

Building on a Foundation of Grit: Houston's CHAMP Gives Students Tools for Success in STEM (and Life)

By Elizabeth Platt Hamblin

To Mark Tomforde, Associate Professor of Mathematics at the University of Houston, success in STEM fields is open to anyone and everyone—you just need the right mindset.

This is the basic premise underpinning the Houston-area program CHAMP, which the AMS Committee on the Profession chose as the 2018 winner of the AMS Mathematics Programs That Make a Difference Award. CHAMP, which stands for Cougars and Houston Area Math Program—“Cougars” being the University of Houston mascot—provides middle and high school students from Houston's Third Ward, Sunnyside, and East End neighborhoods with mentoring and math tutoring by volunteer undergraduates from the University of Houston (UH).

While the goals of the Program are to encourage students to graduate high school, attend college, and major in STEM fields (Science, Technology, Engineering, and Mathematics), CHAMP's approach is innovative in that it doesn't focus primarily on teaching the nuts-and-bolts of mathematics. Instead, its methods are centered around the psychology of success, emphasizing real-life applications of knowledge and building students' confidence in their ability to solve problems. At the same time, CHAMP has a significant effect on its undergraduate student volunteers, inspiring them to pursue mathematics at the graduate level and/or mathematics teaching.

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Mark Tomforde, CHAMP program director and founder (far left), with the CHAMP facilitators for this upcoming semester of programs.

Catherine Godfrey, who graduated from UH in 2017, originally planned to major in chemistry and pharmacology. A recruiting email from CHAMP aroused her interest, and she met with Tomforde to discuss a possible role for her as a volunteer. That meeting led to a change in major and a new career path.

For the first time, she realized that there were opportunities to be had in mathematics. “I was always good at math, always liked math, but I never really knew that a career in mathematics was an option,” she says. Once she got involved with CHAMP, however, she was infected

by the excitement of working with the math students and professors and got a sense of where her interest in math could be put to excellent use. After changing majors and completing her bachelor's degree, Godfrey is now a mathematics graduate student at the University of Nebraska (whose Mathematics Department won the 2009 AMS Award for an Exemplary Program or Achievement in a Mathematics Department).

More generally, of the 40 volunteers participating in CHAMP since its inception in 2013, 15 (9 men, 6 women) enrolled in mathematics graduate programs, and 9 more became math teachers. Of those who became math teachers, 8 are women, and 6 are members of ethnic minorities, increasing the number of greatly needed role models for younger students in groups still underrepresented in mathematics.

A Focus on Grit and Growth

The “process goals” CHAMP outlines on its website are as follows:

We want the students in CHAMP to develop qualities that will make them more successful in academic pursuits. This includes (1) acquiring Grit, (2) cultivating a Growth Mindset, (3) developing Positive Attitudes Towards Mathematics, and (4) practicing Habits of Mind that aid in critical thinking.

Grit

The concept of grit, simply defined, is the capacity to maintain motivation and determination in the face of setbacks and obstacles. University of Pennsylvania researcher Angela Lee Duckworth and colleagues described it in 2007 as “perseverance and passion for long-term goals” and established a “grit scale” for assessing individuals' level of grit. Tomforde has used Duckworth's grit scale to evaluate the effects of the program on participants.



Tomforde and CHAMP volunteers working with high school students.

Growth Mindset

The CHAMP program takes the position espoused by Stanford professor of psychology Carol Dweck in her 2007 book, *Mindset: The New Psychology of Success*, that an individual's intelligence can be developed and expanded with effort. A “growth mindset” is one that accepts the concept that intelligence is not fixed, and is a factor contributing to students' success. Growth mindset, like grit, is a facet Tomforde has measured in participants as a way of gauging the program's impact.

Positive Attitudes Towards Mathematics

“Math is hard” is a popular meme on social media—but it's not a helpful point of focus for students struggling with math in the academic setting. So CHAMP seeks to replace that thinking with more positive foci: that math is beautiful, powerful, important in everyday life, and open to all. Hard work and making mistakes are highlighted as important tools for learning math—and greater career opportunity is one prize that comes from use of those tools.

Habits of Mind

The end goal is not to have students just be better at math—it's to have students who develop thought processes that make them successful at solving any problem, in the classroom or in real-world situations. “We want students to see math as problem-solving,” Tomforde notes in a video summary of CHAMP's impacts. “So we want to get them to think critically, we want them to come up with their own methods of solving problems, we want them to find different ways of solving problems, and we want them to be able to communicate their solutions effectively.”

