Graduate Assistantships in Developing Countries (GRAID): Supporting Mathematics Graduate Students in the Countries that Need it Most.

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Introduction

In most of the world there is little support for graduate students in mathematics. This leads to a large fraction of the mathematical talent not being fully developed since access to educational opportunities depends strongly on where someone is born. One program that addresses this problem is the Graduate Assistantships in Developing Countries (GRAID) from the Commission for Developing Countries (CDC) of the International Mathematical Union (IMU). GRAID provides scholarships for graduate students in mathematics in low income countries.

The origin of the program was a grass roots effort where the need to support graduate students was identified while sending volunteer faculty to teach graduate courses in Cambodia. The faculty could provide instruction but the ability for the students to spend the time needed was limited by their need to work (often a full time job) to sustain themselves while completing the master's degree. GRAID was adopted as an IMU CDC program in early 2017. What started with an individual mathematician supporting a particular student has become one of the programs of the CDC which has supported 31 students in 14 countries in just 6 years.

Recent publications have shared an overall view of the IMU [Ken20], the Breakout Graduate Fellowships [Dum19] and the volunteer lecturer program [Ses18]. In this paper, we share the work of GRAID. We begin by sharing the stories of two collaborations supported by GRAID, one in Uganda and another in Nepal. We then describe the structure of the program and summarize the outcomes.

Uganda: algebraic geometry

One of the groups funded early in GRAID (2018) was at University of Makerere in Uganda with David Ssevviiri as the principal investigator (PI) and Michael Wemyss as the international partner (IP) at the University of Glasgow, UK. There were two students in that group, Caroline Namanya and Brian Makonzi.

In 2021, Caroline Namanya received an IMU Breakout Fellowship [Dum19] half-way through her 4-year PhD trajectory and so is finishing her degree under that program. The IMU Breakout Fellowships have significantly more support for students and having a GRAID-supported student receive such a competitive award is an indicator of the quality of work being done. Brian Makonzi

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Figure 1: Hiking near Glencoe, Scotland in a research visit, from left to right, Michael Wemyss (IP), Caroline Namanya (GRAID-supported student), David Ssevviiri (PI), Brian Makonzi (GRAID-supported student).

Figure 2: From left to right, Anjana Pokharel (GRAID-supported student), Naveen K. Vaidya (IP), Kedar Nath Uprety (PI), Khagendra Adhikari (GRAID-supported student), Ramesh Gautam (GRAID-supported student). This photo was taken at the 2022 Infectious Disease Modeling Workshop in Nepal.

has a paper accepted for publication already in the Journal of Noncommutative Geometry. He is expected to complete his PhD in 2023.

In this project, the GRAID support provided a catalyst for a visit from the students to the PI's institution (Figure 1) for both students and a larger fellowships for one of the students. The collaboration and the opportunities facilitated by GRAID are examples of what is possible with a small amount of support.

Nepal: mathematical biology

The group in Nepal was first funded in 2020 with Kedar Nath Uprety of Tribhuvan University as the PI with Naveen K. Vaidya as the IP at San Diego State University, USA. The group has three GRAID-supported students Anjana Pokharel, Kagendra Adhikari and Ramesh Gautam.

These students have participated as co-organizers and presenters in national and international programs including a Summer Research School of the International Center for Pure and Applied Mathematics (CIMPA) in Bangladesh (May 2022), a four-day workshop in infectious disease modeling in Nepal (July 2022), and a disease modeling lab session: "Solving basic disease models using MATLAB" in collaboration between Nepal and San Diego State University, USA (June 2022).

The students meet with the PI and IP every Saturday for 2-3 hours to discuss the weekly progress of students and plans for further work. They present their progress work regularly in the scheduled meeting of the Research Committee of the Central Department of Mathematics, Tribhuvan University. In this short time, their research has already result in four publications modeling the spread of measles, malaria and Covid-19 in Nepal [$\mathrm{PAG}^{+}22, \mathrm{GPA}^{+}22, \mathrm{AGP}^{+}21, \mathrm{AGP}^{+}22$].

