The S-STEM program in mathematics and its impact on student success

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THE S-STEM PROGRAM IN MATHEMATICS AND ITS IMPACT ON STUDENT SUCCESS

1. INTRODUCTION

The UTA (University of Texas at Arlington) is one of the eight campuses in the University of Texas system, and it is located in the Dallas-Fort Worth metropolitan area between the cities of Dallas and Fort Worth. It offers doctoral, master's, and bachelor's degrees, and it is the second largest campus in the system after the flagship campus at Austin. According to the fall of 2019 figures, it has a student population of 42,863, consisting of 30,652 undergraduate students and 12,211 graduate students. The women make up 60% and the men 40% of the undergraduate student population, 51% of whom are URM (**U**nder **R**epresented **M**inority) and 5% are international students. Among the graduate students, 64% are women and 36% are men, 33% are URMs and 25% are international students. Despite the high percentage of women among graduate students, their percentage in many engineering programs at UTA is very low.

The UTA Mathematics Department offers doctoral, master's, and bachelor's degrees, and it has 25 faculty members, 83 Ph.D. students, 30 master's students, and 262 undergraduate mathematics majors. Among the Ph.D. students, 35% are women and 55% men, 66% are domestic students and 34% are international students, and the URMs make up 42% of the domestic Ph.D. students. Among the master's students, 63% are women and 37% are men, 97% are domestic students and 3% are international students, and the URMs make up 21% of the domestic master's students. Among the undergraduate mathematics majors, 49% are women and 51% are men, 89% are domestic students and 11% are international students, and the URMs make up 33% of the domestic students. The average retention rate for freshmen who declare mathematics as the intended major is about 73%.

The Mathematics Department at UTA has changed in many ways since the fall of 2005. As a consequence of these positive changes the UTA Mathematics Department was recognized nationally in 2013 by the AMS (**A**merican **M**athematical **S**ociety) as the winner of the AMS Award for an Exemplary Program or Achievement by a Mathematics Department. Some of those efforts were described in the four-page article [1] authored by Allyn Jackson of the AMS.

In this paper we describe some of these changes, the implementation of which was especially helped by three externally supported programs providing student scholarships and mentoring. One of these programs has been the S-STEM program supported by the NSF DUE (Division of Undergraduate Education at the National Science Foundation). Our S-STEM program [2] has been running since 2008, and it has helped us to make systematic improvements at the undergraduate level. The second program is the Bridge-to-Doctorate Program [3] supported by the NSF-DMS Infrastructure Program (Division of Mathematical Sciences at the NSF). This is similar to a Post-baccalaureate program, but it is tailored to suit the individuals and aims at moving the participants to doctoral programs. We have been running this relatively new program since 2017 and it is helping us to make improvements at the transitional level from undergraduate to doctoral studies. Our third program is the GAANN (**G**raduate **A**ssistance in **A**reas of **N**ational **N**eed) Program [4] funded by the US ED (United States Education Department). We have been running our GAANN program since 2006, and it has helped us to make systematic improvements in our mathematics doctoral program. These three programs have had great impacts not only at their stated levels, but their combined effects have helped us to make substantial changes at every level in our department. In our paper we outline the changes taken place, the best practices we have developed, and the challenges remaining to be tackled. This paper can also be viewed as an update and supplement for the efforts described in a previous ASEE proceedings article [5] appeared two years ago.

2. THE MATHEMATICS S-STEM PROGRAM

Let us first describe our S-STEM program. A typical S-STEM program is funded by the NSF DUE, as it is also the case for our own. Its main goal is to increase the quality and quantity of undergraduate domestic students enrolled in STEM fields. The eligibility is restricted to U.S. citizens and permanent residents. It has two main components. As the first component it provides a scholarship limited by the maximum of $10,000 per academic year and the financial need level is determined by the FAFSA (Free Application for Federal Student Aid). Until recently an S-STEM scholarship recipient needed to be enrolled full time, but the NSF has recently changed the rule and part-time students can now also be supported. The second component is the mentorship for student success. We interpret the mentorship for success in a broader sense and

help our students not only succeed during their participation in the program but even after the program. This is analogous to successful parenting. Our mentoring concept is not merely focused on the period of participation, and our understanding of success is not limited to seeing that a participant receives a bachelor's degree. We are interested in seeing that our students are trained to succeed as they are prepared for a career in a STEM field, whether this occurs right after the bachelor's degree or continuing to a graduate program with the eventual goal of a career in a STEM field.