This boils down to a key idea: *Give the students tools they can use in problem solving, and they can apply that knowledge not only to their education, but also to their daily lives*—allowing them to achieve success in whatever path they choose.

That's not to say Tomforde, the program's director and founder, wouldn't prefer to see his students enter STEM fields. The majority of students in the schools participating in CHAMP are African American or Hispanic—and both ethnicities are greatly underrepresented in the sciences and mathematics. Moreover, the area CHAMP serves is by no means an affluent community, and many students in the area's schools aren't likely to consider college as a viable option simply because their families lack financial resources.

Tomforde finds this troubling, pointing out the potential loss, not just to the individuals, but to the world: “What if the next Einstein or the next Steve Jobs or the person capable of curing cancer is born in poverty and attends an under-resourced school in inner city America? Their potential contributions will most likely be lost. It's a frightening thought, and yet surely this must be happening all the time. The fact it happens in our own communities, within miles of where we live in work, should be additionally troublesome¹.”

The Community CHAMP Serves

Houston's Third Ward community has undergone a lot of changes in recent decades. Although it was a thriving, self-sufficient center of African American community, business, and culture in the 1960s and 1970s, it declined during the 1980s as Black families, pushed out by "block-busting" and other forms of residential discrimination, moved into integrated suburbs of Greater Houston.² The deterioration of the oil economy also hit the ward hard; by the early 1990s, it was one of the most dangerous neighborhoods in the city, with rampant crime, unemployment, and poverty. As recently as 2013, two sections of the Third Ward were ranked #6 and #15, respectively, on a list of the twenty-five most dangerous neighborhoods in America,³ although it should be noted that as of 2016, both were off the list. Even so, the risk of violent crimes such as murder, assault, and robbery are considerably above the national average in the Third Ward.⁴

But the basic facts and figures about demographics in the Third Ward create a stereotypical—and woefully incomplete—picture of a high-crime, low-income city neighborhood that barely scratches the surface of the Third Ward's rich history. The roots of this community are deeply intertwined with Houston's institutions of higher learning (see sidebar 1), civil rights activism, the contributions of cultural centers like the Houston Museum of African American Culture—not to mention being the hometown of music icons ranging from blues legends like "Lightning" Hopkins and Albert Collins to R&B and pop superstar Beyoncé Knowles.⁵

The public schools in the Third Ward serve a largely Black and Hispanic student population. Although the Third Ward was originally a blue-collar neighborhood, recent demographics show that almost 65 percent of families living there now are white-collar professionals, and more than half of the residents have an undergraduate college degree or higher. In part, this transition is a result of gentrification that began in the 1990s. Gentrification

is itself a problematic process for the school system, as it brings greater wealth into the district at the expense of some of its poorer residents' ability to retain their homes. Average household income has increased 64 percent since 2000, but this doesn't necessarily reflect greater opportunity in the Third Ward community itself so much as a new "commuter" population that lives in the Third Ward but works elsewhere—one that may have limited interest in the local schools' performance, as only about 20 percent of Third Ward households include children.⁶ Another unfortunate outgrowth of this trend is pressure pushing long-term residents with lower incomes out of the community that they have lived in for many years.

1. Higher Education and Civil Rights Activism in Houston's Third Ward

In the decades after the Civil War, the Third Ward drew African American families searching for blue-collar jobs and a better life. Along with the characteristic shotgun houses that dominate the ward, they built churches and schools. By the early 1920s, a number of primary and secondary schools focused on educating Black children had been firmly established, as well as several colleges. One, the Colored Junior College founded in 1927, was to become Texas Southern University (TSU). As the result of a 1947 Supreme Court decision *Sweatt v. Painter* challenging the University of Texas School of Law's decision to deny entry to a Black applicant, the state of Texas created a law school for Black students on the TSU campus. The law school eventually took the name of the celebrated Supreme Court Justice Thurgood Marshall, who was the NAACP's attorney in the *Sweatt v. Painter* case.

At the same time, another university was in its infancy in Houston's Third Ward: The University of Houston began its life as a junior college in 1927, transformed over the next half-decade into a 4-year college, and ultimately moved to a larger campus to serve more students. The two segregated universities coexisted mere blocks from one another in the Third Ward.

