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√Mathroots Summer Program Evaluation Report

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EvaluatEdPro

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Summary

The goal of this study was to conduct an independent assessment of the √Mathroots program at MIT, supporting faculty and staff in the identification of the intended program outcomes, gauging students' perceptions of the learning process, teachers' and administrators' views on program curriculum and structure, and suggesting measures to increase program effectiveness. Given a small number of program participants, we took a qualitative approach to evaluation. We conducted focus group interviews with the students of √Mathroots 2016, followed by interviews with academic mentors, residential counselors and program administrators, and completed the study by conducting observations in the classroom during the program session in 2017.

In the current report we present integrative thematic analyses of the data and suggest some strategies for increasing the effectiveness of the program, based on learners', teachers' and administrators' perspectives.

Introduction and study design

√Mathroots is a 14-day mathematical talent accelerator summer program hosted by MIT PRIMES for high-potential high school students from underrepresented backgrounds or underserved communities who are interested in mathematics.

During the Fall 2016 √Mathroots hired an educational consultant to conduct an independent assessment of the program. The evaluation aimed to address two principal questions: *What are the outcomes of the program for the participants,* and *how did the learners experience the program?*

Looking into the student outcomes, we explored whether the participants felt that they became more knowledgeable, more confident and engaged with mathematical concepts learned during the √Mathroots session. We asked the students if they

continued studying math in other STEM programs after the completion of the program, whether the program had helped them participate in math competitions, whether it had motivated them to take next-level math courses or otherwise improved their math performance. We also inquired to what extent √Mathroots seemed to keep the learners in the field of mathematics or other STEM disciplines, and asked if they stayed connected to math–oriented peer groups and other scientific activities and communities.

Exploring the teaching and learning process, we looked into the student perceptions of the pedagogical process, examining the ways in which they viewed the academic content, structure, delivery, and teaching styles of the instruction during their √Mathroots residence. We also inquired about the social, emotional, and daily life experiences of the participants, including teacher and peer relationships, residential experiences, diversity, and other social aspects.

A principal member of the evaluation team conducted three semi-structured focus group interviews with 14 learners, 7 boys and 7 girls. The consents of the students and their parents were obtained prior to the focus groups participation. The interviews took place on November 11, 2016, at the MIT Math Department, during the Harvard–MIT Math Tournament, where the students came to participate following their √Mathroots program engagement. Out of 20 students who completed the summer program in 2016, 16 came to participate in HMMT, and 14 were able to participate in our focus group sessions, which took about 1 hour each. The focus groups were comprised of 2-5 people, depending on the availability of the participants.

During the late Fall of 2016 we transcribed, coded, and conducted a content analysis of the student data using the grounded theory approach. The analysis resulted in the development of a series of themes, which were presented in the first evaluation report of the program.

In the second part of the evaluation we explored the themes raised by program participants from the mentors' and administrators' points of view and listened to

their voices to get views from both sides on the teaching and learning process. In the Spring 2017 the evaluation consultant conducted personal interviews with 4 instructors, 5 mentors, 2 residential counselors, and 2 administrators of the program. The interviews were held at MIT. During the late Spring of 2017 we transcribed, coded, and conducted a content analysis of the teacher data, also using the grounded theory approach.

Not surprisingly, the instructors and administrators added a range of new perspectives on the √Mathroots program, particularly when speaking about the goals of the program, its fidelity to its mission, curriculum development process, social dynamics of teaching, program structure and sustainability.

We concluded data gathering with several classroom observations of √Mathroots conducted during the Summer 2017 session of the program.

In this report we present integrated findings from the first and second parts of the evaluation study, bringing together teachers' and students' views on the program.

Results

In this section we will discuss the main findings emerging from the data, including all data sources, i.e. focus groups, individual interviews, and classroom observations. We will consider the content, structure, learning process and organization of the program, and its outcomes, as seen by the students and by their mentors and administrators, and summarize some ways in which both groups would like to see the program sustained and improved.

Curriculum and content of the program

As we talked about their experiences in √Mathroots, there was an overwhelming agreement among the participants that the program was well designed, interesting, challenging, and extremely useful. It went above and beyond student expectations. The head teachers Yi Sun and Tanya Khovanova, who designed curriculum for √Mathroots, recounted that initially curriculum was based on math Olympiads, as they started with a goal to introduce students to creative problem solving, looking at examples from international and national math competitions. However, as the program evolved, they *"realized that students need more fundamentals, more theoretical background."* The final version of the curriculum included both elements of Olympiad training for competitive problem solving and introductory lectures about various fields of mathematics.