Our own S-STEM program [2] involves only the mathematics majors, and hence it is easier and more efficient for us to run our program. This is in contrast with many other S-STEM programs run at various institutions where students majoring in various STEM disciplines are supported. For such programs it is more challenging to track the progress of the students because faculty, students, advisors, mentors, and administrators involved come not just from one department but from several, and that requires a systematic coordination and bringing together the people who do not necessarily interact with each other on a daily basis or who do not necessarily have offices on the same floor of a building or even in the same building.

We have named our S-STEM program SURGE (A comprehensive **S**ystem for **U**ndergraduates to **R**each **G**oals in **E**ducation). We have been running our SURGE program since 2008, and over the years we have made many improvements to run it effectively, efficiently, and optimally. We have improved the admission process in the program, the monitoring the performance of the scholarship recipients, the effectiveness of the mentoring provided, and the student success. Over the years we have built strong relationships with the UTA Financial Aid Office, the UTA Grant and Accounting Offices, the Undergraduate Mathematics Advisor, and the staff and faculty involved in our program.

The following practice works well for the recruitment and admission into the program. We are able to reach all our mathematics majors easily and effectively in many different ways. In the beginning of each semester our SURGE faculty visit the upper-level undergraduate mathematics courses and briefly speak to the students and encourage them to apply. Since some of our SURGE faculty already teach some of these classes, those colleagues play an active role in informing the mathematics majors about our SURGE program.

There are several student chapters of mathematics organizations in our department, and in fact they are now all run by the students themselves. These organizations include the MAA (Mathematical Association of America), the AMS, the SIAM (Society for Industrial and Applied Mathematics), the AWM (Association for Women in Mathematics), the SACNAS (Society for Advancement of Chicanos and Native Americans in Science), the MAAA (Mathematical Association of Africans and African Americans), the Actuarial Club, and the Pi Mu Epsilon Club. The SACNAS Chapter at UTA was initiated within the Mathematics Department by the mathematics students but was later expanded to include all STEM students. The MAAA organization is unique and was initiated by our own students to increase the number of African and African American mathematics students. These organizations in our department are also excellent vehicles to attract students into our SURGE program.

The MAA Chapter is the largest of our student organization in our department. The MAA members meet twice a month during the academic semesters, and during these meetings they provide free lunch, have invited guest speakers, and inform the audience about many opportunities available. Anyone is invited to attend these meetings, there is no admission charge, and no membership is needed to attend these meetings. The MAA Chapter runs its own outreach activities, run programs for area middle and high school students, gets involved in fundraising activities, provide review sessions for departmental midterm exams for lower-level mathematics courses, provide resources for undergraduate students to attend regional meetings and conferences. A typical meeting of the MAA Chapter is attended by about 45 students. This allows us not only to reach out to most of our prospective SURGE scholars but also to recruit new mathematics majors to our department.

A brief e-mail is initiated by the SURGE Program Director to all mathematics majors in the beginning of each semester inviting the current and prospective SURGE scholars to apply for the SURGE program for that semester. The application process is rather simple and not burdensome to the students. The students are requested to respond briefly to a set of questions. The information requested includes the student's UTA ID number, expected graduation date, academic performance in the previous semester, the list of the current semester courses, the future plan, and any additional relevant information the student would like to provide. The SURGE faculty have access to student records and it is usually the case that at least some of the SURGE faculty have had the applicants in the classes they have taught. The e-mail responses by

