Program: A focused, 5-year effort to increase the number of African American, Hispanic/Latino(a), Native American (AHLN) 7th-grade students who are academically prepared to take algebra

Ms. Virginia Lynn Booth-Womack, Purdue University at West Lafayette (COE)

Virginia received her B.S. in Industrial Engineering and a B.A. in Psychology while at Purdue University. She is currently the Director of Minority Engineering Programs in the College of Engineering. She assumed the position in 2004 after 18 years of manufacturing experience. Her last assignment was Lean Manufacturing Manager for the for the 3.7L and 4.7L Mack Engine facilities at Chrysler Corporation in Detroit, Michigan. Virginia has applied lean manufacturing concepts to identify and close the achievement gap between under-represented minority engineering students and the total engineering cohort. This was achieved focusing on first semester performance and first year retention through implementation of an aggressive transition program targeting first year engineering students from historically under-represented groups. She recently was called upon to serve as interim Executive Director for the National Society of Black Engineers from December 2013 through August 2014 during which time the organization experienced membership growth and strong metric focus towards goal attainment.

Dr. Saundra Johnson Austin, University of South Florida

Dr. Saundra Johnson Austin is the lead project coordinator at the University of South Florida for Florida Alliance for Graduate Education and the Professoriate (FL-AGEP) Transformation Alliance: Improving Pathways in the Professoriate for Minority Women in STEM. She is the project coordinator at the University of South Florida for Project Racism In School Exclusionary Suspensions (RISES), a mixed methods study that addresses the long-standing phenomenon of out-of-school suspensions for African American middle and high school adolescents. Dr. Johnson Austin also teaches math and pre-algebra to 7th grade girls and boys at Academy Prep Center of Tampa.

In 2007 she founded Charis Consulting Group, LLC as the President and CEO. Dr. Johnson Austin has held positions as: executive director of Curated PathwaysTM to Innovation in San Jose, CA; senior vice president for operations at the National Action Council for Minorities in Engineering, Inc. (NACME); president and CEO of St. Michael's High School; executive vice president of the Community Partnership for Lifelong Learning; executive director of the National Consortium for Graduate Degrees for Minorities in Engineering and Science; and Minority Engineering Program director at The Pennsylvania State University. She began her career as a cost engineering at Bechtel Power Corporation.

In 1998, she was recognized with the National Society of Black Engineers' (NSBE) Inaugural Golden Torch Award for Minority Engineering Program Director of the Year and Outstanding Contribution by a Minority Engineering Program Administrator Award by the National Association of Multicultural Engineering Program Advocates (NAMEPA). She was awarded the 2004-2005 Selected Professions Fellowship by the American Association of University Women (AAUW). Since 2014, Dr. Johnson Austin is a member of the United States White House endorsed initiative Algebra by 7th Grade. In April 2015, she was recognized by The Pennsylvania State University as Outstanding Engineering Alumnus for Civil and Environmental Engineering and she currently serves on the College of Engineering's Industrial and Professional Advisory Council (IPAC). Since July 2020, Dr. Johnson Austin is serving as the president of AAUW Tampa, Inc. In addition, she currently serves as Member-At-Large for American Association for Engineering Education Minorities In Engineering Division (ASEE MIND), a member of the Smithsonian Science Education Center's Advisory Committee for 'Zero Barriers in STEM Education,' and on the executive advisory board member for the Northeast STEM Starter Academy at Mount Vernon, NY.

Dr. Johnson Austin is a member of the editorial review board for the Caribbean Educational Research Journal (CERJ). She also served as a reviewer for the National Science Foundation's CS for All Pathways, HBCU-Up, INCLUDES Conference and INCLUDES Launch Pilot.

She earned a Bachelor of Science degree in Civil Engineering from The Pennsylvania State University, an MBA from the University of Notre Dame, and Doctor of Education in Organizational Change and Leadership from the University of Southern California.

Mrs. Renee Serrell Gibert, Purdue University

Renee Gibert is a driven and accomplished educator who thrives on building foundational knowledge for students to achieve excellence. She is a National Board-Certified Teacher in Early Adolescent Mathematics. Only 3% of the nation's teachers have attained this prestigious certification. Also, she is also a certified Jump Start financial literacy teacher. Renee served as a mentor to teachers seeking National Board Certification for the Indiana Department of Education in 2017. Her strength is analyzing data and using the results to modify instruction to meet the needs of special education and at-risk students. She is a former MATHCOUNTS coach and successfully led alternative education students to regional competitions in Upstate South Carolina for 4 years. Moreover, Renee has utilized her skill set to develop engaging mathematics activities for grades 6-12. She has extensive knowledge in Common Core State Standards, National Council of Teachers of Mathematics Standards, and Literacy. Renee is founder of Get Lit Mathematics which infuses current events and culturally relevant pedagogy to teach math concepts. http://www.getlitmath.com The School District of Oconee County recognized Renee for excellence in teaching as the Code Academy Teacher of Year in 2013. While a teacher in South Carolina, Renee facilitated district level workshops on literacy and comprehension in mathematics, historical connections to mathematics, and effective middle grades math and Algebra 1 practices. She is dedicated outreach and advocacy. Additionally, she served as lead teacher and mathematics curriculum coordinator for the Tri County Technical College's Upward Bound program. Renee also is an experienced virtual educator and has taught undergraduate statistics courses online.

Renee holds a B.S. Industrial Engineering and M.A.T in Middle Grades Mathematics Education from Clemson University. She is currently pursuing a PhD in Curriculum and Instruction at Purdue.

Dr. Carol S Stwalley P.E., Purdue University at West Lafayette (COE)

Dr. Carol S. Stwalley, PE joined the Minority Engineering Program team in the fall of 2007 as Recruitment and Retention Analyst. She earned her Bachelor of Science in Agriculture and Biological Engineering (ABE), MSABE, and PhD ABE from Purdue University. Carol has more than 14 years in diversity work with considerable background working with the Women in Engineering Programs at Purdue. In her current capacity as Recruitment and Retention Analyst for the Minority Engineering Program and the Purdue Office of Institutional Assessment, Dr. Stwalley collects, analyzes and manages data pertaining to the outreach, recruitment, retention and graduation of engineering students from historically underrepresented groups.

Dr. Lesley M Berhan, The University of Toledo

Lesley Berhan is currently the Associate Dean of Diversity, Inclusion, and Community Engagement for the College of Engineering and an Associate Professor in the department of Mechanical, Industrial, and Manufacturing Engineering at The University of Toledo. Her research interests are in the areas of composites and fibrous materials and engineering education. She received her B.Sc. in Civil Engineering from the University of the West Indies in St. Augustine, Trinidad, her M.S. in Civil Engineering from the Massachusetts Institute of Technology, and her Ph.D. in Mechanical Engineering from the University of Michigan, Ann Arbor. She joined the faculty at the University of Toledo in 2004. As the Associate Dean of Diversity, Inclusion, and Community Engagement she leads the development and execution of initiatives and programs to facilitate the recruitment, retention, and success of women, students from underrepresented groups and first generation students. These duties are well aligned with her current research interests and external funding in engineering education.

Mrs. Tamara Markey, Purdue University, Minority Engineering Program

Tamara Markey is an innovative, passionate, and dynamic educator. She draws from and applies to her work in education nearly a decade of professional experience as an Engineer with Amoco Oil and BP Pipelines. Mrs. Markey is a Woodrow Wilson STEM Teaching Fellow and a certified Project Lead the Way (PLTW) Instructor. She has taught high school Pre-engineering and served as a STEM Instructional Coach in the Lawrence Township Metropolitan School District in Indiana.

Tamara presently teaches high school physics at Columbus Academy in Columbus, OH. Additionally, she works with the Purdue University Minority Engineering Program, championing an elementary-level math initiative designed to address performance gaps in mathematics for underrepresented students and increase minority interest and program eligibility in STEM majors.

Tamara was honored by Purdue University's School of Industrial as a 2021 Outstanding Industrial Engineer for demonstrating exemplary achievements and leadership throughout her career. Additionally, she is the 2019 Teacher of the Year for the state of Indiana. Tamara holds a B.S. in Industrial Engineering and an M.S. in Engineering Technology Education, both from Purdue University.

Mrs. Cynthia Murphy-Ortega, Chevron Corporation

Cynthia Murphy-Ortega is currently Manager of University Partnerships and Association Relations of Chevron Corporation. Her organization manages Chevron's relationships with universities and professional societies and institutes throughout the world. Cynthia joined Chevron in 1991 as an engineer with the Richmond Refinery in the San Francisco Bay Area. She held various engineering, maintenance, operations, financial, business planning and process safety management positions within the refinery.

Cynthia then went on to work in the technology arena with the Chevron Energy Technology Company in 1998. She developed and managed Chevron's technical competency development programs for new hires in refining and exploration & production roles. She also worked in the Process Planning Group and performed process modeling on large-scale projects. In her role as Organizational Capability Manager with the Process, Analytical and Catalysis Dept, she supported technical competency management, staffing/recruitment, new hire and competency development, and business planning. Cynthia graduated from the University of California, Davis, where she earned a Bachelor of Science degree in Chemical Engineering.