A certain range in student abilities is natural to expect in any classroom, and even more so in a group of students gathered from different schools and from different states. Indeed, some students have reported that the program was a bit too intense for their level of math preparation, others said it was just right for them, still others said that most of the learning material was on the easier side for them.

The instructors confirmed that students come to the program with very different levels of mathematical knowledge.

"*They are all very talented students, capable of picking up material very quickly, but some people come from schools where they were not exposed to math a lot, didn't have these opportunities available, and they may be lacking some background that others might have. So there is a range in backgrounds, and it would be great to try to address this better,"* suggested one of the mentors.

Another mentor explained, *"It is sometimes difficult for 3 mentors trying to help 20 students working on different levels, with different problems on different times. We let them choose among 30 problems they will focus on and let them work at their own pace, but sometimes it's becoming hard to manage."*

An overall student assessment of the program's content and delivery, however, was extremely high and suggests that the teachers and mentors for most of the time managed to keep a delicate balance between challenging the stronger students, supporting the less advanced ones, and making it an engaging learning process for everyone.

"Mathroots was really interesting for me, as it was stuff I have not seen before. It was hard material, but professors and graduate students helped a lot. It was very interesting," one of the participants said. Another had very different, but also positive experience: *"Except for a few geometry concepts, I had seen all the material before at a camp called Awesome Math. I found the content very accessible and fun, and a little easy, but the math we learned was beautiful."*

"I found the content to be well-organized. We covered various topics, varying from number theory (my favorite) to geometry (my least favorite) and everything in between. The opportunity to have one-on-one instruction in solving problems ranging from simple to Olympiad level was very new and interesting," a third learner recounted.

Participants highly appreciated individual approach of their graduate mentors.

"I really liked the problem sessions, where we worked one on one with graduate students. The lectures were tough sometimes because of how fast paced they were," one of the students said.

A concern about the program material being too fast and too intense was echoed by another participant. *"Sometimes we moved too quickly to really understand or master a concept,"* she said. This observation might raise a flag for the program curriculum committee. While most of the students seemed to be interested, challenged, and overall happy to participate, for some the √Mathroots curriculum was too difficult, pushing them beyond their "zone of proximal development" into an area of uncomfortable challenge.

The teachers confirm that there was a range of student backgrounds in the classroom and would like the program to address it better. One of the suggestions voiced by the mentors was to involve them in the process of selecting students for

the program *"to get more information about the students before we see them, get their math background in the admission process."*

Other suggestions included dividing the participants into two academic groups in advance according to their math preparation, or finding a way to select a more homogenous group of participants.

It should be stressed, however, that in spite of the range of student backgrounds, all participants highly praised √Mathroots content and delivery.

Supporting student interest in Mathematics

Designing the program, the head teachers had a clear goal to introduce students to mathematics at MIT as a fun, exciting, and creative body of knowledge and as a way of thinking and opening one's mind. The head teacher Tanya Khovanova has said, *"In a broad sense the idea of this program is to teach them how to think. You need mathematics in your life to learn to make the right decisions and apply it beyond math in things like what house to buy or whom to vote for. Many of these kids do not have teachers who love mathematics as much as we do, so they are not exposed to mathematics as beautiful and fun."*

We asked the participants if the √Mathroots program has added anything new to their math education and received very strong positive responses, describing how the program had supported and expanded their interest in mathematics.

"Not only did it fortify my math skills in weak areas such as geometry, [but also] I learned more about other favorite fields of mine, such as number theory, which deepened my interest," said one learner, indicating how the program was opening a new field for him.

"This program only convinced me more that I want to study math in college," admitted another participant, speaking about her strong desire to make mathematics the basis of her future career.

"It taught me the different ways of looking for patterns and problem solving. It taught me that there are so many aspects of math out there to look at," said a third student,

who also spoke about the variety of mathematical fields she had not known about before.

The students were also speaking about √Mathroots as a way to be introduced to the mathematical community at MIT. Meeting undergraduate and graduate students, mentors and senior faculty, the high school students participating in the program began to see human faces behind the nerdy image of the MIT student stereotype. Many of the learners said it was extremely important for them to meet real MIT people in the Math Department and to see that they themselves might also fit in this place. And all participants, without exception, said that the program made them more confident and motivated to apply to MIT and other colleges. This result is especially impressive, given that according to the teaching team, the main goal of the program was *to give students confidence that they could succeed in mathematics*.

