PIMS Mathematical and Statistical Graduate Education Roundtable

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1 Introduction

The PIMS round-table on math/stat graduate education took place from the 21st to the 23rd of May, 2010. In attendance, by alphabetical order by university and name, were:

- from the University of Alberta: Thomas Hillen (faculty; graduate chair), Cody Holder (grad student; GAME president), Remkes Kooistra (grad student), Jochen Kuttler (faculty), Malcolm Roberts (grad student), and Tara Schuetz (administration);
- from the University of British Columbia: Neil Balmforth (faculty, AIM director), Peter Bell (grad student) David Kohler (grad student), Greg Martin (faculty, grad advisor), David Steinberg (grad student), and Lee Yupitun (administration);
- from the University of Calgary: Ted Bisztriczky (faculty, dept. head), Matthew Musson (grad student), Cristian Rios (faculty), Jedrzej Sniatycki(faculty, acting grad head), and and Colin Weir (grad student);
- from the University of Lethbridge: Wolf Holzmann (faculty) and Hadi Kharaghani (faulty, dept. chair);
- Michael Cavers (grad student) from the University of Regina;
- from the University of Victoria: Chris Bose (faculty), Kseniya Garaschuk (grad student), and Scott Lunney (grad student);
- from the University of Saskatchewan: Christine Soteros (faculty) and Raj Srinivasan (faculty, dept. head);
- and Alexander Dahl (grad student) from the University of Toronto.

The format of the workshop was a series of round-table discussion (though lacking an actual round table) which were led by a variety of people.

2 Graduate Student Involvement in Decision-Making and Governance

This discussion was led by Remkes Kooistra from the University of Alberta.

The subject of this discussion was the role of graduate students in the operation and decision making processes of a department. This mostly refers to graduate student participation on departmental councils

and committees. Remkes began by talking about the written rules and policies that govern graduate student participation. For example, at the University of Alberta, there is university-wide regulation that creates a position for graduate student on department council. However, that policy is vague and relatively unknown, and it doesn't apply to departmental committees, which may not have easily accessible terms of reference. Clear guidelines for student participation are a good starting point, though often less important than culture and precedent.

Better participation might be achieved by clarifying the role of student members, and presented several different models, such as representative, advisory, and supervisory. Another idea for encouraging participation included an honorarium for students to sit on committees. This supports the idea that administration and committee work is a integral part of the academic life towards which many graduate students are working. It was suggested that perhaps committee work could be included in a TA duty, particularly for 3rd and 4th year PhD students.

The discussion then moved away from formal rules to discussing departmental culture: even if the rules are well written and available, departments need to set up a culture to encourage participation. Many aspects of departmental culture were discussed. Transparency is an important aspect of departmental culture. There is a need for confidentiality in many parts of governance, such a financial discussion, discipline, and awards. Departments may benefit from a more open governance in other areas, where students are able to attend meetings, view minutes and budgets, and understand how decisions are made. Openness in these areas can encourage participation from the student population. Transparency is not always consistent: e.g. when a student is recommended for withdrawal at the UofA, there is graduate student representation at the appeal level but not the departmental level. However, there is a risk of conflict-of-interest and confidentiality breaches; one suggestion was that the Departmental Graduate Committee should include a Graduate student from another department to maintain confidentiality.

Another cultural problem with some departments have struggled with is a clash between student and administration. Students need to feel that the department respects their opinions in order to have the confidence to speak up at council or committee meetings. This need for respect goes both ways, and it is important that students avoid a confrontational mentality. A culture of respect is necessary from both sides in order for student participation to be successful.

It is important to recognize the needs of both sides in order to maintain a culture that encourages cooperation. Remkes spoke with students and administrators at the University of Alberta to try to gather this information, and several points were raised at the round-table.
The administration has the following needs from students:

1. Feedback: The department needs students who can act as a conduit from the student body, can speak for the whole, and can inform the department of issues and problems affecting other graduate students.