Cynthia participates on various Boards and Committees in support of higher education and diversity, equity and inclusion – including the Engineering Dean's Advisory Committee, the Chemical Engineering Advisory Committee, the Mechanical & Aerospace Engineering Advisory Committee, the Leadership in Engineering Advancement Diversity and Retention Advisory Committee (LEADR) and the Avenue E Community College Transfer Program Advisory Board at University of California, Davis; the Engineering Dean's Advisory Board and the International House Board of Directors at University of California, Berkeley; the Engineering Dean's Advisory Board at University of California, Los Angeles; the Broadening Opportunity through Leadership and Diversity Advisory Committee (BOLD) at University of Colorado, Boulder; the Viterbi Dean's Corporate Advisory Board and the Viterbi Center for Engineering Diversity Industry Advisory Board at University of Southern California; the Industry Advisory Council for Minority Education at Massachusetts Institute of Technology; the Diversity, Inclusion and Access Advisory Board and the President's Council on Diversity, Inclusion, and Access (past) at Colorado School of Mines; the Women's Engineering Program Advisory Board at Cal Poly San Luis Obispo; the Corporate Membership Council of American Society of Engineering Education (ASEE); the Inclusion, Equity and Affinity Committee of National Association of Colleges and Employers (NACE) (past); the Postsecondary Pathways Innovation Lab Co-Chair of STEMconnector (past); the National Council on STEM and Technology for INROADS (past); the Women in Chemical Engineering Committee (WIC), Minority Affairs Committee (MAC) and Societal Impact Operating Council (SIOC) for the American Institute of Chemical Engineers (AIChE); and the Petroleum Geosciences Advisory Board and Petroleum Engineering Advisory Board at Chulalongkorn University/Thailand (past).

Algebra by 7th Grade: A focused, 5-year effort to increase the number of African American, Hispanic/Latino(a), and Native American (AHLN) 7th-grade students who are academically prepared to take algebra

ABSTRACT

While research on the impact of after-school programs is not new, there is limited research of the combined use of online mathematics tools to increase the knowledge and skill level of African American, Hispanic, Latino(a), and Native American students coupled with qualitative feedback from mentoring, parental involvement, and university-based cultural capital. Using the online tool **A**ssessment and **LE**arning in **K**nowledge **S**paces (ALEKS), this mixed methods study explores the implementation of a university-industry, hybrid model for African American, Hispanic, Latino(a), and Native American students to take algebra by the 7th grade. With the aid of culturally relevant science, technology, engineering and mathematics (STEM) pedagogy, our findings indicate that time spent, and topics learned in the mentor-parental based Algebra by 7th Grade (Ab7G) for 3rd, 4th, 5th, and 6th grade cohorts to date, were factors that contributed to the cumulative improvement of students' mastery of math concepts with accelerated growth of 1.25 academic years ahead of the student's current grade level. This paper shares a mixed methods methodology, which aims to increase math proficiency, algebra readiness, and opportunities for African American, Hispanic, Latino(a), and Native American students in elementary school. The long-range goals are for AHLN students to overcome systemic educational barriers and begin focused mathematics preparation, which will allow them to pursue rigorous STEM-related courses in high school.

Keywords: STEM, culturally responsive, ALEKS, computer-based math instruction, project-based learning, algebra, COVID-19

INTRODUCTION

Engaging students at the elementary level is critical to increasing exposure, interest, and most importantly, preparedness to enter into STEM-related studies and eventually careers. One critical aspect of preparedness is math performance, with advanced achievement serving as a critical indicator of academic preparedness, admittance, and success in college and university science, technology, engineering, and mathematics (STEM) Algebra by 7th Grade (Ab7G) across the nation.

The National Assessment of Educational Progress (NAEP), 2019 Nation's Report Card, indicates a severe math deficit at the 12th-grade level with only 8 percent of African American and 11 percent of Hispanic or Latino(a) students proficient in mathematics. Yet math proficiency levels are not sufficient in preparing students for the rigors of college in STEM environments. Those who aspire to pursue a STEM degree need to perform at the advanced level to survive the rigors of college admissions in engineering and other STEM programs (Lane, 2016; Lane et al, 2020). NAEP data reveals no significant change over the past 10 years in math performance in grades 4, 8 or 12. The performance of African Americans, Hispanic, Latino(a), and Native American students lags behind White and Asian/Pacific Islander students who performed at 32 percent and 50 percent, respectively.

Consequently, the pipeline of African American, Hispanic, Latino(a), and Native American students (AHLNs) qualified to pursue STEM-related fields is staggeringly low. This is significant as the U.S. Bureau of Labor Statistics (2019) projects STEM occupation employment growth from 2019 to 2029 to outpace all other occupations. STEM fields expect 8.0 percent growth compared with 3.7 percent for all occupations. However, African Americans, Hispanics, and Latinos(as) continue to make up a small fraction of STEM professionals and are less likely to earn degrees in STEM than other degree fields.

Asians and Whites are overrepresented among STEM professionals compared with their share of employment across all occupations. Whites represent 67% of STEM professionals. These statistics translate into increased earning potential for overrepresented groups and further exacerbates the socioeconomic racial divide that exists between racial groups and occupations (Pew Research Center, 2021).

Math is a foundational subject that is required for students to earn degrees in STEM fields (Ibrahim & Johnson, 2019; Lane et al., 2020). Yet, educators are challenged with engaging all students to be successful in math (Stansell, Tyler-Wood, & Austin, 2016). Student tracking in K-12 schools begins as early as first grade and depending on the 'track' that they are on, they will experience a curriculum that varies in difficulty, depth of content, and higher order thinking skills (Johnson Austin, 2019). The level of difficulty achieved will be mapped to the criteria required to meet post-secondary options and will impact the career trajectory they can pursue (Douglas & Attewell, 2017). The higher the level of math achieved before college, the more options they will have, especially in STEM fields.

Algebra is a foundational and gatekeeping course to higher level mathematics and science courses. The percentage of students entering STEM fields was higher among students who took trigonometry, precalculus, or calculus in high school (U.S. Department of Education National Cechevronnter for Education Statistics, 2018). For the most part, these are not students of color. Currently, students of color do not meet proficiency standards in mathematics and at this rate of performance, they will not be able to enroll in algebra before high school. Algebra preparation before high school is essential for the AHLN students to cross the finish line if they want to pursue an engineering or STEM career. Across the country algebra-readiness materials are used to rebuild students' knowledge and skill level (Cavanagh, 2008; Johnson Austin, 2019). We propose a national University-Industry Ab7G model that is designed to increase the number of the AHLN seventh grade students who are academically prepared to take algebra. We suggest that efforts to increase these numbers begin as early as the second and third grade. Suppose access and equity for mathematical proficiency are expanded at the fourth-grade level. By the time students matriculate to the 8th and 12th grades, there will be an increase in the number of AHLN populations that can consider STEM as a career option because they will be eligible for more rigorous math courses.

In alignment with the urgency to address root causes of low enrollment of AHLN's in STEM, engaging students and their parent(s) year-round in the Algebra by 7th grade program is one of several initiatives the Chevron Corporation sponsors. Beginning with third graders, this program provides continued academic support and parental dialogue within a university setting, as parental involvement is critical to STEM success (Lane & Id-Deen, 2020). Through partnerships with universities and associations, Chevron demonstrates its commitment to broadening the participation of underrepresented students in STEM. Their support is a strategic investment in the economic development of local communities and the future of the energy business. Chevron's continuing investments in education are long-term and far-reaching, and its support for STEM education helps communities prosper and gives everyone partnership in the process. Chevron is known globally for its diversity and inclusion initiatives and continued support for programs that empower students and enable human progress.

BACKGROUND

In February 2013, more than twenty national STEM organizations were invited by the White House Office of Science and Technology Policy to discuss priorities for African Americans, Hispanics, Latinos(as), and Native American (AHLN) students in STEM. In October of that same year, these organizations reconvened to discuss a collaborative effort to support K-12 STEM education and increase the number of

AHLN students with the prerequisites to pursue STEM. Participants converged on the goal of ensuring that every seventh-grade student in the United States is academically prepared to take algebra.

By February 2014, the nine partner organizations that signed on to support the initiative returned to the White House discussing their commitment. The National Society of Black Engineers (NSBE) and College Tribe piloted the first Algebra by 7th Grade program in September 2014. Each pilot had a cohort of third graders who were taught the skills and concepts over four years to matriculate into Algebra by the 7th Grade using **A**ssessment and **LE**arning in **K**nowledge **S**paces (ALEKS) as a resource for measuring academic progress as well as parental engagement and diverse mentors to work with the students during their sessions. ALEKS is currently used in schools globally as an assessment and learning tool across several subjects, including mathematics. The ALEKS system was purchased by McGraw Hill and has become a primary assessment tool for university placement into first year engineering courses. Parental involvement included information sharing about college readiness and sharing student performance metrics throughout the process. Mentors were secured through a student organization that had a service-oriented membership base.