Talking about the student motivation, one of the mentors particularly mentioned, *"It was surprising to see how enthusiastic and upbeat students remained even though some of them were quite worn out, and some were so motivated that they woke up at 7 am to work on the problem."*

Another theme emerging in our conversations about how the program had enriched these students' interest in mathematics was their appreciation of opportunities to learn about math applications and collaborations in mathematics. The students spoke very highly about the lectures and seminars at √Mathroots where they could see mathematical concepts and methods being applied to other fields. They also appreciated working in groups and developing skills in collaborative problem solving, which the program fostered.

At the same time, the teachers continue to think what else the program could do to prepare these students even better to the competitive environment of the field. *"These students are very enthusiastic about math and quite strong, yet if you compare them with the general pool of MIT applicants, they are still behind because of their school backgrounds. What the program is doing now is great as it is allowing them a fair shot at applying to MIT and other top schools in math and engineering, but if they really want to become mathematicians it's still gonna be uneasy for them. And I*

wonder what else the program could do to address that." A great question posed by one of the head teachers remains to be explored in the next cycles of the program.

Teaching creative thinking

Discussing how √Mathroots was similar to or different from their high school math classes, the participants highly praised the creative thinking component of the program, saying that during these two weeks at MIT they learned to think more 'out of the box' and suggested that the critical thinking skills they developed in the summer went far beyond mathematics.

"The program had more of a critical thinking aspect than my high school math classes. It was more interactive and one-on-one teaching than in high school. I learned many new concepts, I learned a lot about problem solving and √Mathroots showed me how math can be used in games and life in general, through developing problem solving skills," one of the participants said.

"In school I learn calculus BC, while at MathROOTS I learned different types of math and different ways of thinking," echoed the other student.

"Unlike in my school, where we mostly work by the formulas and don't talk much about the logic behind math, the material at MathROOTS allowed for creativity and intuition to take over. Each problem required new thinking," said a third student in the discussion.

The impressions of the learners have closely matched the goals and expectations of the teaching team. As one of the mentors stated, "*In school math they are just given templates to get the right answer, and here we show that there is more to it, that mathematics can really be beautiful and expand your mind."* Another teacher confirmed, *"Our goal was to get students to understand that they could approach math problems in more creative ways."*

Looking at student responses, one could see that the teaching goals have successfully translated into tangible learning outcomes.

Organization of the program

The participants were mostly satisfied with organization of the program, its structure, flow, scheduling, set of activities, lodging and food, and the balance of academic and social life. The learners reported being comfortably lodged, they appreciated the opportunity to stay on the MIT campus and get acquainted with student life, valued the freedom to explore MIT on their own in the after class hours. The participants loved the tours of other campuses, enjoyed the dance party and a tour of Boston, and loved the company of each other and their mentors during the two–week period of √Mathroots.

Here are some quotes from the learners:

"I liked different activities such as the Duck Tour and visiting different schools. I also liked how we were free to look at things by ourselves. I think working with the mentors was the best thing. I liked everything at this camp!"

Asked to suggest some changes to improve the program the participants unanimously voted to make √Mathroots longer. *"I only wish the camp was longer, everything was so fast paced and ended so quickly,"* said one of the girls, and many learners suggested making a program three weeks long for the next generation of participants to learn more math, to have more time to get to know each other, and to make the program a bit less intensive academically.

The teachers and mentors have also appreciated the solid program organization. *"Structure is fine, everything works well and with more support the program would run smoothly even if doubled sized,"* said one of the mentors. Others confirmed that they have not faced any problems related to the logistics and organization of the teaching and learning.

Talking to residential counselors, we gathered a few minor technical suggestions for the organizational improvement. One of the counselors said it might be more practical to consider lodging the participants separately from college students, who were sometimes bothered by high school students and required quiet time in the evenings; another suggested incorporating more frequent check–ins with the residential counselors.

We shared these practical tips with program administration before the start of the √Mathroots session in the Summer of 2017.

Teaching as a relational process

From observations of √Mathroots 2017:

Setting: a very light and spacious auditorium, blackboards around all walls, one wall is fully covered with windows, giving plenty of light and opening a nice view of the river.