2. Communication: The department needs students who can share with their peers what the department is planning, and can help educate their fellow students on policy.

3. Culture: Students need to be well-prepared and professional. In particular, students need to respect confidentiality.

Several idea were prominent on the student side:

1. Culture: Students wish to be treated as professionals.

2. Transparency: They want some level of oversight so they can understand departmental decisions.

3. Input: Students need to be able to influence how their department is run.

3 Research Internships

This discussion was led by Peter Bell from the University of British Columbia.

Industrial internships are available through a number of industries: MITACS IPS (4 month projects) and USRAs, and NSERC internships (12 month projects). Typically, the student must drive the work, including pitching the project to a supervisor and industry, and the funding organizations are often hands-off.

Prospective students who are uncertain about what to do with their degree are good candidates for internships, which can clarify for which jobs a math/stats degree is suitable. Obviously, internships can be an important source of funding, and may help recruit foreign students. Most importantly, there is a huge gap between the mathematics of academeia and those used by industry; internships can help bridge this gap, which could be as straight-forward as implementing an already-established technique.

Internships are difficult to organize:

1. The interaction with industry can restrict what one is able to research; pure science is more difficult to pursue, and the work is often not technically advanced.
2. These internships take real work to organize: the funding org. industry, faculty, and the student all need to be on-board. Some money also comes from the supervisor, which is not always available.
3. The results of the internship may be viewed as trade secrets, so the student and supervisor may not be able to publish the fruits of their labour.
4. The projects are often deadline-oriented, which limits the academic scope of the work. The projects may, however, be seeds for larger MSc/PhD projects.

There is pressure from government and industry that graduate students have skills suitable for industry; there is certainly interest in this area.

4 Teaching Graduate Students

This discussion was led by Thomas Hillen from the University of Alberta.

4.1 Skills students bring

Students enter a graduate program with an important skill set, which can be divided into two general categories (This list was compiled with math students in mind; stats requires somewhat different topic skills):

Soft Skills	Topic Skills
Language (reading and writing)	Math reasoning
Patient problem solving	Proof
Communication skills	Real analysis
Writing skills	Linear algebra
Math talent	Basic algebra
Passion	Computer skills

Determining if an applicant has these necessary skills is not a straightforward process, and there didn't appear to be a consensus on what methods were effective.

The soft skills can be checked by English proficiency exams (of questionable worth), interviews, reference letters, and the personal statement section of the application. Interviews can be very useful, and can be done relatively inexpensively via Skype, but may bias against students for whom English is a second language. Topical skills are estimated from transcripts and reference letters. Self-evaluation can also play an important role: by letting students know what material is expected of them, we can discourage students from applying to degrees beyond their current reach. Additionally, do-at-home entrance exams provide both applicants and institutions with an accurate evaluation while not preventing students from poor countries from applying, albeit at a higher administrative cost for the department.

Evaluation is important in the early stages of the degree. The PIMS universities have the following systems in place:

University	Type of Exam	Time-line (condition)
U of Vic	Qualifying exam	18 months
U of A	Stat entrance exam, core courses	10 days (no fail)
UBC	Entrance exam	2 years (no fail)
U of S	Qualifying exam	12 month
U of T	Comprehensive exam	1 year
U of C	Preliminary exam	1 year

4.2 Skills they learn

Teaching graduate students is obviously a complicated task. We provide but an overview in this section.

Each topic has its own particular set of skills. Soft skills are more universal. When students leave their program, they should have developed:

1. Communication: mathematical writing
2. A sense of mathematical taste,
3. Math outside course-work: The student should be able to study math without the direction of a classroom environment,
4. Networking: Conferences, collaboration, corporation, and
5. The ability to learn new fields.

