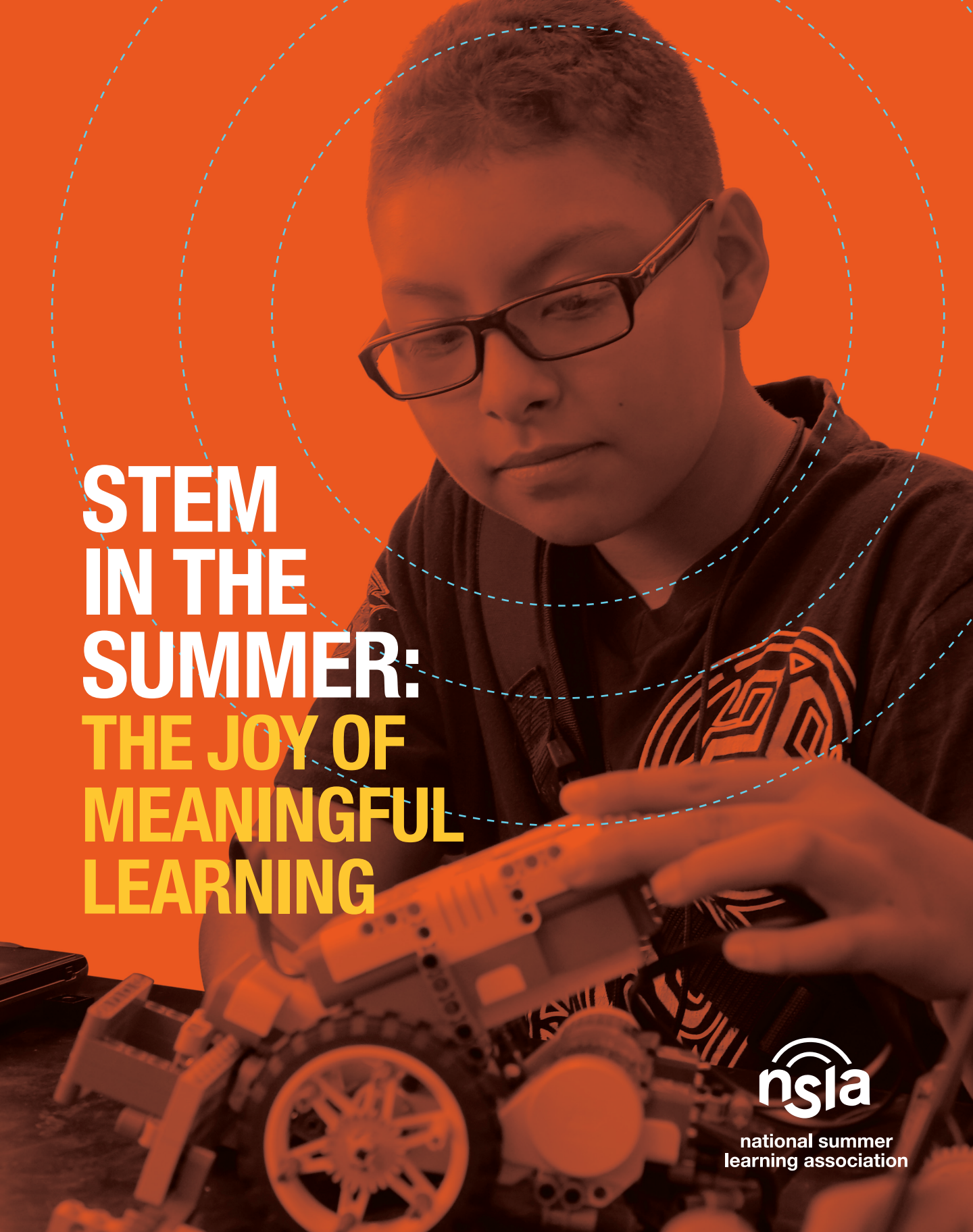

STEM IN THE SUMMER: THE JOY OF MEANINGFUL LEARNING

nsla
national summer learning association

THE JOY OF LEARNING IS AS INDISPENSABLE IN STUDY AS BREATHING IS IN RUNNING.