The class was divided into 4 groups. One group went out of the room to work in the lobby. Working on the list of problems, each group actively discussing. Mentors are guiding whether to start with "random problems" or work specifically on induction, which was the subject of yesterday's lecture. Students are free to choose any problem to start with.

Students seem to be very actively engaged with discussing the problems, all seem comfortable working in their groups, most are actively working on the task.
The discussion dynamics looks good, respectful in behaviors, tones, and discourse.
The larger group seems to be dividing into two subgroups along the way, focusing on the same problems, 4 people probably work more comfortably then 8 together, then uniting again to discuss their progress in a bigger group.

Mentors are helping, sometimes giving hints and explanations, at other times asking targeted questions which lead towards better understanding.

One girl sits very quiet, not engaging in her group discussion, trying to figure out some problems on her own. She keeps to the solitary work throughout the session, with different mentors checking on her progress from time to time.
Others start putting their decision on the blackboard, a mentor joining their discussion, providing help with writing down their thoughts in an appropriate manner. "How might you write this…?" " In how many ways can you arrange this…?"
There are lots of supporting comments from teachers: "That's a good way of thinking!", "You are really close," "You made pretty good progress."
Kids in the bigger group spring to their feet and go to the board on the opposite wall to discuss a solution; a mentor is helping with the discussion. Happy with their solution, they proceed to the next problem.

Tanya Khovanova is teaching fair division. She spreads colored paperclips on the desk and suggests a difficult division problem to the entire group. The students begin to offer various ideas. Ten minutes after the lesson has started everyone is on their feet, gathered around Tanya's table and brainstorming actively together as one large group. One of the girls lies on the desk facing the paper clips others stand in a tight circle around. Everyone is totally immersed in the task and engaged in the search for

the solution. Tanya carefully considers each idea, and nudges collective thinking further.

When talking about the teachers and mentors of √Mathroots, all the students suggested that the learning process felt less like a formal instruction and more like a warm, caring guiding relationships. The teachers were praised for the one-on-one attention, interactive style of teaching, knowledge of the material, creativity, sense of humor, and lots of patience. Students described their teachers and mentors as a very warm, almost "family-like" team. One of the mentors was half–jokingly described as a "simply perfect human being."

From speaking to the mentors, it became clear that they genuinely enjoyed working with this group of gifted children and were happy to share their passion for mathematics with the participants. One of the mentors, for example, said,

I've enjoyed it a lot, both as academic mentor and residential counselor. I like tutoring the students, working on the problems, but also knowing these students, meeting interesting people and being able to help them in some ways is great. I spent an entire day with the students, and it's a lot of work but also lots of fun.

Another mentor echoed, *"I loved this chatting group of 20 high–schoolers. It was a welcoming break from the usual silence of the math department, and the kids seemed always happy."*

In the focus group discussion with students it was clear how the personal approach to mentorship was an unexpected treat for the students, who anticipated more of a school like formal and distant way of teaching. The participants have taken a gift of caring relationships with much gratitude. Here are some of the students' words:

"I didn't know what to expect in terms of supervision, so the relaxed nature was surprising (but I liked it!). I also did not know how personal my connections would be with the instructors."

"The program went beyond my expectations by the amount and rigor of math, but also the care of counselors and academic mentors."
"I learned more than I expected and also forged relationships with students and faculty in a way I wasn't expecting."
"The people (students/teachers/staff) were all amazing to meet and work with."
"I couldn't ask for better guidance and friendship!"
This level of relational commitment and personal engagement on the part of the teaching staff is truly remarkable for a 2-week summer program. All teachers of √Mathroots received glowing reviews from the students as friends and pedagogues.

Addressing diversity

√Mathroots is a program for underrepresented minority students and aims to provide opportunities and boost confidence in mathematics and science specifically for this group. As one of the program administrators mentioned, *"The mission of the program is to provide role models and examples for young Black and Latino students in mathematics, introduce them to the mathematical community, particularly at the high end, and help them integrate into the mathematical community, racially, ethnically, as well as gender-wise."*
In conversations with minority students who attended √Mathroots we found that the program was indeed developing their confidence in many ways, and particularly as a minority person in STEM field. *"Prior to this program I perceived MIT as a school I could NEVER see myself going to, particularly due to the high level of intelligence in students. However, as I became acquainted with the campus, counselors and students who attend here, I realized it is possible for me to attend here,"* said one of the learners.
The participants reported that the √Mathroots program was creating a safe space to enter the math world for students who struggled with perceived social stereotypes of minority students and feared that they would not belong to MIT or math community. *"I believe programs like √Mathroots allow students to see themselves in*

an environment in which they may not have previously been able to, due to perceived challenges in terms of race, gender, or financial background," said one of the girls. Students mentioned how valuable √Mathroots was in creating opportunities specifically for minority students to oppose the overt or covert discrimination they sometimes faced back in their schools.