It would be another 7 years before *Brown v. Board of Education* overturned the "separate but equal" doctrine in 1954, and another 15 years before the legalized discrimination in public education was entirely dismantled. TSU's students and faculty would take a prominent role in civil rights actions against the Jim Crow laws in Texas in the 1960s. In the meantime, TSU grew quickly from a small college with a few hundred students to a large university with a few thousand students. As of 2018, the student body at TSU is nearly 10,000 students enrolled in over 80 undergraduate, graduate, and professional degree programs. Meanwhile, the battle to fully desegregate UH during the Civil Rights era gradually transformed it into the ethnically diverse institution of higher learning it is today; in 2016–2017, the school tied for second place in the *US News & World Report* Campus Ethnic Diversity ranking with Stanford University with a diversity index of 74%.

¹"UH Program Helps High School Students Achieve College Dream," *University of Houston*, www.youtube.com/watch?v=qd-CCQcCNMsk.

²K. Duggins, "Third-Ward Rebound," *Houston Press* November 16, 2000.

³W. Radley, "Crime hotspots hit home: Two of the most dangerous neighborhoods in the country are in Houston." *Culture-Map Houston*, May 1, 2013. houston.culturemap.com/news/city-life/05-01-13-crime-hotspots-hit-home-two-of-the-most-dangerous-neighborhoods-in-the-country-are-in-houston/#slide=0.

⁴www.point2homes.com/US/Neighborhood/TX/Houston/Greater-Third-Ward-Demographics.html.

⁵C. Feidman, "Third Ward: The epicenter of Houston's fight for racial equality," *Houston Chronicle* August 22, 2014. www.houstonchronicle.com/life/article/Third-Ward-The-epicenter-of-Houston-s-fight-for-5706658.php.

⁶www.point2homes.com/US/Neighborhood/TX/Houston/Greater-Third-Ward-Demographics.html.

The Stumbling Blocks Impeding Success

In considering the educational opportunities for low-income students in the Third Ward, two facts stand out: First, the historical community environment of the Third Ward is one that values—and is willing to fight for—quality post-secondary education; and second, the resources to provide higher education are abundant and locally available for students who want to obtain a college degree. So, if educational resources are present and available, why are many students not using them?

There is no small irony in the fact that one of the key obstacles keeping many Third Ward students from having the opportunity to further their education is something that originated in an effort to ensure students' success—Texas' annual achievement tests, which go by the acronym STAAR (State of Texas Assessments of Academic Readiness). “The biggest obstacle to graduation is scores on the standardized tests in Texas, and it's often the math scores that are the lowest,” Tomforde notes.

The STAAR testing system assesses students' readiness to progress to the next grade level, but it has not been without controversy since its initiation in the 2011–2012 school year. One point of contention was the significant increase in high-pressure tests that students must endure, estimated at four times⁷ the amount of assessment in place prior to the passage of the amendment that established the STAAR testing protocol. Another: the grading system used to determine students' outcomes, where the test results count as 15 percent of a student's final grade, regardless of classroom performance.⁸ The result: even students who were regularly performing well in the classroom were penalized for poor test performance, to the point at which, as early as 2014, many Texas parents were seeking to opt their children out of the testing process.⁹

One possible reason for the difficulty was that the tests were designed in such a way as to require students to exercise specific skills that are not necessarily incorporated into classroom instruction. A 2015 evaluation of the test content in the *Journal of the Effective Schools Project* noted that skills such as visualization, prediction, and inferential reasoning were embedded within the STAAR mathematics tests from fifth grade on, and that the math, science, and social studies tests all have high-level literacy skills embedded within them—meaning, a student who has less advanced reading comprehension or reasoning skills may

⁷www.tamsatx.org/uploads/3/1/6/2/3162377/2012-12-05-brief-history-of-staar.pdf.

⁸www.chron.com/news/houston-texas/article/STAAR-s-grading-system-criticized-3646465.php.

⁹www.dallasnews.com/news/news/2016/05/26/hate-the-staar-test-opting-out-is-possible-but-not-easy.

¹⁰Fowler TW, Bradley KS, Bradley J, Cude K. *Comparison of Process Student Expectations Across Content Area STAAR Examinations. JESP 2015;22:13-16.* www.thejesp.org/index.php/jesp/article/view/9/12.