the students are gathered by the SURGE Director and passes to the program faculty and the Undergraduate Mathematics Advisor. The SURGE faculty and the Undergraduate Advisor provide comments, and the SURGE Director, based on the comments, invites the applicants to a brief interview in person. We feel that this interview is a crucial step. It helps to determine whether an applicant will benefit from the mentoring to be provided. Based on the interviews we select the SURGE scholars for the semester. The students who cannot be supported for that semester are encouraged to apply next semester and are kept in mind also for the future. Every student, even the SURGE scholars from the previous semester, goes through the e-mail application process and the interview process. These two steps enable us to assure that the students admitted into the SURGE program will be successful. It is very rare that any of the students admitted into the SURGE program fail, and it is almost always the case that the admitted students graduate with their bachelor's degrees and are mentored continuously until they graduate. The application and readmission of the previous SURGE scholars in the beginning of each semester, with minimal burden to the students, also allow us to monitor their progress. Let us remark that we are easily able to track the progress of our SURGE scholars because those scholars usually take classes from our SURGE faculty and also we are in close contact with all the mathematics faculty teaching those scholars. This allows us to have relevant information immediately on each SURGE scholar's academic performance. Furthermore, regular meetings of our SURGE faculty with the SURGE scholars allow us to monitor the progress of our mentees.

We have had NSF funding for our SURGE program since 2008 and currently we are in the middle of our third funding cycle. The crucial information for our SURGE program is provided in Table 1 below, where the figures reflect the status quo [2] as of February 2020. We supported 123 students; 2 of whom quit without getting a bachelor's degree, 101 have obtained their bachelor's degrees, and 20 making timely progress toward their bachelor's degrees. About 32% of the supported students have been URMs.

123 scholars supported	101 degree recipients	20 continuing
45% women	43% women	55% women
55% men	57% men	45% men
32% URMs	30% URMs	45% URMs

Table 1. The supported student data in the UTA Math S-STEM program during 2008-2020

There are 5 mathematics faculty members directly involved in our SURGE program. Each SURGE scholar is assigned to one of these faculty for additional individual mentoring. Such individual interactions between the faculty and the mentee also help the SURGE scholars to interact with the faculty member's graduate students doing thesis research under supervision. This provides an opportunity for SURGE scholars to learn from graduate students about graduate studies and graduate research.

The entire SURGE group also meets regularly several times during each semester. These meetings usually take place on Mondays during 12:00-12:50 pm with lunch provided. During these meetings the students are treated as a cohort, they interact with each other and with faculty, and discuss any problems or obstacles. These meetings also involve some guest speakers, and in fact some of the speakers are former SURGE scholars who are now professionals working in industry or academia after receiving their undergraduate and perhaps also doctoral degrees. Such former SURGE scholars also act as good role models for our current SURGE scholars.

We never pressure our SURGE scholars to be involved in supervised undergraduate research or to move on to graduate school. On the other hand, our scholars learn about undergraduate research, career opportunities, and graduate studies. About half of our SURGE scholars move on to graduate studies, usually more than half become involved in supervised undergraduate research, and almost all of them participate in organizing outreach activities, and almost all of them become involved in leadership activities in various mathematical organizations in our department.

Before our SURGE program there were hardly any financial and mentoring resources for our undergraduate mathematics majors. The SURGE funding from the NSF has had a drastic impact on our mentoring and financial support of our undergraduate mathematics students.

We fully realize that our resources are limited and must be used carefully. We provide financial support to a student only after we have confidence that the student is serious, motivated, and resilient, will not easily quit, and will respond positively to mentoring. We help such students and we help them to be successful. At times we delay the admission into our SURGE program until we gain confidence that the student has these characteristics. This helps us to use our resources optimally and prevents waste. This is a good practice we recommend at every level. It is unacceptable to us to support everyone without screening and then regretfully seeing that a

substantial percentage of them quit their studies or move into other areas. We use our SURGE funding to support and mentor those who will not waste resources. We use this practice also in our mathematics graduate programs.