The Ab7G program was led by a multi-organizational steering committee and launched in two environments. The first was at the College Tribe, a community-based facility with adequate space for an after-school effort with limited technology. The second facility was at the NSBE World Headquarters in an organizational training room where access to shared technology was made available on the weekends. Parents and students expressed excitement over the initiative and despite the difficulty with transporting their children and facility limitations. Parents shared testimonies of noticeable improvements in academic performance and increased self-confidence in math understanding. Over time, however; the logistical, resource and access constraints threatened the sustainability of the program. The community-based program, targeted for a four-year effort, ended in the spring of 2017. It was determined that the program was better suited for a university-industry collaborative effort. Access to adequate technology and exposure to a university setting would resolve logistical and resource constraints. In addition, the university-industry model provides participants with exposure to the university environment, as well as an opportunity for industry partners to invest in early learning opportunities within their respective communities.

The program objectives aim to support accelerated math mastery, resulting in algebra readiness in middle school, include the following: (1) Improved student attitudes towards mathematics and school, writ large; (2) Improved academic performance in mathematics; and (3) Achievement of a performance level that meets, or exceeds, proficiency for Common Core State Standards (CCSS).

The Ab7G program framework is designed around four core tenets: Integration, Acceleration, Engagement, and Research.

1. Integration: Incorporation of enhanced math rigor and STEM exposure into the base programming of the host organization;

2. Engagement: Commitment to regular session attendance and fulfilling Ab7G learning goals between scheduled sessions as determined for each designated grade level;

3. Acceleration: Implementation of an ancillary, year-round math Ab7G that uses blended learning to augment the standard academic curriculum and enable mastery of foundational math concepts; and

4. Research: The tracking, monitoring, and assessment of student performance and attitudes towards math.

These tenets provide the needed framework and methodology to meet Ab7G objectives. Subsequently, the program was reconfigured as a university-based model and was piloted at Purdue University in partnership with the Chevron Corporation in the Fall 2017-18 academic year. To begin the university effort, meetings were held between a director of the Purdue-based program and the director of elementary education in a school district nearby. An urban, Title I school system was chosen for recruitment into the program, since it had the highest local African American, Hispanic, and Latino(a) population in the county (Moore, 2021). To be classified as Title I, a minimum of 40% of the students must qualify for free or reduced-priced lunch. Among the groups of students who are served are limited English proficient students, homeless students, students with disabilities, at-risk students, migrant students, and any students in need.

There were eight elementary schools in the system with AHLN populations between 41-64%. The free or reduced-price school meals participants between 57-87% within the individual schools. Table 1 presents data showing the ethnicity and free or reduced-price lunch participation for the eight schools in the district. The information was taken from the 2016 school data provided by the program's State Department of Education.

Table 1 - *Ethnicity and Free or Reduced-Price Lunch participation data from the elementary schools in the urban, Title I school system used in first-year recruitment for Algebra by 7th Grade. (https://www.in.gov/doe/it/data-center-and-reports)*

	African American	Hispanic/ Latino	Native American	Multiracial	AHLN (total percentage)	Free/ Reduced Price Meals	School Enrollment	First Year Ab7G Participants
School #1	36%	19%	0%	10%	64%	87%	366	16
School #2	15%	18%	0%	9%	42%	71%	233	2
School #3	10%	32%	0%	5%	47%	82%	503	4
School #4	14%	42%	0%	6%	62%	73%	525	4
School #5	7%	25%	1%	8%	41%	57%	505	
School #6	28%	30%	0%	6%	64%	83%	499	
School #7	16%	30%	0%	7%	53%	84%	274	
School #8	15%	22%	0%	8%	45%	66%	409	

The Superintendent of Elementary Education suggested three of the eight schools for the Ab7G launch. The next step was to engage principals from the target schools to explain the objective of the program, namely, to serve as an after-school program, engage parents, and provide gender and ethnic-matched mentors and role models in hopes to positively impact participant self-efficacy (Mitcham et al., 2012). With buy-in from the principal, solicitation emails were provided to principals about the Algebra by 7th Grade. The university-based team developed recruitment activities that ranged from attending introduction of teacher nights, attending school-wide math nights already planned, and pizza dinners for targeted families. The top three schools were invited to participate in the inaugural Ab7G. They were given first priority for enrollment and each school was given 10 seats until the priority deadline. After the priority

deadline, four additional students were added from a fourth school. After the enrollment process is completed, parents and students commit to a parent and child agreement. The agreement details the criteria for completing the time and topic goals in ALEKS and committing to attend the Saturday sessions.

Based on the feedback from the school administrators, we were encouraged to continue the Ab7G program over the next few years. We were able to open the program to other schools as indicated in Table 2. The demographic profile of each cohort is reflected in Table 2. Note, over 50% of the participants were from AHLN demographics. For continuing students that began as 3rd graders in 2017, the initial cohort of 17 - 3rd graders completed the 6th grade in 2020-21, making them eligible for University's summer engineering workshops in summer 2021.

Table 2 - *Demographic Profile of the Algebra by 7th Grade*

	Schools Represented each Year	% Female	% Male	% African American	% Hispanic/ Latino(a)	% Native American	% Two or More	% Caucasian
2017-18	4	72	28	44	28	0	11	17
2018-19	6	63	37	37	26	4	15	18
2019-20	8	77	23	26	30	5	14	25
2020-21	10	62	38	44	11	0	14	30

METHODS

The purpose of the mixed-methods study is to understand student perceptions in mathematics as it pertains to culturally responsive mathematics. The guiding research questions are as follows:

1. How do African American, Hispanic, Latino/a, and White students view the contributions of minorities in the field of mathematics?

2. Does participation in a math mentoring program influence elementary students' perceptions of mathematics and their math self-esteem?

3. Can artificially intelligent math software increase math proficiency in African American, Hispanic, and Latino/a students?

The research questions guided student learning outcomes. Furthermore, the curriculum seamlessly integrates the historical contributions of women and minorities in STEM fields. For example, one summer program's component focused on farming with implications to area and perimeter. During this time,

students learned about George Washington Carver's immense contributions to agriculture. This example highlights how historical references were an added value to the curriculum to increase cultural responsiveness. Finally, through using initial and final assessments in ALEKS, the research team could quantitatively determine if there was a change in math proficiency.

The initial and final assessments are based on Indiana Department of Education Mathematics standards, which are modeled from the Common Core Mathematics Standards. The content of these assessments test students' knowledge that vary based on the grade level. Grade 3 content knowledge includes the following content standards: whole number place value; adding whole numbers; subtracting whole numbers; multiplying whole numbers; dividing whole numbers; fractions, measurement, representing and interpreting data; perimeter and area; geometry; and decimals. Grade 4 content knowledge includes the following content standards: whole number place value; addition and subtraction; multiplying whole numbers; dividing whole numbers; expressions and equations; fraction equivalence; operations with fractions; and fractions and decimals; measurement; perimeter and area; geometry, data, graphs, and probability. Grade 5 includes the following content standards: place value and review of arithmetic; multiplying whole numbers; dividing whole numbers; adding and subtracting decimals; multiplying and dividing decimals; fractions; operations with fractions; expressions and equations; measurement; geometry; perimeter; area and volume; data ratios; and probability. Grade 6 includes the following content standards: whole numbers; decimals; fractions; ratios; proportions and measurement; percents; integers and rational numbers; and equations and inequalities. Utilizing the Indiana Department of Education Mathematics Standards allows the research team to have a benchmark to measure student performance, which aligns directly with what they are learning in the school environment.

Students are assigned weekly goals to meet or surpass based on time spent in ALEKS and number of learned topics. Time in ALEKS for 3rd and 4th graders: 10 minutes per day, six days per week. An incremental increase is applied to 5th and 6th graders for time in ALEKS: 15 minutes per day, six days per week. Likewise, students have a number of learned topics to meet or surpass each week. Third and fourth graders need a minimum of three topics per week. While 5th and 6th graders need a minimum of four topics per week.

Furthermore, this daily practice is supported by research. Ku et al. (2007) found that individually personalized computer-based instruction improved students' attitudes toward mathematics and enhanced the performance of students with lower-level skills in mathematics. Students also work in small groups with a mentor during the Ab7G sessions for one hour in ALEKS building problem solving fluency. The data on each student is reviewed weekly to determine misconceptions, areas of weaknesses, and strengths. Project-based learning is modified to take into consideration these adjustments, which helps to maximize learning for students. Throughout the process, qualitative data, such as general observations and comments by the participants, are observed during the sessions.

