

From Breakthrough Prizes to Breakout Graduate Fellowships: “Mathematics Is a Community”

Della Dumbaugh

Introduction

On February 11, 2019, the International Mathematical Union (IMU) issued a new call for the Breakout Graduate Fellowship Program of the IMU Commission for Developing Countries (CDC). What are Breakout Graduate Fellowships? What is the IMU Commission for Developing Countries? Why does the IMU support these initiatives? In the mathematical community, the IMU is typically known for organizing quadrennial International Congresses and awarding the Fields Medal [1, p. 8]. But the IMU is much bigger than those two initiatives. This article aims to call attention to the work of the IMU to advance mathematics in developing countries, especially through their new initiative, the Breakout Graduate Fellowship Program.

Brief History of the IMU and Its Commitment to Developing Countries¹

The International Mathematical Union (IMU) had a bit of a bumpy start. Originally founded in 1920, it disbanded in 1932 and only came to life again after the celebrated American mathematician Marshall Stone brought a cohesiveness to the group in the late 1940s and early 1950s. It officially re-formed again in 1951 with Stone as the first president of the new IMU. His vision for the IMU focused on the three main aims of promoting international cooperation

Della Dumbaugh is a professor of mathematics at the University of Richmond and an associate editor of the Notices. Her email address is ddumbaugh@richmond.edu.

¹The IMU defines developing countries as those with GNI per capita of less than \$11,000 (US). For a complete list see <https://bit.ly/2W1IcFI>.

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DOI: <https://dx.doi.org/10.1090/noti1933>

in mathematics, supporting the International Congress of Mathematicians (ICM), and encouraging any and all international mathematical activities that contribute to the discipline [1, p. 7]. In restarting the IMU, Stone “pressed hard for inclusiveness.” At the time, this “inclusiveness” focused on advancing mathematics within the broader frame of “post-War and Cold War sensitivities” [1, p. 7].²

The IMU has continued Stone’s commitment to inclusiveness and expanded it to many other areas. In particular, in the 1970s, the IMU formed an international group of mathematicians, chaired by A. Adrian Albert of the University of Chicago (and vice president of the IMU at the time), to begin exploring the growth of mathematics in developing countries and advise the Executive Committee [5, p. 180]. As Olli Lehto pointed out, “the composition of the group,” which included Henri Cartan and Michael Atiyah, among others, served as “further proof of the Union’s serious aim to do something” [5, p. 180].

These efforts eventually led to the establishment of the IMU Commission on Development and Exchange (CDE) on January 1, 1979, to “support and encourage the growth of Mathematics in developing countries and co-operate with appropriate bodies to that end” [5, p. 201] and later the Developing Countries Strategy Group in 2004 “to increase the organization’s attention to the needs of mathematics and mathematicians in the many countries of the world which do not have the national development or resources necessary for official IMU membership” (<https://www.mathunion.org/imu-net/archive/2004/imu-net-008>).³ In 2011 the IMU united these two

²As Lehto characterized it, “Stone’s personal view was clear: He was for unrestricted internationalism” (p. 75). See Chapter 4 of [5] on “Foundation of the new IMU (1945–1951).”

CDC Programs to Support Mathematics in Developing Countries

Conferences and Projects

Conference Support Program: This program gives partial support to conferences organized in developing countries and to a few major international conferences occurring in developed countries for the participation of mathematicians from developing countries.

Project Support Program: The CDC supports capacity-building projects and programs in mathematics and mathematics education, be they international, regional, or local initiatives in developing countries. It is worth mentioning the Capacity and Network Project (CANP) of the International Commission for Mathematical Instruction (ICMI).

Lecturing and Mentoring

Volunteer Lecturer Program: The goal of this program is to offer universities in developing countries lecturers for intensive 3–4 week courses in mathematics at the advanced undergraduate or master's level. The program is partially supported by the American Mathematical Society and the Niels Henrik Abel Board (Norway).

African Diaspora Mathematicians Program: This program ran as a pilot in Africa for two years (May 2017 to June 2019) and offered three partnerships to be established between a mathematician originally from Africa and now living and working outside Africa and a mathematics department based in Africa.

Individual Research Visits

Abel Visiting Scholar Program: Financed by the Abel Board, this program supports young mathematicians professionally based in developing countries to visit an international research collaborator for a period of one month.

IMU-Simons African Fellowship Program: Financed by the Simons Foundation (US), this program supports research visits for mathematicians from African developing countries employed in Africa to travel to an internationally known mathematical center of excellence (worldwide) for collaborative research.

Individual Research Travel Program: This program supports travel costs of mathematicians based in developing countries for research visits to an international center of excellence for a period of at least one month. The program is partially supported by donations of the Japan and Swiss Mathematical Societies.

Graduate Support Programs

IMU Breakout Graduate Fellowship Program: This program is described in the article.