During the selection process for our SURGE scholars, two crucial steps help us to determine the seriousness of the applicants. The first is the interview our SURGE Director has with the applicants, and such a brief interview reveals a lot about the applicant. The second is the opinion of the Undergraduate Mathematics Advisor in our department. The Undergraduate Advisor knows all the mathematics majors well, meets with them individually, has all the information to make a good assessment whether the student will survive in the academic program, successfully graduate, or quit before receiving a degree. The Undergraduate Advisor also knows of any special circumstances or obstacles each student has and can make a good prediction about the resilience and attitude of each student. If needed, we may delay the admission of a student into our SURGE program and we may admit the student after seeing the academic progress during certain key classes in the semester. Observing the progress of a student, especially in the two courses Introduction to Proofs and Analysis I, is a good predictor whether the student will receive a bachelor's degree.

Once the student is admitted into our SURGE program, since we have confidence about the seriousness of the student, we cooperate with the student and our mentoring of the student succeeds. An unmotivated student normally does not respond well to mentoring, and there is no point for us to admit an unmotivated student into our SURGE program. That is why it is important for us to determine the seriousness and motivation of the student before the admission into our SURGE program. If the majority of scholars in such a program were not serious or not motivated and could quit, this would affect the morale of all the students in the program negatively. We are well aware of the fact that an NSF-supported S-STEM program treats the students as a cohort and hence the success of the program heavily depends on the seriousness and motivation of the participants.

One problem with the S-STEM funding is that the $10,000 limit per year somehow negatively affects the success of some of our students. There are still many students who work too many hours holding jobs not related to academic studies, and this is done just to finance their education and to cover their living expenses. Quite a few of our students still feel that they have to have a

full-time job in addition to being a full-time student. The hours spent on the job drastically reduces the quality time devoted to academic studies. Although capable of succeeding academically, not devoting enough quality time prevents the students to use their full potential for academic success and negatively affects their academic performance. The NSF recently has changed the previous restriction that students supported by S-STEM funding had to be full-time students. However, this does not bring a complete solution to the real problem. Especially, if the student is the primary provider in the family (e.g. a single mother with two young children with no additional income or resources), the $10K per two academic semesters does not provide the quality release time for academic studies. In fact, any release time is usually used to increase the work hours or to hold a second job. This is a serious problem that needs to be addressed at the national level. The individual S-STEM programs cannot solve this serious national problem within their program. The issue is more severe at UTA because about half of our students are first generation college students and many of them come from low-income families.

3. THE DIVERSITY

Over the past 15 years we have diversified our student population both at the undergraduate and graduate levels. There is now hardly any racial, ethnic, or gender discriminations in our department, and there is a nice harmony and no one feels isolated or discriminated. The students also feel comfortable interacting with faculty, staff, and other students in our department. Since 2005 we have been able to create such a comfortable and good atmosphere in our department, and this has been accomplished without causing any clashes among different groups. Many years ago the percentage of women in our undergraduate and graduate mathematics programs were very small, and we certainly continually work to have more women in our programs, but compared to the past we now have an improved gender balance and women do not feel isolated in our mathematics programs. The gender imbalance is still a major problem in engineering programs at UTA, but in mathematics, thanks to our own departmental efforts in the past 15 years, this is no longer a serious issue in our mathematics programs.

In some graduate mathematics programs in the U.S., international students make up the majority and at times the overwhelming majority of the student population. Without discriminating against our own international students in the past 15 years we have been able to create a

harmonious atmosphere where international and domestic students study together and cooperate without competing for resources. Until 15 years ago we had about 25 doctoral students all supported by graduate teaching assistantships and about 70% of these students were international students coming from a few countries. We have been able to secure some large external federal funds, and these funds were restricted to U.S. citizens or permanent residents. Such federal restrictions resulted in a dramatic increase in the domestic doctoral student population in our department. The mathematics doctoral student population has gone up from 25 to 75 and the percentage of domestic students moved from 30% to 67%, and even though the percentage of our international mathematics doctoral students decreased drastically, their number has actually increased. The increase was also partially due to the fact that we started having a large number of international students funded by their own governments. The good atmosphere created in our department, the increased quality in our mathematics doctoral program, and the good treatment received by our international doctoral students have helped to continue attracting more international students.

We have learned that a good departmental atmosphere created is beneficial to everyone, where each person feels safe, does not feel discriminated against, feels cared about by others, and feels comfortable to rely on others in case of any problems. It is crucial to create such an atmosphere, where each person gets respect, trusts others, feels a part of the community, and does not have to fight to compete for resources.