"I live in South Carolina, and my school has an extremely low minority population. We have a lot of problems with diversity and race relations and for many minorities at my school attending our high school is not pleasant. Coming to a program that appreciates and values diversity was INCREDIBLE. We need these programs," confirmed another participant.

Considering the gender composition of the group, it is important to note that female students of √Mathroots did not differ in their perceptions of learning and organization of the program from their male peers. Both boys and girls spoke very highly of the program content and structure. Considering the well–researched fact that girls often feel less confident in STEM areas (Ellis et al., 2016), it is a good indicator that the program does a great job supporting girls to pursue their interest in math.

Some students have mentioned that there were a few moments when they felt a bit awkward, due to the teachers' different backgrounds. One suggestion is to add diversity training for the teachers and mentors in addressing cultural issues with students, and also diversifying the group of mentors in the program. Another is to find time to talk explicitly about these issues during the program.

We spoke with one of the MIT admissions officers who helped the Math Department conceptualize the program for minorities and at the moment of the interview was working with the program to find minority participants in the schools across the country.

He suggested the program taking a more proactive approach on the issue of diversity, *"One thing I would encourage the program to grow into is really helping young people talk about issues around their unique racial and ethnic identities in addition to their basic math training, carving out some time to talk about it, making sure they see diversity in mentors and other people they see and also having some*

spaces like lecture series or conversations. You have to talk about it. The kids are already having different experience than their white and Asian peers, when they get admitted to certain colleges people think it's because they are Black or Latinos or women, and when they get these messages they should be ready to deal with it, they should know that it's not a reflection of your accomplishment, it's somebody else's problem, and to not talk about it is not to prepare them for the future."

One can see that √Mathroots is doing a great job creating opportunities for the minority students and boosting their confidence in STEM. One area to improve is to take a more explicit stand on diversity conversations. It may be difficult to carve out time during the program, yet it might be worthwhile to consider this idea for future sessions of the program.

Discussion

In this section we will discuss the results of the evaluation in light of the recent outcome studies on STEM programs, particularly studies of residential summer camps similar to √Mathroots. It is important to understand how the program compares to other successful programs.

For the last decade there has been an increased interest in summer programs designed to support students' development in STEM. Recent educational studies indicate that STEM summer programs have been very successful in supporting students' engagement with STEM disciplines and careers (Mohr-Schroeder et al., 2014; Yilmaz, Custer & Coleman, 2010). Free of the grades, exams and other stressors of the school year, summer programs engage students in hands-on activities and expose them to authentic learning experiences, which allow them to delve deeper into STEM concepts (Hakim et al., 2014).

Bhattacharyya's research (2011) reported findings from a summer camp where exposing students to scientific experiments and field investigations changed students' attitudes towards science and mathematics. The change in attitude was attributed to the opportunity students had to deepen their scientific knowledge, which in turn influenced their identities and role of science in their lives.

It was documented that the quality and effectiveness of summer programs vary significantly. The variation in the quality of summer programs is particularly critical for students of low-SES backgrounds, where research demonstrated that high quality summer programs can have an even greater positive impact on achievement scores (Borman & Dowling, 2006). This finding is very relevant to √Mathroots as the program is geared specifically towards the students from underrepresented backgrounds or underserved communities.

To ensure the quality of summer programs, scholars propose a number of criteria that can be summarized in four categories (Bell & Carrillo, 2007; Borman & Dowling, 2006; Black, 2005):

Curriculum and Pedagogy

Bell (2007) suggests a quality summer program should adopt curriculum with clear goals and intentional focus on accelerating learning. Black (2006) further pointed out that small-group or individualized instruction could achieve these goals by providing more personalized learning opportunities.