Structure of GRAID

GRAID was established in 2017 to provide research assistantships to graduate students of emerging research groups with an ongoing collaboration with an international mathematician. The GRAID committee (Figure 3) manages the program with administrative support from the American Mathematical Society (AMS). GRAID provides modest support for emerging research groups, working in a developing country listed in priority 1 or 2 of the IMU (per capita gross national income less that 3995 USD), making it possible for them to fund their most talented students to study full-time as graduate research assistants thereby fostering the growth of a math-

Figure 3: 2019-2022 GRAID committee meeting, from left to right (top row), Ingrid Daubechies, Galina Rusu, Michel Waldschmidt, (bottom row) Herbert Clemens, Jose Maria Balmaceda, Angel Pineda

ematics community.

The amount of the stipend per graduate research assistant does not exceed USD 3,500 per year. One team can apply for up to 3 graduate research assistantships. The stipends typically cover tuition, fees and living expenses. For PhD students the stipend typically covers 4 years depending on satisfactory progress based on annual reports. Master's students are typically funded for 2 years.

Collaboration in mentoring

The GRAID teams are founded on an ongoing collaboration between the PI and IP. The PI should be a university professor in mathematics holding a PhD, working at a university or research centre in a developing country, who is training mathematics master's or PhD students. The IP should be a mathematician working at a university or research centre in a country with a strong mathematical community. The PI and IP should be in regular contact and through their collaboration create a support structure for the students. By regularly meeting the students, the PI and the IP provide multiple levels of guidance and support.

Application process

The PI has to complete an online application form including information about the research program, mentoring of students and the collaboration with the IP. The details of the application process can be found in the GRAID website.[1]

Reporting

The groups with GRAID support submit annual reports for each student and funding is contingent on appropriate student progress. These multiple levels of reporting provide a careful evaluation of the groups supported by GRAID.

Summary of outcomes

There have been 15 distinct groups in 14 different countries that have been supported with a total 31 students (Table 1). Four students have completed their PhDs, 5 have completed their master's degrees, two students transferred to PhD programs in Europe or the USA and one student got a Breakout Fellowship [Dum19]. The impact of GRAID is significant in the local mathematical community of the supported groups but it also has already resulted in several publications [PAG+22, BDTW21, BKTW22, GTESN22, AGP+21, AGP+22, GPA+22].

Year	PI	IP	Students
2017	Morocco	Spain	3
2017	Cameroon	USA	2
2018	Uganda	UK	2
2019	Pakistan	Germany	6
2019	Burkina Faso	France	1
2020	Benin	USA	1
2020	Nepal	USA	3
2020	Ivory Coast	France	1
2020	Cameroon	USA	5
2021	Congo	France	1
2021	Philippines	Canada	1
2021	Ghana	UK	2
2022	Madagascar	Canada	1
2022	Ethiopia	Finland	1
2022	India	USA	1

Table 1: A total of 31 students in 15 different groups have been supported by GRAID so far.

[1] https://www.mathunion.org/cdc/scholarships/graduate-scholarships/graduate-assistantships-developing-countries

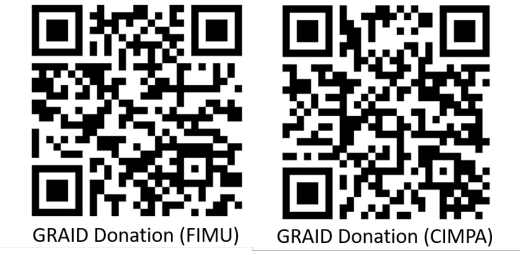

Figure 4: QR codes for GRAID donations through FIMU and CIMPA.

How to support GRAID?

GRAID has been supported by donations from individual mathematicians and mathematical institutions worldwide. Individual mathematicians have donated their personal funds and prize money for mathematical awards to GRAID through the Friends of the IMU (FIMU) and CIMPA, members of the AMS support GRAID as an option in the membership form, and CIMPA also supports GRAID. There has even been small grass roots initiative to support GRAID by running (runForGRAID)[2]. It has been through a combination of all these efforts that these research experiences for students have been possible. Thank you to all the donors!

If you would like to support GRAID, please go to the FIMU donation page (for US-based donors) [3] or the CIMPA donation page (for European-based donors) [4] under the donate to GRAID option. The QR codes for donating to GRAID through FIMU and CIMPA are included in Figure 4.

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[2] https://sites.google.com/manhattan.edu/runforgraid/
[3] https://friends-imu.org/donate/#graid
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