4. THE MATHEMATICS BRIDGE PROGRAM

There are many mathematics undergraduate programs in the U.S. where the undergraduate degree recipients are not ready to start a doctoral program in mathematics. This is not necessarily the fault of those institutions. There may be several reasons for this under preparation. The first reason may occur as follows. In most U.S. universities the idea behind an undergraduate education is a liberal arts education and hence a typical undergraduate student must take not only mathematics courses but also courses in many other areas. Furthermore, a large percentage of students at a U.S. university may be transfer students from community colleges and such students may need to take many other courses to fulfill the degree requirements within a short period of two or three years. In some other countries such courses are taken by students at the

high school level and at the university level the student concentrates only on mathematics courses and hence the preparation for mathematics doctoral studies is fulfilled when the undergraduate degree is obtained. A second reason may occur as follows. There are many institutions in which the population of undergraduate mathematics majors is rather small and hence those institutions cannot afford offering advanced mathematics courses for only a few students. As a result the students at those institutions are not exposed to advanced mathematics needed as a prerequisite for a mathematics doctoral program. A third reason might occur as follows. Even if an undergraduate student is involved in undergraduate research experiences and may have developed good presentation skills the student might still lack a broad solid training in fundamentals of mathematics, especially in mathematical analysis. A fourth reason may be the lack of quality time devoted to learning basic areas of mathematics from a unified view point. The students typically learn mathematics while taking courses, and it is possible that different mathematical subject areas are taught independently of each other and the student is unable to develop broader mathematical skills needed to start a doctoral program. For example, the student may not have developed enough mathematical skills to view linear algebra, real and complex analysis, and ordinary and partial differential equations as a single discipline of analysis.

Our department has shifted its funding of graduate students from master's students to doctoral students, and in fact this has happened in many doctoral programs in the U.S. In the past a master's degree was required to start the doctoral program, but now it is possible to start a doctoral program in mathematics without having a master's degree first. In our department a new doctoral student is formally admitted either into the BS-to-Ph.D. program or the PhD program. The funding is available to a BS-to-Ph.D. student but not to a master's student. This funding issue negatively affects especially talented URMs coming from smaller institutions or other talented underserved students from smaller institutions with under preparations especially in analysis. With an additional training of one or two years, such students can be ready to start a standard doctoral program in mathematics, but many doctoral institutions may be reluctant to provide an additional two-year funding for such students. We feel that it is to everyone's interest to find a solution to this important issue. Some possible solutions could be as follows. Underprepared students can first be enrolled in a master's degree program, and within two years they can receive a master's degree while funded as graduate teaching assistants. On the other hand the academic culture in a master's program and the culture in a doctoral program may be

different, and this may not be an ideal solution. Another solution could be to enroll an unprepared student in a doctoral program and provide academic help and mentoring to strengthen the student's mathematical preparation. The latter is the idea behind our Bridge program, i.e. to create a bridge to doctoral studies by strengthening the training in advanced linear algebra and in analysis. It is extremely important that the students admitted into our Bridge program will be treated as equals to other doctoral students and that no one will ever feel that the Bridge students are different than any other doctoral students. We secured some funding from the NSF DMS (Division of Mathematical Sciences) to run our Bridge program. Each year of the program we had 10-12 Bridge fellows, most of whom came from HBCU (Historically Black Colleges and Universities) and a few from other HSIs (Hispanic Serving Institutions). The demand for our Bridge program is growing and it is clear that there is a national need to run such programs. The NSF normally expects that such programs are continued to be sustained by non-NSF funds. On the other hand many institutions with doctoral programs do not provide funds to invest an additional two years on talented underserved students. On the contrary the administrators in some institutions would like to reduce even the standard funding duration, minimizing the doctoral graduation period. This could result in greatly diminishing the quality of a doctoral degree. As we have many talented but underprepared undergraduate degree recipients, we could end up with many talented but underprepared doctoral degree recipients. A doctoral degree from a good U.S. university has been viewed as an asset, but that could easily become a liability. It is against our own national interest to award doctoral degrees in mathematics by underpreparing our doctoral students. Sacrificing quality by minimizing the time to a doctoral degree in mathematics may save a few dollars initially but with a very heavy consequence of losing the credibility of a doctoral degree in mathematics from a U.S. institution.