This can be summarized as the "three Cs": C^3 = competence, criticism, creativity:

Competence	Become an expert in something Responsible for program Ethical standards Be resourceful and ready beyond course material Learn to read papers Know how to get help Learn computer skills, software, latex TA skills Communicating research How to apply for grants/scholarships
Criticism	Self criticism Supervisor is not always correct Challenge ideas Æsthetics of math
Creativity	Direction by supervisor Teach to ask god questions Keep "big picture" in mind Lead by example Build confidence in their (students) own ideas Creative simplification

Some of these skills (e.g. those in the creativity category) may not be directly teachable, and discussion centered ways that we we can influence improvement in these areas.

4.3 Skills they need to find jobs

Students should be able to find a job when they leave. In addition to the skills listed above, graduates should be able to deal with complex systems, make connections between research areas, find structures, and generalize. They should have experience with committees, leadership, and teaching. Finally, it is important to know the job market (choose your supervisor and area wisely!) and have the potential to do research.

5 Recruitment Strategies and Open Houses

This discussion was led by Greg Martin and Lee Yupitun from the university of British Columbia.

5.1 How is recruitment important?

Recruitment is an important aspect to every graduate program if they are interested in attracting the best students to apply and to choose their university as the place to continue their graduate education. Collecting feedback from current graduate students is a good way to determine effective recruitment strategies and strengthen the department in general.

5.2 Why do students choose a particular university?

Most students who responded to the survey indicated that it was the faculty and areas of research that helped convince them to make their decisions. Other times, the reasons could be just personal, for instance, their spouse was offered admission there as well or it was closer to home. Another advantage is when the students already have friends attending the university and they have heard great things about it. Word of mouth is an excellent recruitment tool! Alumni and postdocs may encourage their students to apply if they had positive experiences at that university. The following key factors could also influence their decisions: financial offer, scholarships available, number of graduate courses offered, standard of living, tuition and university ranking.

5.3 Recruitment Strategies

1. Create a poster, postcards, or brochures for faculty or students to bring with them when they travel to conferences.
2. Faculty connections with other universities can help connect and encourage applicants from abroad to apply.
3. Reduce or waive the application fee for students from third world countries so that its more affordable for them to apply.
4. Host an open house for prospective students, especially those who have been offered admission but havent decided where to pursue graduate school.
5. Enhance your graduate website so that its easier to navigate and information is readily available for prospective students, for example, list of graduate course offerings, faculty and research pages.
6. Respond to emails promptly especially from prospective graduate students help them gather information about your program.

6 Graduate Student Self-Governance

This discussion was led by Colin Weir from the University of Calgary.

Math and stat graduate student organizations are a relatively recent phenomenon in PIMS universities. Their role in the department is often unclear and prone to change, the more so because of the high turn-over rate of graduate students. The following organizations are in place at participating universities:

University	Math-Stat GSA
UofA	GAME
UofC:	GUMS
UBC:	Math Grad Committee
UofR:	Math Actuarial Science Stats (MASS) (undergrad)
UVic:	MASCU (though much is done informally)
SFU:	MSU math student union (grad and undergrad)
ULeth:	Combined grad and undergrad organization
UofS:	TBA: still being organized
UofT:	MGSA

From the discussion, math-stat graduate student organizations (MSGSAs) were created to initiate policy change, coordinate existing events, help organize academic events, and for community outreach. MSGSAs can help the department:

1. as part of the recruitment strategy (e.g. UBC),
2. by providing a point-of-contact between administration and students,
3. by running various programs (e.g. graduate colloquia, graduate-level conferences, and mentoring new students),
4. by providing access to funds for graduate student activities,
5. by acting as a framework for providing graduate student representatives for other university committees, and
6. by highlighting the importance of graduate students in the department.

In addition to the problem of graduate-student turnover, MSGSAs face a variety of challenges. The student body is often not involved in the MSGSA (which is sometimes seen as a clique), increasing the workload for those that do participate and leading to burnout. This can be overcome by having a clear mandate, and advertising what the organization does. Notably, participation by stats grad students is often very minimal - perhaps because stats degrees are often industry-oriented, though the connection is not entirely clear.