–SIMONE WEIL

introduction:

Enhancing STEM (science, technology, engineering, and mathematics) learning in elementary and secondary education has become one of the most critical issues in education. Many sectors have a stake in student interest and outcomes in these topics. Under new education law, students will be tested regularly against science standards; employers have a growing need for a workforce trained in STEM-related skills; and communities have a desire to attract and retain businesses with a strong home-grown employee pipeline. Summer learning programs offer students the chance to study STEM topics of their choosing with greater depth and focus than is possible during the school year, and to engage community partners and businesses in the education system in a meaningful way.

At the U. S. News STEM Solutions National Leadership Conference, held in May 2016,[1] Blair Blackwell, Manager of Education and Corporate Programs at Chevron Corporation explained:

> *"Education is the backbone of a strong workforce and helps fuel the innovation needed to address some of the world's biggest challenges. Our business is rooted in engineering and science, and we rely on top talent to think outside the box to discover new, safe and efficient ways to deliver affordable energy. We understand the importance of STEM education and know firsthand that having a robust supply of STEM workers is vital to ensuring economic competitiveness – for businesses and for our country."*

What makes STEM education successful? From a corporate perspective, Ray Almgren, Vice President of Marketing for National Instruments stated:

> *"National Instruments believes the best way to encourage students to pursue careers in engineering and science is to give them rigorous, but fun, hands-on experiences with real-world engineering tools. We invest in improving science and engineering education globally to motivate and empower today's students to become tomorrow's innovators."*

When we look at best practices for STEM education, we find that summer offers a unique opportunity for students to engage in STEM learning in ways that mirror real-world needs, while also drawing on the practices that make these learning activities most successful. Furthermore, summer is not just a convenient venue for engaging youth; as we describe in the next section and illustrate with the four exemplary programs that follow, a strong summer STEM program is a critical opportunity for our most vulnerable youth.

why summer?

Summer Learning Loss

Summertime presents the challenge of summer learning loss for many students, but also the potential for summer programs to reverse these losses by engaging students in exciting ways that look and feel very different from learning during the school year. Young people who lack stimulating and substantial summer experiences are likely to lose up to three months of learning from the previous school year. Because of differences in families' resources, the impact of the problem is greatest for students in low-income communities, compared with those in affluent communities.[2]

Summer STEM Programs: "Hands-On." "Rigorous. "Fun."

High-quality summer learning programs have been shown not only to improve reading and math skills, but to increase graduation rates and post-secondary success as well. STEM summer programs in particular offer a unique and multi-faceted opportunity to maintain and build core skills in math and literacy during the high-risk summer months. They do so by engaging young people in hands-on, inquiry-based learning that motivates students by immersing them in activities with real-world application, without the stigma of traditional summer school.

"The learning process is something you can incite, literally incite, like a riot." **–Audre Lorde**

When we speak of *engaging* young people, we mean something that includes, but is more than, having them recognize the pragmatic value of preparing for a STEM career. We mean also engaging them with the adventure of discovering new ideas, the exhilaration of better understanding both big and small features of the world they inhabit, and the joy of learning using scientific method, logic, and both deductive and inductive reasoning. That joy in turn can help to commit them to a lifetime of learning, within a broad range of STEM fields. Students go on to pursue careers that address overall improvement of the human condition and global ecosystem, from medical research to climate change advocacy, and may eventually apply today's STEM learning in ways that have yet to be discovered. By ensuring that STEM summer programs are hands-on, rigorous, and fun, we foster students' natural curiosity and stimulate them to create their own questions and problems, in addition to solutions.

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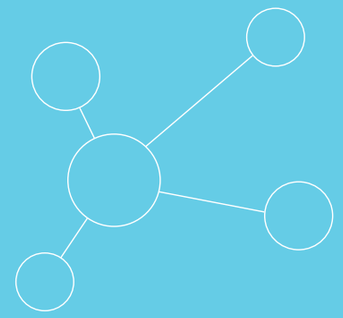
a framework for effective practice:

Connecting School and Summer STEM Learning

Two reports from the National Research Council provide important perspectives on identifying research- and evidence-based practices related to STEM learning during the summer. Published in 2012, *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* provides a conceptual framework for K-12 science standards with significant implications for both school and afterschool and summer programs. A 2015 report, *Identifying and Supporting Productive STEM Programs in Out-of-School Settings*, specifically addresses what works in summer and afterschool programming. Together, these reports provide strategic scaffolding for developing and implementing effective summer STEM programs. In broad terms, they point to the critical importance of summer programs to address students' interests and culture as well as to link learning from school, home, and other settings.