The methodology described supports the aim of this research, which is to increase the number of AHLNs prepared to pursue STEM studies through the use of the ALEKS, an artificially intelligent web-based math assessment tool, and a culturally sensitive engagement strategy to establish a connection between learning and family culture. ALEKS is used to promote math mastery and accelerate cumulative math level progression under the mentorship of diverse college mentors. Parents are integrated into the engagement strategy to provide a mechanism to make parents aware of college preparation strategies at an early age and to create an environment of information exchange between parents and with university outreach programs that encourage collaboration and year-long engagement. ALEKS is also used nationally at the university level to assess math competency and course placement for incoming first-year students. Developing a national model, integrating the ALEKS software with a culturally relevant pedagogical

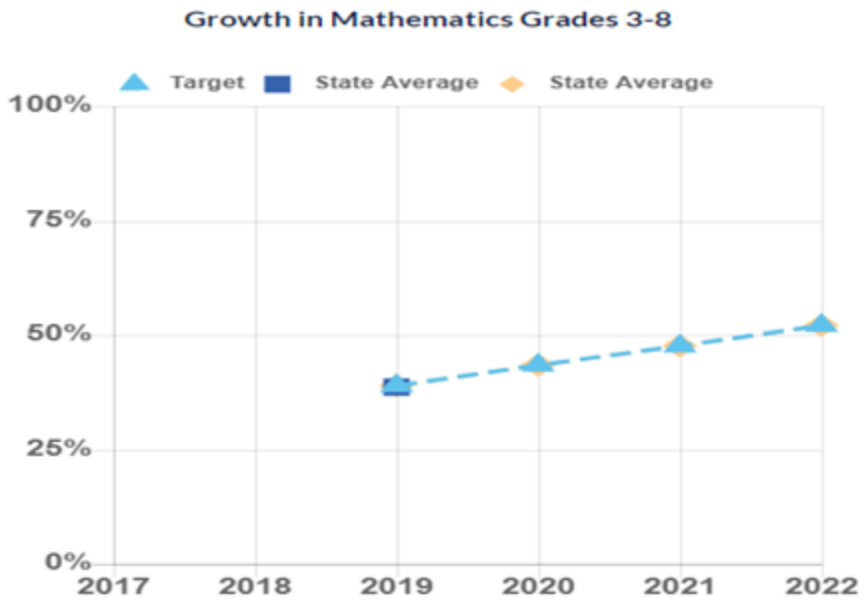
approach with elementary school children may prove beneficial to post-secondary education placement requirements. The program anchors math proficiency in a proven, ALEKS framework while working with AHLN students and their parents in an after-school setting (2017-19) but now in a virtual setting (2020-21) due to the coronavirus pandemic.

Through additional support from Purdue University, the program was able to expand beyond the first year. Results from the first full year of engagement showed a significant improvement for participants. We requested test results from the feeder school that had the largest number of participants. Beginning of Year (BOY) and End of Year (EOY) Standardized test scores from 2017 (before the program) and 2018 (after year one of the program) are shown in Table 3. These results stimulated the expansion of the program to all eight schools in the school district pending funding support.

The 2017 Student Growth Percentile (SGP) shows the percentile ranking of each participating student. Each row in Table 3 represents a participating student in the Ab7G program. The BOY number reflects the BOY score the participating student earned at the beginning of the school year. The EOY score reflects the growth the student experienced since the BOY. The percentile shows the percentage of students that scored lower than the participant in the program. For example, for the first student in the 2017 STAR exam, at the end of the year, 31% of the students with the same beginning score achieved a lower score than the participant. Note that for the same student in the 2018 test, the growth score by the EOY for 2018 this student's growth percentile improved to the 99th percentile. Additionally, the percentile ranking for each student that participated in the program is listed. The entire group of participants achieved a percentile score that exceeded the expectation for the district, as indicated in Table 3.

Table 3 - *Sample of 2017 Cohort - Student Growth Percentile (SGP)*

Student	2017 STAR BOY	2017 STAR EOY	2017 STAR SGP	2018 STAR BOY	2018 STAR EOY	2018 STAR SGP
[redacted]	508	593	31	549	784	99
	456	624	73	600	728	78
	468	603	36	557	771	99
	466	620	84	543	702	78
	478	540	43	556	692	86
	565	592	8	586	766	98
	489	676	90	643	751	67
	522	681	89	625	813	98
	408	554	76	528	685	86
	401	526	36	507	682	92



https://inview.doe.in.gov/schools/1078758138/growth?lang=en#chart-grid

Figure 1 - *State of Indiana Expected Student Growth Percentile Projection in Mathematics*

The program is designed to be a substantive, high-impact year-long initiative that is highly scalable, replicable, and versatile for diverse organizations and organizational program models. The program centers around core elements and methodologies, providing sufficient variability to work with each organization's programs, calendars, and constituencies.

Versatility

The Ab7G's program versatility was tested in the spring of 2020 as 'distance learning' unexpectedly became a requirement. The traditional model of face-to-face meetings with students and parents twice a month was immediately challenged and transformed into a virtual model. The support and resources provided through the program were even more critical, as many students were and will continue to be adversely impacted by COVID-19 learning disruptions. The separation from brick-and-mortar constraints quickly yielded a level of program versatility that had not yet been realized. As most Ab7G mentors left campus and returned to their homes across the country, a virtual program framework was developed to engage our student cohorts. Thus, allowing us to complete the academic school year and offer the inaugural 2020 Ab7G six-week summer virtual camp. With the conveniences and resources of on-campus gathering taken away, a revised approach to engagement was required. During this transition, our focus centered on maintaining the Ab7G model's integrity while creating a virtual program framework. The most significant virtual program challenges were technology, Ab7G delivery, and student/parent retention.

A lack of technology presented an immediate and significant barrier. Families attempted to engage in virtual programming while lacking adequate devices to support student and parent participation. Additionally, Wi-Fi accessibility presented an issue for some families. Once schools issued tablets and chrome books to students, some students returned to the program. Unfortunately, this was not an area where we could assist the families, contributing to a rise in mid-year Ab7G attrition.

While working to maintain the general structure of the sessions, Ab7G changes were necessary to sustain a high level of engagement. For example, supplemental training was developed for mentors to learn

strategies to boost student participation while online. Parent sessions became even more critical, as many parents expressed the need to support their students during distance learning. As such, more sessions focused on math topics that were challenging for parents and students. Parent sessions organically became a support group where parents rallied to provide moral support and share learnings in assisting their children through the pandemic and distance learning. Hands-on learning activities also took a shift due to the limited resources accessible to families in their homes, resulting in hands-on projects that could be completed in one session, utilizing easily accessible, low-cost, and safe materials. In the six-week Math in Gardening virtual summer camp, project kits were purchased and delivered to the homes of student participants. This hands-on learning experience allowed many students to experience gardening for the first time while applying learned math concepts to design and plan their gardens.

For some, the virtual framework was simply not an attractive math enrichment option. Parents and guardians faced challenges in monitoring their students while at the same time attempting to participate in the parent programming. Many parents expressed difficulty motivating their students to get on Zoom for the program after an entire week of Zoom for school, driving some families to leave Ab7G or to attend sporadically.

Flexibility

Algebra by 7th Grade flexibility remains necessary as we move into the 2021-22 academic school year. Realizing many benefits of a virtual platform (extended geographic outreach, extended geographic participation, and ease of session attendance), the 2021-22 programming framework will now reflect a hybrid model, recognizing in-person and virtual benefits alike. The hybrid learning model maintains program integrity and the goal of addressing existing performance gaps in mathematics, with an ultimate desire to grow the pool of AHLN students interested and eligible to pursue STEM-related fields. Table 4 highlights a comparison of the Ab7G model. Appendix A outlines a sample Ab7G agenda as a guide for instruction and engagement.

Table 4 - *Algebra by 7th Grade Model Comparison.*

In-Person Model (2016 - Spring 2020)	**Virtual Model (Spring 2020 - Summer 2021)**	**Hybrid Model (2021-22 School Year)**
Sessions: Held two times per month.	**Sessions:** Held two times per month.	**Sessions:** Held two times per month.
Framework: Sessions held at R1 Doctoral University, serving local area students and school districts. Participants were assigned designated classroom and lab spaces for planned programming over three hours.	**Framework:** Sessions held on a Zoom virtual meeting platform, enabling the expansion of participants to include students outside the immediate R1 Doctoral University area. Enrollment expanded to include students throughout the state and nationally. Attendees followed required conventions, meeting norms, and guidelines key to maintaining a virtual environment conducive to sharing, learning, and celebrating student learning efforts. Student and parent programming are carried out in designated Zoom Breakout Rooms.	**Framework:** Three sessions held at R1 Doctoral University. Five sessions are to be held on a Zoom virtual meeting platform. Both, In-person and Virtual frameworks, as subsequently outlined, apply to this hybrid model.
Session Content: Student progress goal recognition, Student/Mentor math mastery support time, Parent programming, and Experiential Learning Activities designed specifically for each grade-level cohort. Third-grade students engaged in introductory coding using Scratch. Fourth Grade students engaged in coding microprocessors through BBC Micro: bit. Fifth-grade students engaged in CAD design and 3D printing. Additionally, lunch was provided for all participants and Ab7G staff.	**Session Content:** Student progress goal recognition, Student/Mentor math mastery support time. Parent programming, Experiential Learning Activities conducive to being done in the homes of the program participants. All activities were scrutinized for safety, minimal expense, and ease of acquiring materials. Project-based learning materials were mailed to all summer Ab7G participants.	**Session Content:** Virtual sessions will encompass Student progress goal recognition, Student/Mentor math mastery support time, separate Parental programming, STEM Career Presentations, and Experiential Learning Activities. The virtual experiential learning activities will be carried over to in-person sessions, providing students with an opportunity to apply their work from the virtual sessions to STEM manipulatives that are not available during virtual sessions. Fifth, sixth, and seventh-grade cohorts will work in the R1 Doctoral University innovation & fabrication laboratory to create prototypes of their design projects.