5. THE MATHEMATICS GAANN PROGRAM

Our department has been successful in securing funding from the U.S. Education Department since 2006 to run the Mathematics GAANN fellowship program, which has been supported by four consecutive grants awarded to the UTA Mathematics Department. During 2006-2020 our GAANN program has supported 54 doctoral students in mathematics, 45 of whom have already received their doctoral degrees and 9 are within a year of finishing their doctoral degrees. One

third of the GAANN fellows we have supported have been URMs. We present the relevant data for our GAANN program in Table 2, where the figures reflect the status quo as of February 2020.

54 supported Ph.D. fellows	45 Ph.D. degree recipients	9 continuing
35.2% women	35.6% women	33.3% women
64.8% men	64.4% men	66.7% men
33.3% URM	31.1% URMs	44.4% URMs

Table 2. The supported student data in the UTA Math GAANN program during 2006-2020

The GAANN program has been a blessing for our mathematics doctoral program. It has helped us to improve both the quality and quantity of our mathematics doctoral enrollment and mathematics doctoral degree recipients. Since the fellowship recipients are restricted to U.S. citizens and permanent residents, it has helped us to drastically increase the enrollment of domestic students without lowering the number of our international doctoral students. Because the funding is external, it has helped our mathematics doctoral program grow drastically. Because a GAANN fellowship is awarded based on the financial need of the individual fellow, it has provided funding for many talented, but needy, domestic students to enroll in our mathematics doctoral program and receive their Ph.D. degrees. The mentoring provided to our GAANN fellows has helped them to become mentors for their peers and younger students. Since we have been very selective and awarded GAANN fellowships only to those who have been fully committed to receive their Ph.D. degrees, no money has been wasted and the funding has been fully used on the GAANN fellows' stipends and educational needs.

Unfortunately, the US ED has recently changed its policy and now neither mathematics nor any areas of basic sciences are considered to be an "area of national need." We fear that this could negatively affect the talented, but needy, domestic U.S. students to receive their doctoral degrees in mathematics and other basic sciences. This could also negatively affect the enrollment of domestic U.S. students in doctoral programs in the U.S. universities in mathematics and basic sciences.

The doctoral studies in mathematics and basic sciences in the U.S. have traditionally attracted many talented international students from all over the world to come to the U.S. and receive their degrees, and afterwards either returning to their own countries and educating the next generation

of students in those areas or remaining in the U.S. and greatly contributing to advances in fundamental research in their fields. In some cases there is a big difference between the undergraduate training of a domestic student in mathematics or in basic sciences and the undergraduate training of an international student in those areas. It is possible that the training of the international student is sharply focused on the specific field, enabling the student to be well prepared for doctoral studies and research. On the other hand, it is possible that a domestic student's undergraduate training is in the spirit of a liberal arts education rather than the sharp focus on the major studies or the preparation for doctoral studies. This may result in a big advantage for an international student over a domestic student in a doctoral program in mathematics or basic sciences. The disadvantage for a domestic student intending to move to doctoral studies can even be more drastic if the student receives an undergraduate degree at a smaller institution where advanced undergraduate courses cannot be offered due to low enrollment. This may result in an overwhelming majority of international students in a typical doctoral program in mathematics and basic sciences, low numbers of enrollment by domestic U.S. citizens in those programs, and extremely low numbers of enrollment by domestic U.S. students graduating from underserved institutions. This may create serious national problems, which may have long-term consequences in national security, fewer opportunities for talented but needy domestic U.S. students, social separation of the haves and have nots, the widening of the income gap between the poor and the rich, and the loss of the world leadership for the U.S. in mathematics and basic sciences.