A summary introducing the *Framework for K-12 Science Education* states:

> The overarching goal of our framework for K-12 science education is to ensure that by the end of 12th grade, all students have some appreciation of the beauty and wonder of science; possess sufficient knowledge of science and engineering to engage in public discussions on related issues; are careful consumers of scientific and technological information related to their everyday lives; are able to continue to learn about science outside school; and have the skills to enter careers of their choice, including (but not limited to) careers in science, engineering, and technology.[3]

Furthermore:

> A coherent and consistent approach throughout grades K-12 is key to realizing the vision for science and engineering education embodied in the framework: that students, over multiple years of school, actively engage in science and engineering practices and apply crosscutting concepts to deepen their understanding of each field's disciplinary core ideas.[4]

The *Framework* also notes the value that cultural diversity can bring to STEM education, both in and outside of school:

> There is increasing recognition that the diverse customs and orientations that members of different cultural communities bring both to formal and to informal science learning contexts are assets on which to build—both for the benefit of the student and ultimately of science itself.[5]

In summary, this approach to STEM standards addresses objectives (students' appreciation, knowledge, and use of, as well as possible career orientation towards, STEM), content areas (practices, crosscutting concepts, and core ideas in broad areas of STEM), pedagogy (active and applied learning around core ideas), and cultural diversity.

The 2015 report on *Identifying and Supporting Productive STEM Programs in Out-of-School Settings* builds on the *Framework* concepts and finds that "there is growing evidence that opportunities to learn STEM outside of school directly affect what is possible inside classrooms, just as what happens in classrooms affects out-of-school learning."[6]

Furthermore, out-of-school programs have been shown to:

- Contribute to young people's interest in and understanding of STEM
- Connect young people to caring adults who serve as role models
- Reduce the achievement gap between young people from low-income and high-income families.[7]

The report concludes that:

> Research and evaluation findings are not yet robust enough to determine which programs work best for whom and under what circumstances. The limitations of the existing research are due to the many types of out-of-school STEM programs and the difficulties of measuring the outcomes of such programs. The findings are strong enough, however, to identify three criteria of programs that produce positive outcomes for learners: they are engaging, responsive, and make connections.[8]

> ENGAGE
> RESPOND
> CONNECT

Research shows that participation in a summer science program can stimulate greater interest in STEM careers.[10]

These criteria provide the best key to unlocking the power of STEM summer learning. To be effective, such programs must:

- Engage young people intellectually, academically, socially, and emotionally
- Respond to young people's interests, experiences, and cultural practices
- Connect STEM learning in out-of-school, school, home, and other settings.[9]

Taken together, these reports guide the kinds of learning objectives, content areas, and pedagogical methods that summer STEM programs must address in order to be effective.

The case studies on the following pages highlight best practices and defining features of exemplary summer STEM programs with strong outcomes. These four programs together illustrate some of the best STEM summer programming in grades K-12, use a variety of methods, and highlight a few key practices, recognizing that there is much more to learn from current and ongoing experience.

Student engagement based on culture and passionate interest in STEM topics is critically important to deeper learning as well as to commitment to STEM careers. By encouraging students to pick projects based on personal interests within their own cultural framework, youth engage in STEM learning deeply and with great relevance. In addition, by encouraging groups of students to develop projects of their own based on mutual interests, programs promote important STEM career skills like teamwork and communication.

case one:

Project L.I.N.K.