RESULTS

The program started in September of 2017 and the results from the 2018 BOY and EOY are shown in Table 3. The test results listed in Table 3 are for the participants of the school with the largest cohort of student participants (n=10). The school was rated 'C-' and performed 'Below Average' compared to other schools in the district. Results from two other schools are not included due to the low number of participants in each school (n<5). As a comparison, a graph of the Indiana State Growth Percentile Projections for mathematics is presented in Figure 1. Against this backdrop of student improvement in end of year results, the program piqued the interest of district level administration to continue the program and expand it to include other schools in the district.

Critical in this blended learning model is the web-based assessment tool and learning system known as ALEKS. ALEKS is designed to deliver standards-based mathematical content that is aligned with CCSS, ensuring students are working on the math topics they need for academic advancement and achievement. ALEKS uses adaptive questioning to determine which concepts a student has and is ready to learn. This tool is instrumental as part of the student's mathematical practice and for monitoring and measuring student progress. The use of ALEKS in the program allows the selection of any state standards in the nation. Since the majority of our students are in the state of Indiana, we use the Indiana State Standards to measure student success. We request the school learning objectives for each grade level for alignment with ALEKS Assigned work.

The Model

The Ab7G sessions are held throughout the academic school year, with additional programming offered during the summer months to minimize lost progress. Each academic school year, a cohort of 3rd graders begin the program. Students are also permitted to enter the program at the 4th and 5th grade-levels. Every participant begins the year completing an Initial Knowledge Check in ALEKS to determine their beginning of year (BOY) baseline. Students complete additional ALEKS Knowledge Checks mid-year and at the end of the school year, allowing student progress to be monitored at each student's given grade level.

Third through seventh grade-level cohorts engage in blended experiential project-based learning, mentoring from a university STEM student, and exposure to practicing STEM professionals. This multi-faceted approach aims to cumulatively improve student mastery of math concepts 1.25 years each academic year, to result in a five-year advancement in four years. Thus, increasing math proficiency, algebra readiness, and opportunities for AHLNs to pursue STEM-related post-secondary studies. The Algebra by 7th Grade model consists of three core pillars; Students, Parents, and Mentors, each of which are supplemented with projects that encourage the appreciation for cultural capital and discussion.

Students

Students maximize learning by engaging in online and in-session learning, meeting grade-level assigned progress goals, group exercises, hands-on projects, meaningful mentor assignments, and exposure to practicing STEM professionals in a cooperative environment. Mathematics mastery is accelerated through this multi-faceted approach, supporting student growth and attitudes toward learning. Students are recognized and rewarded for their effort and Ab7G dedication through STEM Bucks rewards. Not losing an opportunity for learning, each student has a STEM Buck account that accrues "stem buck" rewards associated with Ab7G attendance, accomplished goals, and ALEKS grade level completion. Students are allowed a yearly spending allowance of 10% of their accrued bucks to secure engineering focused games, projects, and learning. The remaining balance is saved and carried over from year to year for full or partial payment for an engineering summer camp at the R1 Doctoral University. The STEM Bucks incentive program is motivating for both students and parents. Our qualitative efforts produced the following quotes from students:

Students 1: "*I like being with my friends and having lunch together. I like my mentor. I want to learn to make 3D printed dinosaurs like the mentor Alex does. I wish we could play math games outside and go places."*

Student 2: *"I like having smart friends that are nice. I wish we could explore the Purdue University campus and go to the labs and work. Then we can create things with our mentors."*

Student 3: *"I wish we could take field trips to jobs of engineers. Like when we talked to a mentor and she said she will work for a makeup company as an engineer. I didn't know you could be an engineer and do something fun like create makeup. Or you can even engineer shoes for a company like Nike. You don't just have to be an engineer or scientist of something that you are not interested in. I want to know what jobs engineers can have that are fun. Like my mentor is doing something really cool with space, but I want to do something that is fun for me."*

Parents/Guardians

Parents/guardians attend Ab7G sessions with their children. During these sessions, parents/guardians are involved in a separate 'track' of the program. The parent/guardian track involves discussions concerning national trends of math proficiency, reviewing math concepts related to their child's learning objectives, starting early to plan for college, as well as relevant topics related to supporting their child's learning and development at home and at school. It is important for parents to see their children thrive in an environment where they can be their authentic selves and not feel out of place. Parents also engage with student experiential learning opportunities, designed to support their students' engagement and progress. Parents play an active role in fun engineering projects with other parents, learning the engineering design process along the way. Our qualitative efforts produced the follow quotes from parents/guardians:

Parent/Guardian 1: *"As a parent, I like the program for many reasons, but the fact that I can attend the program with my children has been extremely beneficial. Being able to ensure the safety of my children is my top priority and the transparency that is offered in this program made me feel extremely comfortable. Being able to know the mentors and educators involved with my children was a big deal for me as a parent. Seeing the nurturing, encouraging, and positive influences that my children are exposed to is equally as important as the educational benefits this program offers. The environment is structured for children to grow successfully on many levels. Even exposing my children to facts about gaps in education based on race has been beneficial. My children have changed the way they view their community. They think on such a higher level with the knowledge they have gained. My 11-year-old daughter talks about how her and her Ab7G classmates are learning things and that they will be a generation of change. She believes that they will become future leaders and change the world. This is not an exaggeration! This program is literally shaping my children's path to a successful future."*

Parent/Guardian 2: *"As a parent, I couldn't have imagined that a math program would have had such an impactful way of thinking for my children. I say it every time I talk about Algebra by 7th Grade; I wish every child has this opportunity. It truly would make a generation of change."*

Parent/Guardian 3: *"The [program] has helped my children to be more confident and eager to learn and to show their teacher they know how to complete new problems she has presented to the class. I also appreciate that you can join Algebra by 7th Grade living across the country. It is offered to all regardless of their location."*

Mentors

Mentors work with their assigned group of students throughout the academic year. Mentor assignments are carefully established, with great effort given to race/ethnicity and/or gender matching when possible. Mentors receive training to facilitate blended learning environments and personalized learning strategies, using a combination of web-based and tactile engaging exercises that are designed to support culturally responsive learning environments. Hard work, achievement, and fun are promoted during each session, as

math mastery and a growth mindset are supported. Research has shown that positive relationships with mentors and peers in a cooperative environment promotes academic achievement.

Mentor 1:

"This is my favorite job! For me, this program is important because I am able to reach more students and speak to the parents in Spanish to make sure they understand and to communicate what their children are doing and what they will learn as well."

Mentor 2:

"This program gives an opportunity for student leaders from all organizations to come together and make a difference in our communities by helping young people learn mathematics, and they PAY US to do this, making college more affordable!!"

Data Analysis

The most pronounced result is that students and parents alike have shown a marked improvement in their attitudes toward math. Students formed positive relationships with their mentors and fellow students within their cohort, motivating them to engage actively during the in-person sessions and between sessions. The program engages undergraduate and graduate student mentors, who earn a stipend each semester that helps meet the needs of college affordability and provides an opportunity for organizational collaboration to achieve community-based initiatives. Student mentors are also members of student organizations, including, but not limited to the national student societies of National Society of Black Engineers (NSBE), Latinos in Science and Engineering (MAES), and Leading Hispanics in STEM (SHPE), as well as other organizations.

The 2020-2021 Ab7G program yielded 40% (13/32) of year-long active students achieving student mastery of math concepts of 1.25 per academic year. The Ab7G goal is to end 3rd grade at a 4.25 grade level, 4th grade at a 5.50 grade level, 5th grade at a 6.75 grade level, and 6th grade at an 8.0 grade level which would place them in Algebra during their 7th grade. All students achieved significant growth, as measured against initial- and final-assessment performances. In addition, the first eligible cohort will attend Purdue University's Summer Engineering Workshops designed to expose participants to the impact of engineering careers and academic success strategies.

The 2020-21 program enrollment of 3rd graders was particularly large with the addition of students from a large, urban school district. The 2020 summer Ab7G enrolled 19 students who were rising third graders from this large urban school district, of which 3 students were from medium-sized urban areas. All of the three students who began the 2020-21 school year at grade level of 3.90 or above had taken part in this summer Ab7G. Of the 20 active students in the 2020-21 school year, six students continued from the summer program from the large, urban school district and two from a medium-sized, urban district. We recruited eight new students in the fall of 2020, and four more were added in the spring of 2021. One student completed 66% of the ALEKS sixth grade level and achieved these results while on the accelerated track in school. Three students completed half or more of the fifth-grade level in ALEKS, which counts the student identified as accelerated by their school. Eleven of the students completed the 4.25 grade level goal for 3rd grade students. These students spent an average of 27.7 hours in ALEKS throughout the school year. Three students completed the academic year with an approximate grade level of 3.5 and spent an average of about 3 hours in ALEKS throughout the school year.