Graduate Research Assistantships in Developing Countries Program: GRAID provides research assistantships to graduate students of emerging research groups with an ongoing collaboration with an international mathematician. The program is funded by voluntary donations from mathematicians or mathematical institutions worldwide, in particular by donations received from nearly one thousand AMS members through their annual voluntary contribution to IMU activities. The AMS provides administrative support for the program.⁴

initiatives to form the Commission for Developing Countries (CDC). This merger reflected the strong emphasis of the IMU to increase activities in developing countries. Mandated to manage all “IMU initiatives in support of mathematics in the developing world,” the CDC supports initiatives ranging from visiting lectureships to travel fellowships to mentoring through its various programs.

The Year 2014: A Report, a President, and a Prize

In 2014 the Friends of the IMU, known as FIMU, engaged the services of an editorial consultant to prepare a white paper entitled *The IMU in the Developing World: Past, Present and Future*. The report offers a comprehensive overview of these efforts and emphasizes three main points: (1) mathematical communities are vital to the economic development of all nations; (2) quality mathematics education serves as the foundation for strengthening mathematics worldwide; and (3) the IMU is committed to education that is open to all, that nurtures and rewards mathematical talent, and that provides access to historical and current mathematical literature.

In particular, the report notes that developing countries face many challenges in cultivating an interest in mathematics in students, providing role models for those students, and funding graduate work. For those who do complete their studies and obtain faculty positions, they are often overwhelmed with large teaching loads and/or classes and face professional and geographic isolation [1, p. 12]. The CDC has determined that there is not a lack of indigenous talent

but, rather, that the opportunities to develop that talent “vary widely depending on circumstances.” In particular, the single largest need for mathematical communities in developing countries is graduate student support [1, p. 14]. It is expensive to educate a student from a developing country in a developed country. Moreover, in these cases, students often do not return to their home country. With

³IMU members are countries, not individuals. Fees for countries are based on a tiered scale. If a country would like to begin to develop its mathematical culture and has an interest in establishing links to the international community, that country can join as an Associate Member of the IMU. See <https://bit.ly/2JTtFDU>.

⁴Information about other CDC activities, such as the Library Assistance Scheme, and more details of each program can be found at <https://www.mathunion.org/cdc>. The Notices would like to thank Olga Gil-Medrano for her help with the CDC programs.

so few students interested in mathematics, losing even a single student has a dramatic effect on the emerging mathematical communities.

Despite identifying these vast needs for developing countries, the IMU remains a small, underfunded organization dependent on many volunteers [1, p. 27].⁵ Not surprisingly then, in its outline of possible future actions, *The IMU in the Developing World: Past, Present and Future* includes, among other suggestions, incorporating fundraising as part of the mission of the IMU [1, p. 28].

Interestingly, in June of 2014 the inaugural Breakthrough Prizes in Mathematics were announced. These prizes form part of the broader group of Breakthrough Prizes that “honor important, primarily recent, achievements in the categories of Fundamental Physics, Life Sciences and Mathematics” [2]. Sergey Brin, Anne Wojcicki, Pony Ma, Yuri and Julia Milner, and Mark Zuckerberg and Priscilla Chan sponsor the general Breakthrough Prizes. Mark Zuckerberg and Yuri Milner founded the Breakthrough Prizes in Mathematics, which reward “significant discoveries across the many branches of the subject” [3]. The five inaugural winners in mathematics included Richard Taylor of the Institute for Advanced Study, Simon Donaldson of Stony Brook University and Imperial College London, Maxim Kontsevich of Institut des Hautes Études Scientifiques, Jacob Lurie of Harvard University, and Terence Tao of University of California, Los Angeles. Each mathematician received a monetary prize of \$3,000,000.

With this generous award, the Breakthrough Prize recipients gave thought to how to use some of the funds to advance mathematics. The five winners decided they could achieve the greatest influence by combining their efforts. They were ultimately persuaded by Ingrid Daubechies, then president of the IMU, who had written to them about the importance of supporting graduate students studying in the developing world. Each mathematician contributed \$100,000 to create an endowment for the IMU “Breakout Graduate Fellowships.” Designed to support students in a developing country pursuing a PhD in the mathematical sciences, these fellowships aim to educate the next generation of mathematicians. As Breakthrough Prize winner Richard Taylor described it,

[t]raditionally, support for mathematics in the developing world has consisted mainly of scholarships for highly talented students to study in Europe or North America. Such students rarely return to their home countries, so the impact

⁵In his remarks as incoming president of the IMU, David Mumford (in)famously noted the financial stature of the IMU as an asset when he remarked that “[w]hen I got involved in the Executive Committee, [Jean-Pierre] Serre told me what he considered the two secrets of its success. First, no one was ever nominated to the Executive Committee who wanted the job; second, the IMU has no money to speak of” [7].

of the scholarship ends with one student. The hope of the IMU and our fellowship is that if these students study in centers of excellence in the developing world, then they are more likely to return to their home countries and help educate the next generation of mathematicians. We felt that here, relatively little money had the potential to have a big impact. [6]

The FIMU and the World Academy of Science (TWAS) assist the IMU with the Breakout Graduate Fellowships. In particular, TWAS administers the Fellowship awards.