St. Stephen's Community House, Columbus, Ohio

Project L.I.N.K. was developed by St. Stephen's Community House in 2012, as a part of the overall strategy of Columbus City Schools and its partners to prepare students year-round for STEM education and to increase elementary and middle school students' aptitude in math and science. To ensure students' increasing awareness of STEM career fields, the program provides engaging, interactive team-based projects. It combines a number of academic, physical fitness, and developmental activities that challenge and engage students over the course of eight weeks.

100%
QUALIFY FOR FREE OR REDUCED-PRICE SCHOOL MEALS

200 YOUTH SERVED IN GRADES 1-8

ARE AFRICAN-AMERICAN

STUDENT PROFILE

The program serves students who are entering grades 1-8 (ages 5-13). One hundred percent of the youth qualify for federally subsidized free or reduced-price school meals. The Linden neighborhood in Columbus is low-income with high numbers of single-parent homes and vacant homes. Eighty-four percent of the population is African-American; 96 percent of youth in Project L.I.N.K. are African-American.

GOALS

Project L.I.N.K. is an all-day camp implemented at one site. The program's goals represent best practices for summer and STEM programs:

1. Offering safe, high-quality programming to 200 Linden area youth
2. Providing two nutritional meals each day that may have not otherwise been available
3. Including structured physical fitness activities to address childhood obesity
4. STEM learning experiences that support national and local STEM initiatives
5. Boosting academic skills and interests related to the STEM field
6. Offering both interpersonal and intrapersonal development opportunities

PROGRAM DESCRIPTION

All program youth participate in hands-on learning activities that relate to a weekly theme. The themes include: The Science of Nature, The Human Body, The Science of Music, Engineering: Build It!, Forensics, Aviation, Food Science, and The Science of Sports. Each theme has a detailed curriculum designed by St. Stephen's Community House/Project L.I.N.K. administrative staff and education professionals to challenge and encourage youth to solve everyday problems. These activities also promote communication and collaboration by emphasizing a team approach in the instructional units.

Each week, students are divided into small groups to complete a project related to the theme. At the beginning of each project, the youth in each group decide how they will assign each of the roles, responsibilities, and tasks. The teachers in each class have oversight to ensure a fair division and rotation of these roles.

For example, during the "Engineering: Build It!" theme week, each class learned all of the principles of the engineering design process, including: asking what the problem is; imagining or brainstorming a solution; planning by drawing it out; creating by implementing the solution; and continuously improving the product. Youth worked in small groups to create their own item that would be useful in the future. The fifth grade class decided to create their own version of a hovercraft to demonstrate how technology could impact transportation. The hovercraft was made primarily of recycled and reused materials found in many homes. The students combined particle board, a tarp, and a leaf blower to lift the base of the hovercraft from the ground.

A highlight for many students was the weekly competition in which groups present their project to the remainder of the class. Held each Friday, and judged by community members, these competitions helped to reinforce important 21st century skills such as teamwork, relationship building, and communication. The fifth grade class won the Friday competition for their creativity, hard work, and resourcefulness in building a working hovercraft.

81%
OF PARTICIPANTS MET OR EXCEEDED THE BASELINE SOCIAL-EMOTIONAL DEVELOPMENT SCORE

STUDENTS ADDRESS THE FOOD INSECURITY EPIDEMIC IN THEIR COMMUNITY BY HELPING TO DESIGN GARDEN BEDS

Project AquaStar, a recently added feature of Project L.I.N.K., is St. Stephen's Community House's commitment to addressing the food insecurity epidemic prevailing in the Linden community. Youth learn the importance of reducing our carbon footprint through recycling, reusing, composting, and energy conservation. Students use creativity by helping to design garden beds. They also are engaged in critical thinking by helping to conduct experiments, as well as problem solving by looking at ways to deal with garden pests and disease while doing no further damage to the environment.

OUTCOMES

Daily activities allow program participants to build upon and practice skills they have attained thus far, as well as acquire new skills.

PROGRAM ADMINISTRATORS BELIEVE THAT TEAM ACTIVITIES LED TO AN INCREASE IN EMPATHY, COMPASSION, AND INTERPERSONAL SKILLS.