The low enrollment in the Ab7G fourth-grade cohort may have been due to the 100% virtual platform, which did not have the enticement of visiting the Purdue University campus, as prior classes did. There were four active students in the 2020-21 school year, with three renewing from the previous year and one student joining in spring 2021. Two of those students reached the 5.5 grade level goal for fourth graders. The average study time of these two students in ALEKS was 38.6 hours. The other two students did not complete the LV3 class during the 2019-20 school year, nor did they during the 2020-21 year. These two students averaged 7.5 hours during the course of the Ab7G program.

The fifth-grade level consisted of eight students who consistently participated. Five students began the year at level 5 in ALEKS and one student met the 6.75 Ab7G goal for fifth graders. The other three students remained in the grade level 4 of ALEKS. Two of these students spent over 25 hours completing problems in ALEKS and demonstrated a half year growth between the beginning and the ending of the school year. Initially, these two students encountered difficulties progressing in ALEKS beginning in the third grade. While they did not meet the growth of 1.25 grade levels, they benefited from the Algebra by 7th Grade program by strengthening weaknesses in their math skills.

The sixth-grade class consisted of six students who consistently participated in the Ab7G program. Four students have been active since the start of the program when they came in as 3rd graders. One student entered in the beginning of the summer 2020 Algebra by 7th Grade program, and one entered in fall 2020. No students reached the goal of completing pre-algebra by the end of their 6th grade year; however, two students completed half of the ALEKS program at this level. These student's participation began with the program during the 2017-18 school year; and they were recognized by their urban school district to enter the challenge program for the 2021-2022 school year. The challenge tracking prepares students to enroll in Algebra I in the eighth grade.

Two years of data were analyzed using SPSS to compare means using the independent t-test. The test for the 2018-19 school year had two cohorts present with 3rd and 4th graders. The Ab7G delivery for that school year was 100% on campus. The growth between the initial assessment and the final assessment was recorded for each child as well as the number of Ab7G sessions attended and hours spent in ALEKS. The demographics of the students are presented in figure 2 and performance data are in Table 5.

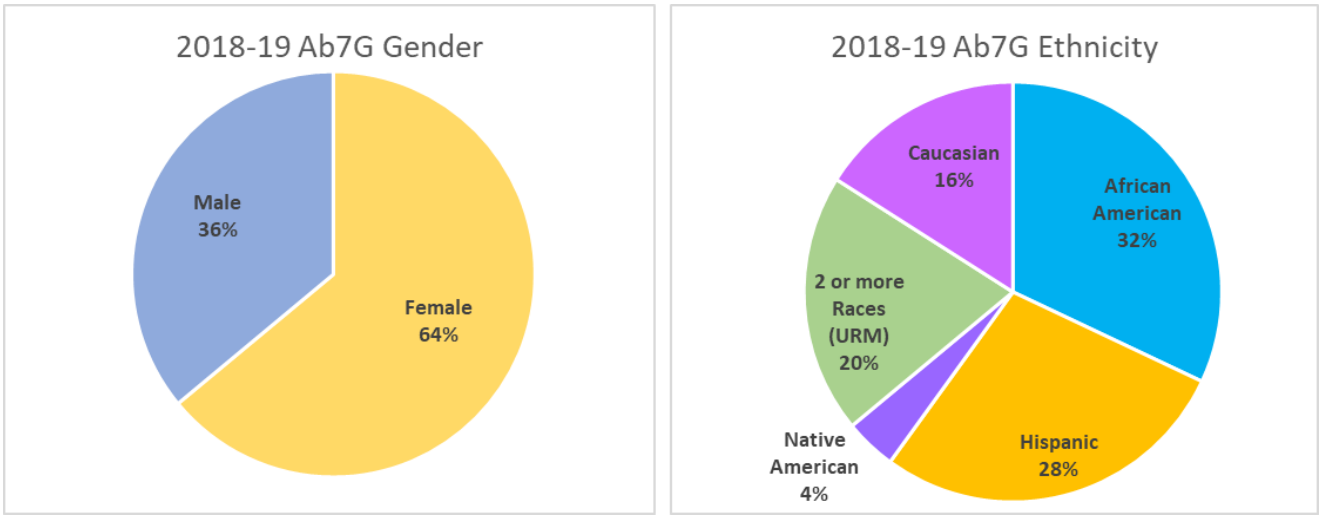


Figure 2 - *Demographics of the 2018-19 participants in the Ab7G program.*

Table 5 - *Algebra by 7th Grade Performance of 2018-19 Students in 3rd (3.x) and 4th (4.x) grades.*

	2018-19 Ab7G Sessions Attended	Total Time Spent in ALEKS (hrs)	Total Growth (Grade Level)
Student 3.01	4	8.6	0.10
Student 3.02	6	19.3	1.34
Student 3.03	14	20.1	0.58
Student 3.04	10	10.4	0.53
Student 3.05	2	0.0	1.00
Student 3.06	8	29.6	1.29
Student 3.07	12	12.5	0.38
Student 3.08	9	21.7	1.34
Student 3.09	12	8.7	0.37
Student 3.10	1	1.6	0.02
Student 3.11	1	1.4	0.02
Student 3.12	9	21.0	0.55

	2018-19 Ab7G Sessions Attended	Total Time Spent in ALEKS (hrs)	Total Growth (Grade Level)
Student 4.01	13	10.9	1.08
Student 4.02	7	6.2	0.21
Student 4.03	13	11.1	0.97
Student 4.04	14	10.7	0.20
Student 4.05	10	11.0	1.10
Student 4.06	2	4.1	0.17
Student 4.07	11	14.1	0.16
Student 4.08	10	4.5	1.20
Student 4.09	4	2.2	0.12
Student 4.10	6	4.8	0.04
Student 4.11	14	30.7	0.24
Student 4.12	10	8.2	0.19
Student 4.13	14	31.3	0.19

The data were sorted by sessions attended and then by time in ALEKS to determine the upper and lower quartiles of the students. These two quartiles then were tested to determine if there were differences between the two groups. The three tests that were used to compare the students were comparing the averages of the total growth when number of sessions was considered. The second test was the averages of the total growth when the amount of time in ALEKS was considered. Finally, the averages of time in ALEKS were compared when the number of sessions were considered. On average, students in the upper quartile with an average of 14 sessions attended had higher grade level advancement (Avg Growth= 0.54) than students in the lower quartile with an average of 2 sessions (Avg Growth = 0.10). This difference was statistically significant $t(5.5)=2.439$, $p=0.028$. On average, students in the upper quartile with an average of 36.2 hours spent in ALEKS had higher grade level advancement (Avg growth)=0.862) than students in the lower quartile with an average of 3.4 hours spent in ALEKS (Avg growth)=0.102). This difference was statistically significant $t(5.3)=3.369$, $p=0.009$. On average, students in the upper quartile with an average of 14 sessions attended had higher hours spent in ALEKS (Avg time)=24.6) than students in the lower quartile with an average of 2 sessions (Avg time)=3.4). This difference was statistically significant $t(5.4)=5.032$, $p<0.002$. These tests indicated that for this year's data, the more Algebra by 7th Grade sessions a student attended, and the more time spent in ALEKS would both result in higher math proficiency. Likewise, the more Algebra by 7th Grade sessions a student attended would increase the likelihood of spending more time in ALEKS. The Algebra by 7th Grade program is 100% voluntary and although it is mapped to the academic state standards for mathematics, student activity in the program is not connected to the academic requirements of the institution that the student attends. As a standalone program, all of the student participants are experiencing academic growth in mathematics, in spite of the complications of operating on a virtual platform.

Figure 3 presents the demographics information for the 2020-21 Ab7G participants. In Table 6, the tests for the 2020-21 school year had four cohorts present with 3rd, 4th, 5th, and 6th grade students. The Ab7G delivery for that school year was 100% virtual. The student designations do not have any correlation

between the 2018-19 school year students above, though there are some students in both year's groups. The same tests as used in the previous analysis were performed for this set of data.