The current assessment of √Mathroots demonstrated that the program satisfies this criterion, utilizing an individualized approach and setting clear goals for the curricular activities. An increased interest of learners in the field, following their participation in the program, further engagement with the mathematical subject, and planning their future as based on math and science are all testaments to the quality of the program's teaching materials and sound pedagogical strategy.

Program Organization

Empowering leadership and collaborative planning are essential to the implementation of summer programs. Extensive opportunities for staff training can ensure that everyone shares understanding of the program goals (Bell & Carrillo, 2007). The assessment of √Mathroots demonstrates that according to both learners and teachers the program is very well organized. From initial application to traveling, classroom activities, after class activities, and social life the program runs

smoothly and efficiently. Some technical suggestions have been made to improve the program logistics in the area of lodging and in admissions, yet overall the program seems to function very smoothly.

Evaluation and Improvement

Rigorous approach to evaluation could guarantee the fidelity, sustainability and cost-effectiveness of programs, while also indicating directions for future improvement (Borman & Dowling, 2006). The √Mathroots program conducts regular content assessments to fine tune the teaching, does internal after-program reviews each year, and currently adds an independent external evaluation component to provide a more objective assessment.

External Support

Finally, good summer programs rely on external support, such as strategic partnerships and parent involvement (Bell & Carrillo, 2007; Borman & Dowling, 2006). √Mathroots is supported by the MIT Department of Mathematics and planning to apply for external grants and seek more partnerships in the future.

Conclusion and Recommendations

The focus group data collected for this assessment indicates that the participants have been greatly satisfied by the program. The interviews with the head teachers, mentors, residential counselors and administrators have also suggested that the program is effective, runs smoothly, and with minor technical improvements and financial support could be sustainable and scalable.

In terms of the **outcomes**, the students reported that √Mathroots supported and increased their interested in mathematics, fostered their critical thinking skills, boosted their engagement with STEM fields in school and beyond, and strengthened their sense of belonging to the mathematical and science community, specifically in

the context of their diversity backgrounds. The teachers have also reported seeing students more interested and confident in math by the end of the program and beyond. √Mathroots also created a special sense of affection and admiration for MIT, as all participants claimed that they consider the MIT Math Department as their first choice in college applications.
According to MIT records, out of 20 √Mathroots alums from the 2016 program, 17 applied to MIT, 13 were admitted, and 9 enrolled. Out of 12 graduating alums from the 2017 program (the others will graduate in 2018), 9 applied to MIT, 6 were admitted, and 4 enrolled. In total, out of 32 graduating √Mathroots alums, 26 applied to MIT (80%), 19 were admitted (60%), 13 enrolled (40%). These numbers give us another confirmation for the success of the program and confirm that √Mathroots is doing an excellent job attracting strong minority students to MIT.

In terms of the **learning process and pedagogy**, the participants highly praised the content of the program, the quality of instruction, the creativity and variety of teaching methods and materials, and genuine care in mentor relationships. One area where participants indicated possible room for improvement is finding a better match between their preparation and the intensity of the curriculum.
Another suggestion coming from the students themselves is to consider extending the program up to three weeks to allow for even greater immersion in the math content and social world of √Mathroots.
The teachers, for their part, were very satisfied with teaching and felt enthusiastic about mentoring this group of students, creating opportunities for young mathematicians from underrepresented communities. Some of the mentors also felt that, given additional resources, the program might benefit from expansion in time.

Considering the **organization and effectiveness** of the program we observed a very high level of satisfaction among the learners as well as the instructors.
Some of the suggestions voiced by the teachers and administrators were about the preparation of much younger minority students, 5-8 graders, as it might be necessarily to prepare them to be really competitive by the end of high school. Other

ideas we discussed considered the possibility of opening an online component of the program, allowing mentors to work with participants after they complete the program, providing continued academic and social support to the cohort. In this sense, another branch of MIT PRIMES, Crowdmath,[1] a networked space where academic mentors provide online guidance to collaborative solution of math problems to high- and middle-school students, might be an effective way to address some of the challenges posed by the limited time of the √Mathroots program.

It would be highly recommended to keep the program running and to maintain its high quality of instruction. Our evaluation indicates that √Mathroots is a very strong outreach program, which has all necessary components for sustainability and scalability and should continue providing minority students opportunities in mathematical education for years to come.

[1] CrowdMath (http://artofproblemsolving.com/polymath/) is a free, massively collaborative mathematical research program open to high school and college students around the world.

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