7 Graduate Students as Instructors

This discussion was led by Raj Srinivasan from the University of Saskatchewan.

The natural progression is to first grade written work, then TA, and then lecture courses. Grading and TAing are important sources of funding for graduate students. A typical workload is 12 to 15 hours a week, often including exam grading. Training is often simply a pep talk at the beginning of term and occasional university-wide teaching seminars.

Should graduate students lecture? Lecturing is generally limited to students in the later years of their PhD program (UBC allows master's students to teach as well), often following university regulations. Grad students usually teach first or second year courses, often under the supervision of a mentor and/or with formal training. The results are generally positive. However, there are a variety of issues associated with graduate students lecturing:

1. Monetary:
   (a) Graduate students compete for teaching positions with sessional and post-docs, which may have first right of refusal.
   (b) Funding structures may prevent graduate students from teaching, e.g. if there are different costs for grad students or sessionals lecturing, or if graduate students cannot be paid from the sessional budget.

2. Philosophical:

   (a) First-year classes can be large and difficult to teach; smaller classes are better (but more expensive). Summer courses are a good option.

   (b) Grad school has a heavy workload: post-docs might be a more appropriate time to learn to teach.

   (c) On the other hand, teaching experience is important when applying to academic positions, even post-docs.

   (d) Teaching during grad school helps students decide if teaching is something they would like to pursue later in their career.

Whether students are to TA or lecture, training is important. UVic has a faculty position for graduate-student mentoring, which provides subject-specific training. Other solutions are teaching seminars (there was some discussion as to their effectiveness) and TA accreditation programs, as in UBC.

The consensus reached after this discussion was that graduate students should teach, keeping in mind that this not greviously interfere with their thesis- and course-work.

8 Inter-University Teaching Collaboration on Hot Topics

Universities in the Netherlands have a unique opportunity: the universities are so closely situated that it is feasible for students to attend classes at different universities each day. This allows special topics to be taught at one place to students from all the universities nearby.

The situation is quite different in western Canada, where commuting between universities isn't an option. However, technology is in-place in many PIMS universities to collaborate over the Internet using virtual-classroom technology and PIMS has already expressed interest in supporting such collaboration. The number-theory group at the UofA and the UofC are already using this for seminars; it is a natural extension to use this for classes as well. The facilities in place are:

Faculties	
U of SK	
U of C	Already used by number theory
U of R	Too small
U of Leth	
SFU	Coast to coast
U of A	Already used by number theory
U of BC	Being built

Thanks to the Western Deans Agreement, it is relatively straightforward to include such courses on a student's transcript. In terms of teaching, it needs to be decided how this will counted in the professor's teaching load, particularly if the class is team-taught by two professors at different universities.

The advantage of inter-university collaboration is that one is able to offer high-level classes which would otherwise not run due to lack of enrollment. Exactly which topics could be taught in what areas remains to be decided. A pilot project has been proposed as an action item (section 10.4).

9 Outcomes for Graduate Students

This discussion was led by Jochen Kuttler the University of Alberta and David Kohler from the University of British Columbia.

Where do students go after graduating? UofC, UVic, and UBC all have some data, but outcomes are generally unknown. The AMS collects data on employment; the CMS and PIMS do not, though NSERC has data on those students they funded during grad school. It was decided that we should gather more data on where students go after they graduate (section 10.1).

Employment in mathematics is heavily dependent on the field, university, and supervisor. Unpopular fields (even if still worthwhile) often won't lead to academic jobs, unless students switch fields and/or are

extremely good. There was a generally reported administrative push to increase the size of the graduate program - this may be harmful, if there number of graduates is more than the job market can absorb. Knowing more about the job market for graduates would help us determine the correct course of action. The situations is quite different in stats, where there is a very good, industry-driven job market. PhDs are accordingly rare, which reduces competition for academic positions.