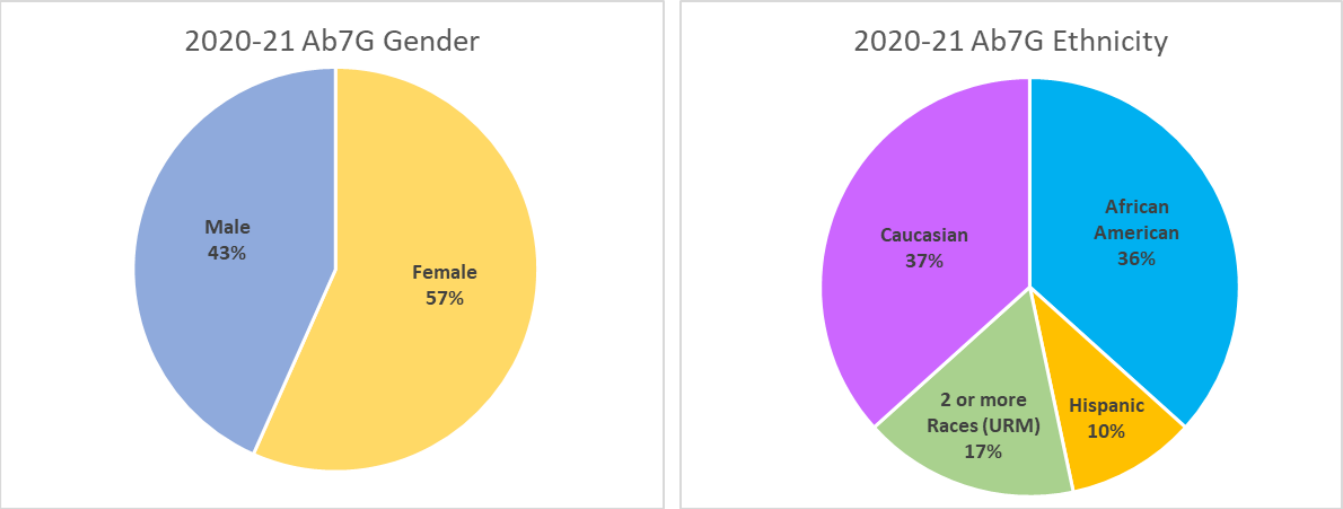


Figure 3 - *Demographics of the 2020-21 participants of Ab7G.*

Table 6 - *Algebra by 7th Grade Performance of 2020-21 Students in 3rd (3.x), 4th (4.x), 5th (5.x), and 6th (6.x) grades.*

	2020-21 Ab7G Sessions Attended	Total Time Spent in ALEKS (hrs)	Total Growth (Grade Level)
Student 3.01	11	25.7	0.49
Student 3.02	5	11.8	0.40
Student 3.03	9	33.5	0.90
Student 3.04	12	22.1	0.17
Student 3.05	10	33.0	0.94
Student 3.06	12	34.8	1.29
Student 3.07	5	17.3	0.87
Student 3.08	4	12.2	0.54
Student 3.09	14	16.3	1.02
Student 3.10	9	3.5	0.11
Student 3.11	4	3.5	0.22
Student 3.12	10	41.2	1.15
Student 3.13	8	28.5	0.89
Student 3.14	10	24.2	1.04
Student 3.15	3	2.0	0.02

	2020-21 Ab7G Sessions Attended	Total Time Spent in ALEKS (hrs)	Total Growth (Grade Level)
Student 4.01	7	7.9	0.17
Student 4.02	10	28.1	1.16
Student 4.03	2	7.3	0.38
Student 4.04	3	39.7	0.88
Student 5.01	13	26.6	0.52
Student 5.02	11	12.5	0.09
Student 5.03	11	7.7	0.20
Student 5.04	7	16.3	0.86
Student 5.05	5	6.9	0.21
Student 6.01	8	33.8	0.54
Student 6.02	13	47.8	0.77
Student 6.03	11	19.5	0.08
Student 6.04	7	13.5	0.15
Student 6.05	10	41.7	0.56
Student 6.06	9	29.7	0.43

On average, students in the upper quartile with an average of 12 sessions attended had higher grade level advancement (Avg Growth = 0.637) than students in the lower quartile with an average of 4 sessions (Avg Growth = 0.377). This difference was not significant $t(12)=1.383$, $p>0.05$. On average, students in the upper quartile with an average of 38.0 hours spent in ALEKS had higher grade level advancement (Avg growth)=0.879) than students in the lower quartile with an average of 5.5 hours spent in ALEKS (Avg growth)=0.188). This difference was statistically significant $t(6)=6.052$, $p=0.000$. On average, students in the upper quartile with an average of 12 sessions attended had higher hours spent in ALEKS (Avg

time)=25.8) than students in the lower quartile with an average of 4 sessions (Avg time=8.7). This difference was statistically significant t(12)=3.248, p=0.004. These analyses were only slightly different from the results from 2018-19. The number of Ab7G sessions attended did not show significance with increasing math proficiency but increasing the number of sessions did predict higher time spent in ALEKS. The other item of note was that both years showed the time spent in ALEKS for the upper quartile was close to the 1.0 – 1.5 hours per week which was the goal for the students. Additional analyses are found in Appendix B.

CONCLUSIONS

The Algebra by 7th Grade program is designed to be a substantive, high-impact year-long initiative that is highly scalable, replicable, and versatile for diverse organizations and organizational programming models. The program centers around common core elements and methodologies, providing sufficient variability to work with each organization's programs, calendars, and constituencies. We do not request information from parents on medical conditions related to learning deficiencies, Individual Education Plans, or a 504 plan. Participation in the Ab7G is voluntary, and participants may leave at any time without penalties. There is an opportunity to look more closely at student deficiencies; however, the focus on this after-school effort was better to understand cognitive and cultural influences on student performance.

Due to the attrition of students during COVID-19, the generalizability of these results is limited. In addition, student enrollment in the program declined during the pandemic due to a lack of technology and reliable home internet access. Students who dropped out of the program were not included in the data analysis, which influenced the results' outcome.

Previously piloted programs have demonstrated that the Ab7Gs' integrity hinges on the uniform understanding of the importance of integration, acceleration, engagement, and research. Therefore, organizations aspiring to host such an Algebra by 7th Grade program must assess the feasibility, scope, needs, requirements, and commitment involved in embarking upon the program.

Recognizing the importance of math proficiency, family involvement, and mentorship, the program intends to continue to track student pathways towards calculus while offering continued engagement in STEM-related experiences. In addition, we realize that the support and resources provided through the program are even more critical, as many students continue to be adversely impacted by the coronavirus (COVID-19) pandemic learning disruptions.

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APPENDIX A

Sample Algebra by 7th Grade Session Agenda

9:00 am: Algebra by 7th Grade Staff, Mentors, and volunteers join Zoom Meeting

9:00 - 9:10 am: Agenda Review and necessary revisions - **Algebra by 7th Grade Lead**

9:10 - 9:55 am: Mentor and Staff Instructions

- Update Zoom Names according to our session naming convention
  - <u>For Mentors and MEP Staff</u>
    - **"M-" or "S-"** (denoting Mentor or Staff person)
    - **LastNameFirstName**
    - Example: S-LastNameFirstName

- Video Expectations - Cameras On

- Necessary Mentor Assignment Revisions

- Mentor/Student Progress Checklist
  - Know your students' overall progress in ALEKS
  - Know your students' progress towards their weekly goals
  - Are they struggling with a specific topic?
  - What do you have planned to support student progress?
  - What students haven't shown up to the session?
  - Encourage students to complete Weekly Time and Topic Goals
    - TIME IN ALEKS Weekly Goals
      - 3rd and 4th Graders: 10 minutes/day, 6 days per week
      - 5th and 6th Graders: 15 minutes/day, 6 days per week
    - LEARNED TOPICS Weekly Goals
      - 3rd and 4th Graders: minimum 3 topics/week
      - 5th and 6th Graders: minimum 4 topics/week

- Breakout Room Overview

  Student/Mentor Session
  10:20 - 11:05: ALEKS Work
  11:05 - 11:10: Break
  11:10 - 11:40: BALLOON PROJECT Pre-Work

  Parent Session:
  10:20 - 11:40 Supporting Your Student's Growth Mindset
  Next Session Project Review

9:50 - 9:55 am: Questions

9:55 - 10:05 am: Families Joining

- We will use this time to begin getting student names changed to fit our student naming convention. This will help expedite the breakout room process. Mentors, please keep an eye out for **your** students and modify names as necessary.

10:05 am: **Meeting Begins**

- Breakout rooms will be created during Announcements and Session Norms presentation

10:05 - 10:10: **Introductory Announcements**

Each session will be recorded

- Roll call for devices: each student and parent will need a device to complete the engagement activities
- A/V check for each participant
- Mute audio during the session: all participants should be muted at this time
- SHARE PREPARED Naming Convention SLIDE

10:10 - 10:13: **Algebra by 7th Grade Welcome - Purdue University, Minority Engineering Program Director**

10:13 - 10:15: **Session Norms - Program Administrator**

SHARE PREPARED SLIDE

- Do not unmute unless you have a question or comment
- Discuss chat room opportunity - do a demonstration (Have a participant test it out by sending a message to everyone)
- If you have a question, send it to the speaker in the chat room
- If you would like to speak, please raise your hand
- Stay focused on the material being presented or the work requested
- Be polite
- If you are not currently sharing your screen, do not write on the screen being shared unless otherwise asked
- Messages in the chat room should be appropriate to Algebra by 7th Grade

- Use the restroom before the session begins so that we can have a great session without interruption

10:15 - 10:20: **Session Review with Participants - Algebra by 7th Grade Lead**
Student programming
Student Goal Celebrations - Mentor Lead

10:20: **Invite participants to join assigned breakout rooms - Algebra by 7th Grade Lead**

10:20 - 11:50 am **Student/Mentor and Parent Breakout Sessions**

- 10:20 - 11:00: ALEKS/Group Math Activity
- 11:00 - 11:05 Break/Transition Time
- 11:05 - 11:45: Project Based Activity
  - Math Game: KaHoot! (if time is available)
  - Math Videos (if time is available)

11:45 - 12:00 **Return to the Main Session**

- Mentor Group Progress Shout Out
  - Topics completed
  - Proficiency level achieved (grade completion)
  - Time spent in ALEKS
  - STEMBUCKS earned
- Closing Announcements

12:00 **Student/Parent Session Ends**

12:00 - 12:30 pm **Algebra by 7th Grade Mentor and Staff Post Session Meeting**

- Shared Learnings
- Upcoming Announcements
- Reminders

APPENDIX B - Statistical Table Comparisons

T-Tests (2018-19)

Test 1.1 Comparing Average Growth Between Upper and Lower Quartile of Attending Algebra by 7th Grade Sessions (2018-19)

Upper Quartile Avg Number of Sessions: 14

Lower Quartile Avg Number of Sessions: 2

The average growth of the Upper Quartile was 0.537 and the Lower Quartile was 0.102, these averages are statistically significant.