¹¹www.washingtonpost.com/news/answer-sheet/wp/2014/04/22/11-problems-created-by-the-standardized-testing-obsession/?utm_term=.d7995bfbfc735.

score poorly on the test (and thus get a lower or failing grade in the subject overall) despite having the subject matter knowledge the tests seek to assess.¹⁰ Such disconnects between students' performance in the classroom and the assessment's findings—which also impacts how a school's overall performance is rated—is discouraging to all concerned, and potentially harmful to students' ability to make progress.

This isn't, of course, a problem unique to Texas: As one Virginia high school teacher argued in a social media post that was later published by the *Washington Post*,¹¹ “It is also true that many students do poorly on standardized tests even though they may have achieved mastery over the material. The stress of “test anxiety” can be debilitating for many students.”

Thus, the problem as encountered by Tomforde in 2012 when he took the first steps toward creating CHAMP, was that many students in Houston's Third Ward faced a complicated social and educational environment that had students struggling—including the (then) brand new STAAR testing protocol.

CHAMP's Genesis

The pivotal moment that led to Tomforde's founding CHAMP came in 2012—the year he was granted tenure by the University of Houston. He'd been aware throughout his education of the underrepresentation of women and minorities in STEM fields, and while it had been on his mind to actively try to address the problem—particularly with respect to reaching out to underserved communities like the Third Ward—time constraints imposed by the rigors of graduate school and, later, the continual need to publish and build a body of research put the idea on hold.

With tenure came a certain freedom to branch out, and Tomforde wasted little time. After doing background research to develop a strategy, he concluded that there was more value in simply “getting out there and doing it” than in seeking grants or institutional support. As he notes in the program's mission statement,

Mathematics can be taught without expensive equipment, computers, labs, or materials. It is easy to give quality math education with very little funding, and what we do in CHAMP can also be replicated by teachers or administrators in the partnering high schools without requiring them to spend money or purchase additional resources.

And that was an important consideration for Tomforde at the outset, because when he did look for financial inputs, he found that “there wasn't a lot of support available for such a program, and what funding was there didn't seem to fit the project.”

“I was more interested in action rather than doing grant admin,” Tomforde adds. “My choice was to try to do it as cheaply as possible and rely on volunteers.”

There's a secondary rationale to Tomforde's decision, as well. He cites research that shows unpaid volunteers are more effective at accomplishing goals than paid staff,

in part because they invest more of their emotional commitment to the program when given autonomy to help decide how the program is run. Research also shows, he adds, that service learning activities tend to offer the greatest benefit to women and minority volunteers—and in CHAMP’s case, the pool of volunteers consists mainly of University of Houston (UH) undergraduate students, many of whom are women and minority students. So, a volunteer-run program to help Third Ward and Sunnyside high school students develop better math skills, he reasoned, could serve double duty by encouraging UH undergrads to explore a career in STEM after graduation.

Tomforde sought out interested students and had them help with putting the program together and raising a group of committed volunteers—students who *wanted* to make a difference in the Third Ward community where the university campus is located.

Then he started approaching area schools to drum up interest—and ran into his first roadblock. “I couldn’t even get a meeting or a phone conversation with anybody,” Tomforde says ruefully. “No one would listen to me; [CHAMP] was something they didn’t want.” Finally, some of the student volunteers connected with a small charter school located near the university—called, appropriately, Hope Academy—to pilot the program.

Early Success at Hope Academy

Hope Academy was a small “second chance” charter high school serving students who were considered at risk. The initial cohort of high school students from Hope Academy numbered just fifteen, but the small numbers were intentional; keeping the program small not only allowed volunteers to spend more time one-on-one with the students, it also permitted coordination between the school and CHAMP in transporting students from their school to the university campus. And the curriculum was designed to focus on problem-solving skills, using puzzles and game-like lessons that focused on the mathematics of probability, logic, mathematical reasoning—even a unit on symmetry in poetry, and a trip to a robotics lab. All teaching materials, Tomforde notes, were collected or developed by the CHAMP staff and run in the style of math circles to introduce topics that students don’t typically get in the classroom using real-world examples: everything from the number of chicken nuggets in a box from McDonald’s to the probability of false positives versus false negatives in disease, exponential growth, credit card debt, interest accumulation, and similar examples.

This focus, as Tomforde details on the program’s website, takes advantage of a particularly valuable aspect of mathematics: It “can also be used to teach critical reasoning, problem solving, logic, and general quantitative literacy... [it] helps students to understand how to think and how to learn, and its skills are useful and transferable to many other situations.”