A pre- and post-questionnaire created by the United Way of Central Ohio measures each student's social-emotional development level. During the summer of 2015, 81 percent of program participants met or exceeded a baseline score of 122.

case two:

Connecticut Pre-Engineering Program (CPEP) Summer Math Challenge

Six sites across Connecticut

CPEP is an educational organization in Connecticut whose mission is to serve as a catalyst in preparing and inspiring underrepresented students to explore, prepare for, and reach their full potential in Science, Technology, Engineering and Mathematics (STEM) careers. The CPEP Summer Math Challenge is an exciting, free, five-week program for middle-schoolers that stems summer learning loss, particularly in mathematics, and is aligned to grade-level standards. Participants work on teams to do fun, challenging games and activities while they improve their math abilities and have essential opportunities to develop socially.

395 URBAN STUDENTS SERVED

45% FEMALE

ELIGIBLE FOR FREE OR REDUCED-PRICE SCHOOL LUNCHES 65%

STUDENT PROFILE

In 2015, the CPEP Summer Math Challenge served 395 urban students at six sites across Connecticut. Of these students, 65 percent were eligible for free or reduced-price school lunches. Forty-five percent were female. Thirty-one percent were black, 25 percent Hispanic, 11 percent Asian, 24 percent white, and 9 percent other.

GOALS

The CPEP Summer Math Challenge focuses on improving math proficiency through immersive, interactive instruction and students' use of game-based software to learn mathematics. The central goal of the CPEP Summer Program is not only to eliminate the loss of up to three months of math proficiency experienced by most Connecticut urban students each summer, but for students to make significant gains in mathematics as well, thereby improving under-represented students' ability to pursue careers in STEM.

PROGRAM DESCRIPTION

CPEP's blended learning model integrates face-to-face teacher instruction with cutting-edge, games-based mathematics learning software to create an engaging, customized, and differentiated learning experience. In addition to math learning, students work in teams to address four hands-on STEM challenges. Each challenge requires students to apply the engineering design process in order to develop a solution. The challenges in the 2015 program were to:

1. Create a digitally animated advertisement using the Scratch programming language
2. Apply principles of gravity, force, and structural integrity to create a package optimized for aerial drop-delivery
3. Design and manufacture a working pair of specialized-function shoes
4. Develop a more "green" and energy-efficient model home through the application of new knowledge about insulators, sustainable energy, and efficient home-design

STUDENTS FLEX THEIR PERSONAL VOICE AND CHOICE, WHILE USING THEIR COLLECTIVE TALENTS AND CREATIVITY TO DEVELOP A RANGE OF SOLUTIONS TO THESE CHALLENGES.

To target mathematics proficiency, CPEP has designed an innovative learning system that integrates game-design principles and cutting edge educational gaming software with teacher-mediated blended learning strategies. Teachers are trained in blended learning techniques and data-informed instruction prior to and throughout the summer program. The software chosen for the program makes this computer-based strategy highly engaging and effective. CPEP has experimented with various software options over the years to best meet the needs of the program. Apart from teaching mathematics, any software CPEP chooses feels like any mainstream computer-based game - replete with teams, points, badges, and missions. On the back end, these high-tech games allow for individual differentiation of discrete math skills and also provide students and teachers with instant feedback and dynamic reports relating to students' performance. Teachers and students use these reports to reflect on learning and to make choices about whether to review material or to differentiate to more advanced or more fundamental skills in order to best meet the students' needs.

AVERAGE DAILY ATTENDANCE 94%

31% AVERAGE IMPROVEMENT IN MATH ASSESSMENT SCORES

NINETY-SEVEN PERCENT DEMONSTRATED GROWTH IN PRIORITY FOCUS SKILLS IN MATH SOFTWARE

86% INSPIRED TO PURSUE CAREERS IN STEM

OUTCOMES

A comprehensive assessment of math skills was administered to all participating students prior to beginning the program and again upon completion of the program activities. Assessments results indicated that after four weeks of instruction, student scores improved on average by 31 percent from their previous assessment score. Seventy-nine percent of students increased their scores.

THE CPEP SUMMER PROGRAM RESULTS INDICATE THAT NOT ONLY HAD STUDENT MATH SKILLS BEEN MAINTAINED, BUT THAT STUDENTS ACTUALLY EXPERIENCED AN OVERALL INCREASE IN MATH PROFICIENCY AS A RESULT OF PROGRAM PARTICIPATION.