It seems only fitting that the IMU announced the Breakout Graduate Fellowships on August 12, 2014, at the CDC symposium Mathematics in Emerging Nations: Achievements and Opportunities at the International Congress of Mathematicians in Seoul, Korea. The IMU designed this one-day “satellite event” at the Seoul ICM to call attention to “mathematical activities and young talent in developing countries” [1, p. 15]. Sharing the goals of the IMU, the South Korean Organizing Committee raised funds to invite 1,000 mathematicians from emerging nations to attend the 2014 ICM. The combined message of these initiatives by various groups of mathematicians underscores the value of collaborative efforts to cultivate and advance mathematical talent in general and in developing countries in particular.

Since the time of the inaugural awards, subsequent Breakthrough Prize winners in mathematics—Ian Agol (2016), Jean Bourgain (2017), James McKernan (2018), Christopher Hacon (2018), and Vincent Lafforgue (2019)—have also contributed to the endowment, which now totals \$900,000.⁶ The Fellowship provides tuition, travel expenses to the host institution, accommodation, and basic living expenses up to \$10,000 (US) per year for at most four years. The IMU awarded the first Breakout Graduate Fellowships in 2016. These initial fellowships were awarded to Do Thai Duong, a Vietnamese PhD student at the Institute of Mathematics of the Vietnam Academy of Science and Technology; María Alejandra Ramírez Luna, a Colombian PhD student at the Universidad del Valle, Colombia; and Abebe Regassa Tufa, an Ethiopian student

⁶See <https://bit.ly/2EMkpUj>. Any supporter of mathematics can contribute to the endowment. Other Breakthrough Prize winners have contributed to scholarship programs. In September 2018, for example, Jocelyn Bell Burnell won a special Breakthrough Prize in Physics for her discovery of pulsars. (Her graduate advisor Anthony Hewish won the Nobel Prize for her discovery in 1974.) Although Burnell said she was “delighted” to receive the special Breakthrough Prize, she would not be keeping any of the award money. “I don’t need a Porsche or Ferrari,” she said. “I don’t have an affluent lifestyle.” Instead, the funds will go to creating scholarships for women, underrepresented minorities, and refugees who want to study physics. The funds will be administered by The Institute of Physics (IoP) for the UK and Ireland. “I reckon I discovered pulsars in large part because I was a minority person [at Cambridge],” she said. “And I have a strong suspicion that other minority people might have similar feelings and work equally hard and discover things” [4].

who completed his PhD in June 2018 at the Botswana International University. Tufa is the first Breakout Fellowship recipient to complete his PhD. He studied analysis and completed a thesis on "Approximating Solutions of Fixed Point, Variational Inequality and Hammerstein Type Equation Problems." He has returned to the University of Bahir Dar in his home country of Ethiopia to assume an assistant professor position.⁷ The IMU issued its second call for the Breakout Graduate Fellowship Program in February 2019. The call invites professional mathematicians to nominate motivated and talented students from developing countries who plan to pursue a PhD in a developing country.⁸

Concluding Thoughts: "Mathematics Is a Community"

Clad in a blue checked shirt for the video commemorating his Breakthrough Prize, Richard Taylor chose four powerful words to summarize mathematics: "Mathematics is a community." While Taylor no doubt meant to capture many aspects of the discipline with his statement, his succinct assessment of mathematics perfectly describes the process involved in establishing the IMU Breakout Graduate Fellowships. Marshall Stone's emphasis on a truly international community formed the broader contours for the new International Mathematical Union in the early 1950s. In the 1970s, a veritable who's who of mathematicians began to consider mathematics in developing countries at the request of the IMU. Those explorations continued in various forms over the intervening years, and, in 2014, with Ingrid Daubechies as president, the IMU issued a comprehensive report summarizing the then current state of affairs on mathematics in developing countries. The seemingly unrelated event of Yuri Milner and Mark Zuckerberg's inaugural Breakthrough Prizes in Mathematics with their generous cash awards also occurred in 2014. The IMU, the Breakthrough Prizes, the inaugural winners in mathematics, and mathematics in developing countries became unexpectedly and inextricably linked with the introduction of the Breakout Graduate Fellowships. This extraordinary outcome spanning decades, countries, academics, and industry underscores the collaborative nature of the discipline not only for creating mathematics but also for creating *opportunities* in mathematics.

⁷ For an interview with Tufa by Olga Gil-Medrano, a member of the Director's Board of FIMU and Secretary for Policy of the IMU-Committee for Developing Countries, see <https://bit.ly/2EMkpUj>.

⁸ For more information on the call and the nomination process see <https://bit.ly/2Vt7igA>.

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Della Dumbaugh

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