6. THE PIPELINE AND THE SYNERGY

As we started making positive changes in our department, we realized that a systematic change could only succeed if we clearly understood the connections among different components in our mathematics programs and how those components affect each other. We realized that without strengthening our undergraduate program it is impossible to strengthen our graduate program because some of those undergraduate students could be our own graduate students in the future. We realized that without strengthening our ties with the regional community colleges it is impossible to strengthen our mathematics undergraduate program because more than half of our undergraduate mathematics majors are actually transfer students from our regional community

colleges. Being located in the large metropolitan area (the Dallas-Fort Worth metroplex has a total population of 6.7 million), we realized that we need to strengthen our ties with area middle and high schools because some of those students would be our own mathematics students in the future and in fact we have a large number of mathematics school teachers who have received their degrees from our own programs. We realized that without strong ties with the local industry, it is impossible to strengthen our mathematics programs because we have quite a few students from those local industries enrolled in our mathematics programs and also a large percentage of our mathematics degree recipients get employment in the local industry. We also realized that there are many civic organizations in the region that provide educational programs especially for the needy school children to encourage them to study mathematics and other STEM fields. We realized that without synergy we could not accomplish much with limited resources and we could be more effective by collaborating with those organizations.

We have had successful collaborations at many levels. For example, for many years we collaborated with the Fort Worth Rotary Club [6], which is the second largest in the world, to organize outreach events for all the eighth graders in the Riverside Middle School in Fort Worth, Texas. The city of Fort Worth have very wealthy residents and very rich neighborhoods, but it also has residents that are not financially well and neighborhoods that are not doing so well. About 86% of the Riverside Middle School students come from low-income families, 88% of the students are Hispanic, 5% are African American, and 5% white. With the involvement of Fort Worth Rotary Club members, our undergraduate mathematics majors, mathematics graduate students, faculty, and staff in our department, we were annually hosting about 330 eighth graders and their mathematics teachers on our campus for a day from the morning to the mid-afternoon. The morning sessions included various hands-on mathematical activities allowing interactions between middle school students and college students. Everyone was treated to lunch in the university cafeteria, where the interactions continued and the middle school students learned about college, STEM fields, graduate school, professional opportunities available to college graduates, and doctoral degrees. In the afternoon everyone attended a show in the Planetarium on campus, and a science show demonstrated by college students, and participated hands-on science experimentations. All these were achieved with no cost to students and their teachers. Our own undergraduate and graduate students were actively involved in the organization and running of such outreach activities. These provided an excellent opportunity for everyone to feel a part of

the community, gain leadership skills, improve communication skills, understand collaboration and synergy, and feel the joy of working with others to come up with creative ideas to be effective.

7. THE GULF STATES MATH ALLIANCE

The National Math Alliance for Doctoral Studies [7] was created in 2002 in Iowa through the collaboration of the University of Iowa, Iowa State University, and University of Northern Iowa with the goal of increasing the number of URMs receiving their doctoral degrees in mathematics. Dedicated faculty mentors and some URM college students met annually in a conference called the Field of Dreams Conference [8]. Our mathematics department has been a participant in those annual conferences from the beginning. The National Math Alliance grew in years and the annual Field of Dreams Conference moved from Iowa to other locations.

Most URM students are located in the southern parts of the U.S., and there was a natural need for regional collaborations to help URM students to have a smooth transition from high school to community colleges or four-year colleges and then help those students move to doctoral studies in mathematics. Because of the large Hispanic community in the Los Angeles area, a regional mathematics alliance [9] was formed and it started a successful program called the PUMP (Preparing Undergraduates through Mentoring toward PhDs) [10] preparing college URM students for doctoral studies. We ourselves got together with faculty colleagues from institutions in Texas, Louisiana, and Mississippi and planned the formation of a regional mathematics alliance. Finally, in 2012 we formally established our regional alliance and created the Gulf States Math Alliance [11]. The lack of funding prevented us from having our own regional meetings and we continued to meet during the annual Field of Dreams Conferences. In 2017 we secured our own funding and started organizing our own annual conferences.