Table B.1 - *Group Statistics for Growth compared against upper and lower quartiles of Number of Sessions Attended during 2018-2019.*

Group Statistics

	GROUP1	N	Mean	Std. Deviation	Std. Error Mean
GROWTH	Upper Quartile of Ab7G Sessions	6	.5367	.42725	.17443
	Lower Quartile of Ab7G Sessions	6	.1017	.09131	.03728

Table B.2 - *Independent Samples Test for Growth compared against upper and lower quartiles of Number of Sessions Attended during 2018-2019.*

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
GROWTH	Equal variances assumed	15.273	.003	2.439	10	.035	.43500	.17836	.03758	.83242
	Equal variances not assumed			2.439	5.456	.055	.43500	.17836	-.01222	.88222

*p<.05

On average, students in the upper quartile with an average of 14 sessions attended had higher grade level advancement (Avg(growth)=0.537) than students in the lower quartile with an average of 2 sessions (Avg(growth)=0.102). This difference was statistically significant t(5.5)=2.439, p=0.028.

Test 1.2 Comparing Average Growth Between Upper and Lower Quartile of Spending Time in ALEKS (2018-19)

Upper Quartile Avg Time Spent in ALEKS: 36 hr

Lower Quartile Avg Time Spent in ALEKS: 3.4 hr

The average growth of the Upper Quartile was 0.862 and the Lower Quartile was 0.102, and this difference is statistically significant.

Table B.3 - *Group Statistics for Growth compared against upper and lower quartiles of Time Spent in ALEKS during 2018-2019.*

Group Statistics

	GROUP1	N	Mean	Std. Deviation	Std. Error Mean
GROWTH	Upper Quartile of Time Spent on ALEKS	6	.8617	.54503	.22251
	Lower Quartile of Time Spent on ALEKS	6	.1017	.09131	.03728

Table B.4 - *Independent Samples Test for Growth compared against upper and lower quartiles of Time Spent in ALEKS during 2018-2019.*

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
GROWTH	Equal variances assumed	20.719	.001	3.369	10	.007	.76000	.22561	.25731	1.26269
	Equal variances not assumed			3.369	5.280	.018	.76000	.22561	.18920	1.33080

*p<.05

On average, students in the upper quartile with an average of 36.2 hours in ALEKS had higher grade level advancement (Avg(growth)=0.862) than students in the lower quartile with an average of 3.4 hours in ALEKS (Avg(growth)=0.102). This difference was statistically significant t(5.3)=3.369, p=0.009.

Test 1.3 Comparing Average Time Spent in ALEKS between Upper and Lower Quartile of Attending Algebra by 7th Grade Sessions (2018-19).

Upper Quartile Avg Number of Sessions: 14

Lower Quartile Avg Number of Sessions: 2

The average time spent in ALEKS of the Upper Quartile was 25 hours and the Lower Quartile was 3.4 hours, and this difference is statistically significant.

Table B.5 - *Group Statistics for Time spent in ALEKS compared against upper and lower quartiles of Number of Sessions Attended 2018-2019.*

Group Statistics

	GROUP2	N	Mean	Std. Deviation	Std. Error Mean
ALEKS_TIME	Upper Quartile of Ab7G Sessions	6	24.6000	10.12443	4.13328
	Lower Quartile of Ab7G Sessions	6	3.4333	1.91590	.78216

Table B.6 - *Independent Samples Test for Growth compared against upper and lower quartiles of Number of Sessions Attended 2018-2019.*

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
ALEKS_TIME	Equal variances assumed	21.743	.001	5.032	10	.001	21.16667	4.20663	11.79370	30.53963
	Equal variances not assumed			5.032	5.358	.003	21.16667	4.20663	10.56671	31.76662

*p<.05

On average, students in the upper quartile with an average of 14 sessions attended had higher time spent in ALEKS (Avg(time)=25) than students in the lower quartile with an average of 2 sessions (Avg(time)=3.4). This difference was statistically significant t(5.4)=5.032, p=0.0015.

T-Tests (2020-2021)

Test 2.1 Comparing Average Growth Between Upper and Lower Quartile of Attending Algebra by 7th Grade Sessions (2020-2021)

Upper Quartile Avg Number of Sessions: 12

Lower Quartile Avg Number of Sessions: 4

The average growth of the Upper Quartile was 0.637 and the Lower Quartile was 0.377, these averages are not statistically significant.

Table B.7 - *Group Statistics for Growth compared against upper and lower quartiles of Number of Sessions Attended 2020-2021.*

Group Statistics

	GROUP	N	Mean	Std. Deviation	Std. Error Mean
GROWTH	Upper Quartile of Ab7G Sessions	7	.6371	.41536	.15699
	Lower Quartile of Ab7G Sessions	7	.3771	.27390	.10353

Table B.8 - *Independent Samples Test for Growth compared against upper and lower quartiles of Number of Sessions Attended 2020-2021.*

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
GROWTH	Equal variances assumed	1.851	.199	1.383	12	.192	.26000	.18805	-.14973	.66973
	Equal variances not assumed			1.383	10.388	.196	.26000	.18805	-.15689	.67689

On average, students in the upper quartile with an average of 12 sessions attended had higher grade level advancement (Avg(growth)=0.637) than students in the lower quartile with an average of 4 sessions (Avg(growth)=0.377). This difference was not statistically significant.

Test 2.2 Comparing Average Growth Between Upper and Lower Quartile of Spending Time in ALEKS (2020-2021)

Upper Quartile Avg Time Spent in ALEKS: 38 hr

Lower Quartile Avg Time Spent in ALEKS: 5.5 hr

The average growth of the Upper Quartile was 0.879 and the Lower Quartile was 0.187, and this difference is statistically significant.

Table B.9 - *Group Statistics for Growth compared against upper and lower quartiles of Time Spent in ALEKS in 2020-2021.*

Group Statistics

	GROUP	N	Mean	Std. Deviation	Std. Error Mean
GROWTH	Upper Quartile of Time Spent on ALEKS	7	.8786	.28139	.10636
	Lower Quartile of Time Spent on ALEKS	7	.1871	.11041	.04173

Table B.10 - *Independent Samples Test for Growth compared against upper and lower quartiles of Time Spent in ALEKS in 2020-2021.*

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
GROWTH	Equal variances assumed	5.007	.045	6.052	12	.000	.69143	.11425	.44250	.94036
	Equal variances not assumed			6.052	7.805	.000	.69143	.11425	.42682	.95604

*p<.05

On average, students in the upper quartile with an average of 38 hours in ALEKS had higher grade level advancement (Avg(growth)=0.879) than students in the lower quartile with an average of 5.5 hours in ALEKS (Avg(growth)=0.187). This difference was statistically significant t(7.8)=6.052, p=0.000.

Test 2.3 Comparing Average Time Spent in ALEKS between Upper and Lower Quartile of Attending Algebra by 7th Grade Sessions (2018-19).

Upper Quartile Avg Number of Sessions: 12

Lower Quartile Avg Number of Sessions: 4

The average time spent in ALEKS of the Upper Quartile was 26 hours and the Lower Quartile was 8.7 hours, and these averages are statistically significant.

Table B.11 - *Group Statistics for Time spent in ALEKS compared against upper and lower quartiles of Number of Sessions Attended 2020-2021.*

Group Statistics

	GROUP2	N	Mean	Std. Deviation	Std. Error Mean
ALEKS_TIME	Upper Quartile of Ab7G Sessions	7	25.8571	12.89171	4.87261
	Lower Quartile of Ab7G Sessions	7	8.7143	5.36887	2.02924

Table B.6 - *Independent Samples Test for Time spent in ALEKS compared against upper and lower quartiles of Number of Sessions Attended 2020-2021.*

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
ALEKS_TIME	Equal variances assumed	1.991	.184	3.248	12	.007	17.14286	5.27827	5.64249	28.64322
	Equal variances not assumed			3.248	8.020	.012	17.14286	5.27827	4.97655	29.30916

*p<.05

On average, students in the upper quartile with an average of 12 sessions attended had higher time spent in ALEKS (Avg(time)=26) than students in the lower quartile with an average of 4 sessions (Avg(time)=8.7). This difference was statistically significant t(12)=3.248, p=0.0035.