On average, students improved overall proficiency by 24 percent on their Priority Focus Skills—skills they did not have prior to the program. Ninety-seven percent demonstrated growth in Priority Focus Skills in math software. The 2015 program was able to make a significant difference for the greatest number of students served to date in the program. Average daily attendance for the program was 94 percent, a figure higher than the past four years' average of 92 percent. The program was highly popular with students. Apart from popularity as demonstrated by attendance, in anonymous online surveys at the program's end, students rated the program 9.3/10; 96.5 percent of students agreed the program helped them learn math; and 86 percent of students agreed the program inspired them to pursue careers in STEM.

case three:

Wayne State University (WSU) Math Corps

Wayne State University, Detroit, Michigan

The Wayne State University (WSU) Math Corps began as a purely humanitarian effort on the part of faculty and college students to simply "do something" (coach basketball, paint schools... anything) to help young people in Detroit. In 1992, these efforts crystallized into what has become a powerful mathematics enrichment and mentoring program, built around a six-week summer camp for Detroit public school students. The students are divided into teams with each team having ten middle school students, five high school students who are paid as teaching assistants (TA's) and one college student ("college instructor" or CI) at the head. The CI's and TA's (most of whom were Math Corps students themselves) not only serve as teachers and role models for the middle school kids, but in many instances, as essentially "big brothers" and "big sisters."

400 DETROIT PUBLIC SCHOOL STUDENTS SERVED

OF PARTICIPANTS ARE AFRICAN-AMERICAN

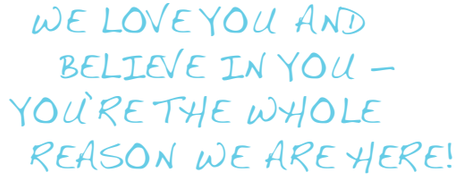
MANY SUFFER THE LOSS OF ONE OR EVEN BOTH PARENTS

STUDENT PROFILE

The WSU Math Corps recruits participants from students in middle school, transitioning to high school, and in high school. The camp serves approximately 400 middle and high school students at two sites on the WSU campus. All of them are or have been Detroit Public Schools students. Eighty percent qualify for free or reduced-price meals at school. Ninety-five percent are African-American. Many of them suffer the loss of one or even both of their parents, and a typical school day for most includes having to walk through a metal detector just to enter a failing school. Even with state intervention, the schools continue to fail and thousands of children remain under-served. The average ACT math score of the Detroit Public Schools in 2014-2015 was 16.5, while the statewide average was 19.5.

GOALS

At its core, the Math Corps is about a very simple but unwavering belief – that all children have a unique and special greatness within them and that, with hard work and the support of a caring family or community, that greatness can be realized. Since its inception, the Math Corps has worked to provide Detroit's children with the kinds of educational and lifetime opportunities that all kids deserve. The goal of the Math Corps is simple: to help as many of Detroit's children as possible graduate high school, fully prepared to go to college, and completely confident in their own abilities to build good and decent lives for themselves and others.



PROGRAM DESCRIPTION

From day one, the message is "we love you and believe in you – you're the whole reason we are here." The rules of the Math Corps include 100 rules for the staff (protect kids, praise kids, give time to kids, notice kids, accept kids, thank kids, etc.) and 3 rules for the kids: be yourself, strive to realize your greatness, and be safe. One example of how kids are encouraged to be themselves is seen through the Math Corps dress code – which doesn't exist. While schools worry about students being picked on for shabby clothes, or students stealing sneakers from others, the Math Corps – believing in its kids – addresses these issues directly, focusing on the virtues of kindness and integrity.

KINDNESS IS EXPLAINED LOGICALLY: "WE ALL HAVE ENOUGH CHALLENGES TO DEAL WITH IN THIS WORLD, SO DO I REALLY NEED SOMEBODY TELLING ME I'M TOO FAT OR TOO TALL OR TOO…?"