The funding for our regional alliance was timely also in the following sense. In the past the National Math Alliance was securing federal funds to cover travel expenses of both students and faculty mentors. A few years ago this changed, and the mentors not only had to cover their own travel expenses but also pay a high registration fee to attend the annual Field of Dreams Conferences. Some mentors were able to secure funds from their own institutions to cover their travel expenses and the registration fees, but this was not sustainable. In most institutions the

faculty members could secure limited travel funds from their own institutions to attend one conference a year, and it may be the best to use such funds to attend a research conference to give a presentation, which may help the faculty member to better prepare for tenure and promotion. This prevented most of our regional faculty mentors to attend the Field of Dreams Conferences even though their in-kind contribution of mentoring students throughout the year and encouraging them to move to doctoral studies were the most important factors in the success of the National Math Alliance.

The vision of our regional alliance is as follows. First, we feel that our mentors form the most important factor in the Gulf States Math Alliance. It is not feasible to recruit students unless we recruit mentors and help mentors to recruit students. The students change from year to year and it is difficult to directly target students unless the recruitment is done by their own mentors. It is not sustainable to expect big personal sacrifices from faculty mentors so that their students succeed. How can we expect a feeble mother to take care of her children? Why does a flight attendant request that in case of an emergency the adults on the airplane must first put on their oxygen masks and then help their children to wear the oxygen masks? Unless the dedicated faculty mentors are strong, their mentoring cannot be expected to be effective.

Second, we believe that the fair credit should be given to everyone involved, not just to the last institution involved. A degree obtained by an URM student is a great achievement, but the credit usually goes to the institution that awards the final degree. When an URM student transfers from a community college to a four-year institution, it is likely that the mentors at the community college and that community college play a key role for the future success of the student but the credit usually goes to the four-year institution. This is also true for faculty mentors at undergraduate institutions who prepare their students for doctoral studies, and once the student receives a doctoral degree the credit goes to the doctoral institution. Unless we all work together at different levels and strengthen the mentors at all levels, it is not sustainable to expect that all the benefits and credits for success go to the highest institution in the pipeline.

Third, we believe that our limited resources should be used optimally. It is not feasible to recruit students into a program and expect that a success is achieved if some percentage of those students complete the program. The admission to a program could be delayed until the success in the program is very likely. It is not a good practice to admit students into a program and dismiss

some of them later. It takes a lot of time, money, and other resources to run programs and the admission. Here, the mentors can play a key role to assess whether a student is ready to successfully participate in a program or the admission should be delayed. A student's departure from a program may lead to a permanent departure from the STEM fields, which causes more damage to our human resources.

Fourth, we believe that each institution should make a genuine effort to diversify their mathematics departments. It is not feasible to have a small number of URM students in a program where those students are isolated and do not feel a part of the program. A person's true mathematical talent can be fully utilized only in an environment where that person feels comfortable, respected, and valued. The local community can function well by assuring that everyone feels a part of the community and everyone's contribution is valued.

The Gulf States Math Alliance has been organizing its own annual conferences since 2017. Every year in mid-February we gather for a conference starting Friday evening and ending Sunday morning, where the conference events on Saturday usually run the entire day. The travel and lodging expenses for teams consisting of one faculty member and two students are covered. The travel expenses are minimized because the majority of conference participants drive and at times a van is used to bring a group of faculty and students coming from the same institution. The most recent conference took place during February 14-16, 2020 on the campus of the Southern University and State College in Baton Rouge, Louisiana, and the number of registered participants was 214.

The agenda for a typical Gulf States Math Alliance conference usually includes a prominent speaker who is also a good model for the conference participants and in particular for the URM students participating in the conference. There are various sessions for faculty and students as well as sessions attended by everyone. For example, the faculty sessions include panel discussions on various topics such as enhancing mathematics programs, exchanging ideas on effective mentoring, and learning about funding and conference opportunities. The student sessions include information about graduate programs, REUs (research experiences for undergraduates) and internship opportunities, and international opportunities for undergraduate students. There is a poster session where students display their supervised research work and explain their research to faculty and other students. There is a recruitment fair where the participants network with various graduate schools, student programs, industry, and national

laboratories. Meals and refreshments are served and that helps participants to fully interact each other and no one feels isolated.

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