provided certain logistical needs are met. This addressed the first research question - "Are under-resourced families interested and willing to participate in an AI-Education program?" Key aspects of the program that kept the families coming back were: the opportunity to learn together as a family, doing hands-on activities, learning new concepts, terms and technologies, and connecting with other families. One of the sites in La Paz, Bolivia engaged families who cleaned shoes for a living (individuals earning ∼$3/day). This group has traditionally been ostracized by society and as a result they really valued the social interactions with other groups during the sessions - to the point where the site leader had difficulty in keeping their attention [Castilo, 2016].

Only about 8% of families submitted prototypes for review. Data analysis shed light on the second research question identifying factors that would enable participants to apply their knowledge to real problems. The analysis showed the need for more training for parents to help their child find meaningful problems, and manage their child's frustration through the product development stages. The site leader from Bolivia mentioned that families at a higher socioeconomic level had a harder time finding meaningful problems. However, families from a lower socioeconomic level did not have the skills for developing and testing prototypes.

Data from the multiple choice questions, quality of the prototypes, and the interviews, showed that both the families and site facilitators needed better analogies and explanations to understand the main concepts, and more guidance to determine which problems were suited to machine learning based solutions.The site leader from Cameroon mentioned using neuroscience analogies, or "this is what is happening in your brain", to help families contextualize Neural Networks and Machine Learning. A potential programmatic solution could be to connect technical mentors with site facilitators and families and provide technical guidance.

Data analysis showed that the families already had a high level of interest in AI. However they did not have access to opportunities to learn more about AI, and this was the gap that the AI Family Challenge filled. The 30 hours of dosage is most likely enough to maintain situational interest (supported by environmental factors) but not enough to develop self-driven interest [Hidi and Renninger, 2006]. Further work needs to be done towards the third research question ("What would enable participants to deepen curiosity and interest in AI?") mapping the lifecycle of interest over 3-5 years, identifying what combination of social, technical and environmental support is needed to develop self-driven interest. Through this analysis we will be able to determine whether the parent's perceptions of their child's increased interest and abilities was accurate and what support is needed to continue deepening both.

6 Future Work

There are three areas of future work:

1. Firstly, the data collection instruments need to be improved to shed light on the fourth research question of families' initial understanding of AI and how it changed through the program.
2. Secondly, the data collection instruments need to measure participant empowerment in a better way. We anticipate using Kabeer's framework of:
    - Resources: Increased access to material, human, and social resources
    - Agency: Increased abilities, participation, voice, and influence in the family, workplace, school, community
    - Achievements: Meaningful improvements in well-being and life outcomes that result from increasing agency and education [Kabeer, 1999].

3. And finally, more work needs to be done to determine what program elements (type of activities, dosage, type of technical mentoring, frequency and type of positive feedback) result in families continuing to learn on their own.

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