The partnership with Hope Academy proved successful for the first two years; students were engaged, and the lessons worked well. Resource constraints, says Tomforde, prevented them from collecting data about the students;

“We were working heuristically, so this is not data based,” he says, “but what we have seen is that [among] the students that we worked with, more of them are going to college than prior to being involved in CHAMP.” What the program did measure, however, was the students’ progress in three of the four process goals (grit, growth mindset, and attitudes toward math; see sidebar 2). The surveys showed encouraging results; students made significant progress in all areas after participating in CHAMP.

2. CHAMP uses three surveys that measure Grit, Growth, and Math Attitude. These surveys are given to each participant when they start CHAMP and then again on the last day they participate in the program. The following is a record of how the scores have changed.

Grit Score (1 = Not at all gritty, 5 = extremely gritty)

Average Before: 2.7

Average After: 3.8

Growth Score (1 = fixed mindset, 5 = growth mindset)

Average Before: 2.4

Average After: 4.1

Math Attitudes Score (answers aligning with positive attitudes)

Average Before: 62%

Average After: 84%

The surveys and their scoring metrics can be found at www.math.uh.edu/champ/surveys.html.

Source: Mark Tomforde, University of Houston/CHAMP

Expanding CHAMP’s Reach

Within two short years, CHAMP faced a setback of its own when Hope Academy lost its accreditation in 2015 due to administrative issues; Tomforde had to seek elsewhere for partners in the Third Ward. “Through luck,” Tomforde says, “I connected with [Rice University professor] Steve Cox, who had in the past run the Worthing Rice Apprentice Program (WRAP) at Rice University. He put me in touch with KIPP Sunnyside High School.” It was also Cox who advised Tomforde to expand the program based on the reality that “high school is too late to reach many students, especially girls,” so Tomforde went to work on reaching out to middle school students. In addition to KIPP Sunnyside High, CHAMP now serves two middle schools: KIPP Liberation College Prep Middle School and Ryan Middle School, the former a public college-prep charter school and the latter a Third Ward public school that operates in affiliation with Baylor College of Medicine.

The number of students served per school remains limited—the tutoring program, which helps students with homework and reinforces classroom skills, typically serves

twenty kids from the participating high school and ten to fifteen from each middle school, Tomforde states. At every level, students are offered tutoring focused on the math section of Texas' annual STAAR exams—targeting the key obstacle to students' ability to continue on to college. For the high school students, the tutoring also assists students preparing for SAT and ACT exams, using test prep samples to help students become familiar with the types of questions included.

Middle schoolers are the focus of two special secondary programs as well. CHAMP runs a middle school math day that can vary from ten to fifty participants. The focus of the math day is to engage the participants in activities that both put mathematics into a physical context—for example, using their math skills for estimating distances on the UH campus (which, not coincidentally, allows students to gain familiarity with a college environment while ensuring they get exercise)—as well as games, such as a math scavenger hunt. CHAMP also runs a summertime “algebra boot camp” open to fifteen to twenty students transitioning into eighth grade to prepare them for algebra in the fall. The goal, says Tomforde, is to “get them mentally primed for going into algebra, get them excited about it, and teach them a few things to hit the ground running.”



A group of CHAMP volunteers with local students during a “Middle School Math Day” of activities.

A Multiplier Effect

Tomforde explains that CHAMP is both self-sustaining and self-expanding. “Since we run CHAMP on a small budget and use mostly volunteer effort, the model can be replicated by almost any math department in the US.” At the same time, he notes that “It’s harder to do things without money.” (The Program has received some funding from the MAA’s Tensor-SUMMA grant program to pay for things like food and T-shirts, but for the most part it depends on donations.)

In order to help like-minded educators to more easily replicate his efforts, Tomforde has made many details of the Program, including his worksheets, available for all by posting

them on the CHAMP website, <https://www.math.uh.edu/champ/index.html>.

For a large number of students, ranging from middle school through college, CHAMP has paved the way to success in further education, and in some cases careers, in mathematics and other STEM fields. The fact that so many of these students come from groups underrepresented in mathematics, makes CHAMP’s results even more important. In creating CHAMP and building it into such a successful program, Mark Tomforde has demonstrated both the basic determination and the creativity in problem solving that he continues to instill in the CHAMP students.

Photo Credit

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See the official AMS 2018 Mathematics Programs That Make a Difference Award citation on page 552.