Letting students know that failure is a natural, frequent occurrence is also critical. Students use hand signals to support each other as they fearlessly tackle math problems at the board. Also, humor is central to the program – as evidenced by the fact that the highest position in the Camp is that of "Minister of Humor." Finally, because the Math Corps is a "lifetime" program with a close to 80 percent yearly return rate, the culture of the Camp is owned by the program's high school students, who pass it down to the younger kids.

IN THE CURRICULUM PLAN, EVERY STUDENT IN THE MATH CORPS GETS BOTH "BROCCOLI AND ICE CREAM" – A COURSE IN THE BASICS AND A COURSE IN ADVANCED TOPICS, TAUGHT THROUGH EXPLORATION AND DISCOVERY.

Over twenty years of programming, the Math Corps has developed a revolutionary K-12 curriculum that focuses on arithmetic and algebra. In the Math Corps, the appropriate level curriculum is employed for each grade, with lessons, daily homework, and weekly quizzes. Senior staff (veteran teachers) lead the program's classes using these materials. The CI's and TA's participate in their teams' classes. In Team Time, the CI's and TA's use individualized checklists to reinforce the material for each of their students. (Each middle school student has a checklist showing his or her updated strengths and weaknesses.) Addressing the entire checklist leads to the desired mathematical outcomes for each student.

In addition to instruction in grade-level mathematics, middle school students take a "Discovery Class" on advanced topics using teaching practices based on the Socratic Method. Students are encouraged to discuss questions posed by their instructors and by each other. Topics include infinite sequences and series, exponents, and fractals. Here, students learn to address the class to make mathematical conjectures, (often beginning with "My esteemed colleagues…") and support one another using hand signals. The conjectures must be accompanied by explanation of the student's thinking and use mathematical terminology and symbols. The ensuing discussion, guided by the instructor, allows for support or disagreement from fellow students. From one-on-one tutoring to journal writing to student presentations at the Closing Ceremonies, opportunities to share thinking are ever-present in the camp and woven into the fabric of the program.

90%
GRADUATE HIGH SCHOOL

EIGHTY PERCENT OF THOSE GRADUATES GO ON TO COLLEGE

OUTCOMES

Over the course of its twenty-year history, the Math Corps has seen consistent results. In summer 2015, seventh grade participants had an average pre-test score of 32 percent, and ended with a post-test average of 90 percent. The eighth graders had a pre-test average of 29 percent, and a post-test average of 84 percent. The ninth graders had a pre-test average of 32 percent and a post-test average of 84 percent. The Camp's high school seniors posted an ACT math average score over 21, significantly higher than Detroit's average. The 2015 overall attendance rate was 95 percent. The rate of students planning to return for 2016 is 87 percent. According to best estimates, over 90 percent of Math Corps students graduate high school, with over 90 percent of those going on to college (80 percent) or the military (10 percent).

case four:

Upward Bound Math & Science (UBMS) summer program

Berea College Carter G. Woodson Institute

Berea College's Upward Bound Math & Science Carter G. Woodson Institute (UBMS) began in 1999 as a federally funded regional program for economically disadvantaged, first generation Appalachian students interested in STEM education and careers, bringing students to Berea College's campus for an on-campus, academically rigorous residential program to allow them to develop their potential for success in such fields. In 2006, UBMS began focusing in five Eastern Kentucky Counties, delivering the same intensive summer program supplemented by academic year services. UBMS's mission is to work with low income, first generation Appalachian students to prepare them to be successful throughout their college and STEM careers.

UBMS WORKS WITH LOW-INCOME, FIRST GENERATION APPALACHIAN STUDENTS FROM FIVE EASTERN KENTUCKY COUNTIES.

100%

ADVANCED TO THE NEXT GRADE LEVEL OR GRADUATED

STUDENT PROFILE

The program serves a maximum of sixty-three low-income and/or first generation students from ninth through twelfth grades throughout their high school careers. The seven high schools from which participants are recruited are in Eastern Kentucky counties where adult academic achievement is well below state and national averages.

PROGRAM DESCRIPTION

While the summer program includes a rigorous schedule of STEM, humanities, and elective courses, it also emphasizes student initiative and choice. Instructors task their students to use time outside of class to explore areas within the course about which they feel passionate. The students develop projects to explore their own ideas and interests.