Four important outcomes were discussed:

1. Academic Track. Each professor produces more PhDs than are needed for replacement, and, despite a predicted "huge retirement wave", academic positions remain difficult to get. The post-doc system creates a difficult work environment, particularly for those wishing to start a family. In the last five hiring attempts at the UofA, no PhDs from Canadian universities were hired.

2. Industrial. One though was to orient masters programs towards industry. Noted employers mentioned were Google and NIST.

3. Educational. In contrast to the academic track, colleges and smaller universities hire mainly PhDs from Canadian universities. There is an increased demand for PhDs in math from recently university-accredited institutions.

4. The Love of Mathematics. It is important to mention this as a separate item: even if graduates end up working in a field other than what they studied, attaining a PhD in math or stats can be an end in itself.

10 Wrap-up and Action Items

The many interesting discussions we had over the course of the workshop will have an effect on our universities only if we act on them when we return. This report is the first step of that. This section also describes action-items we wish to see implemented.

10.1 Gather more data on student outcomes

It was noted in section 9 that we have very little data on where graduate students go after they graduate. This action item describes how we would like to rectify this.

For purposes of simplicity, it was decided to collect data on students who were graduated with a PhD in the last 10 to 15 years. They can be reached via their former supervisors (included perhaps in their annual report). The questions that we would like answered are:

1. Where are they now?

2. What job do they have? What path led them there?

3. What is the student's background? (Gender, citizenship, education.)

At the departmental level, we would like to know the immediate outcome for PhD students after they graduate.

David Kohler agreed to make the template for this survey.

10.2 Sample Exams for PIMS Universities

In section 4.1 it was suggested that sample exams be made available to students who are thinking of applying to grad school.

Thomas Hillen agreed to get sample exams and put them on the PIMS webpage so that all PIMS universities can use these in their application process. Thomas also agreed to start a project whose aim is to standardize the expectation for incoming students between PIMS universities.

10.3 Creation of a PIMS-level GSA

The idea was put forward during an informal discussion that we create a graduate student organization within PIMS. The mandate for this organization would be:

1. to organize the young researcher's conference in mathematics and statistics,
2. to organize future round-table meetings on graduate education,
3. to help organize shared graduate-level courses,
4. and to represent graduate students to PIMS by having a (non-voting) graduate representative on the PIMS board.

The PIMS GSA was thought to be a fairly flexible organization (perhaps as simple opting-in to a mailing list), and can be run via the PIMS offices in each participating university. Since graduate students are not able to travel extensively, the creation of a regional body was suggested as a more workable alternative to existing national organizations.

David Kohler, Colin Weir, and Cody Holder agreed to act on this item.

10.4 Inter-University Courses on Hot Topics

In section 8, we discussed teaching using WestGrid collaboration facilities. These are already in use for number-theory seminars between the UofA and the UofC.

Thomas Hillen agreed to collect ideas for what course to run for the winter term. He will send an email to round-table participants as a proposal. The immediate goal is to find people who are willing participate and start a pilot project to determine the effectiveness of the idea.

10.5 Future Round-Table Meetings

Follow-up is important if we want our ideas to have an effect. There was discussion about making the round-table an annual or biannual event. This item is part of the mandate of the PIMS GSA.

11 Conclusion

I would like to take this opportunity to thank the participants of this workshop for their time, ideas, and willingness to listen - this is particularly important for mathematicians; if you ask n mathematicians for their opinions, you can get up to $\aleph_n$ answers! I would also like to thank Thomas Hillen and Tara Schuetz for their help in organizing this workshop, and BIRS for their on-going support for not only this workshop, but the mathematics community in general. The research station is a unique institution, without which this and many other important workshops would not take place.

The workshop provided time for us to discuss an activity on which we expend a great deal of energy, but rarely have time to think about, and the more philosophical discussions were not included in this report not because they are unimportant. However, this round-table will be a success only if it influences how we run our graduate programs; follow-up is the most important part. I look forward to seeing the participants at future workshops.