The projects the students completed in the STEM City course in summer 2015 were twofold, although they combined to support the same concepts: the science of energy and its application, especially in the context of a city. Students first created a sustainable city using the Sim City software. They then used that information to support their decisions as they created a model of a city of the future, 100 years from now. The students had to create the city primarily using recycled or repurposed materials. They had to apply concepts from their hands-on experiences, their field-trips to the ecovillage, a trip to city hall, and their experiences of having engineers visit the classroom. The class culminated in a competition in which each group was scored on the quality of both their virtual and 3-D model cities.

Also during the summer of 2015, students in one academy participated in a murder mystery scavenger hunt developed by another student group. The students guided other students through multiple locations where they showcased what they learned in the Zombie Camp-themed academy. The main goal of this scavenger hunt was to find the "kidnapped" UBMS director. The students were also tasked with creating bridges of different types that could hold at least 10 pounds using items such as dowel rods, toothpicks, and Popsicle sticks.

In another STEM course, students explored music and the way in which artists are able to gain fame and popularity. The students worked to create a statistical model that allowed them to evaluate how artists reached #1 on the Billboard Top 100 chart and how long they were able to maintain that status. The students then presented their findings to the entire program at the end of the six weeks.

One of the program's third-year students paired with a first-year student to explore photography. With the prevalence of digital technology, they felt that society had lost a basic understanding and appreciation of photography. They set out to build their own pinhole camera demonstrating how light and man-made tools allowed the first inventors to capture reality in order to make it a memory.

A large group of students also performed a double-blind evaluation of their peers' preference for Cheese-Its v. Cheese Nips, building, running, and evaluating the results from the test.

THESE EXAMPLES OFFER A GLIMPSE OF THE DIVERSE WAYS THAT THE UBMS SUMMER PROGRAM ENCOURAGES STUDENT ENGAGEMENT, SELF-DIRECTED AND HANDS-ON LEARNING, THINKING, CREATIVITY, 21ST CENTURY SKILLS (ESPECIALLY TEAMWORK AND COMMUNICATION), AND OPPORTUNITIES TO ENGAGE WITH REAL-WORLD PROBLEMS THAT ARE SOCIALLY AND CULTURALLY RELEVANT.

OUTCOMES

The following table represents students in the Berea College Upward Bound summer program in 2015.

PARTICIPATING STUDENTS 2015	
ENTERED WITH A GPA OF 2.5 OR HIGHER	91%
HAD ACHIEVED AT THE PROFICIENT LEVEL OR HIGHER ON STATE TESTING	52%
ADVANCED TO THE NEXT GRADE LEVEL OR GRADUATED	100%
GRADUATED WITH A RIGOROUS PROGRAM OF STUDY	93%
ENROLLED INTO A POSTSECONDARY PROGRAM OF STUDY	72%
COMPLETED A POSTSECONDARY DEGREE WITHIN SIX YEARS FOLLOWING HIGH SCHOOL GRADUATION	93%

conclusion:

Taking advantage of the opportunities that summer offers is indispensable to an excellent education.

That applies to STEM as well as to language skills, the arts, history, and physical education. From the National Research Council reports and other research, we can begin to identify some types of practices in STEM summer learning that seem both efficacious and replicable. These include practices that are exciting for both students and educators and that:

- Foster student engagement through sensitivity to students' cultural context, personal interests and goals, and challenges they face in both their local and global communities
- Promote 21st Century skills, including teamwork, communication, problem-solving, and creativity
- Use student-centered pedagogy, including individualized and self-directed learning (particularly with online tools)
- Provide a culture that embraces risk-taking and failure as essential to the learning process

Practitioners, policymakers, community leaders, and funders should continue to identify and learn from programs with proven and emerging practices that do these things. In addition, we should also seek program examples that embrace a range of learning objectives and diverse STEM content areas. In addition, we should pay special attention to practices that engage families and integrate students' experiences in school, at home, afterschool, on weekends and during holiday breaks, and during the summer.

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