

Building bridges to broaden and deepen representation

Federico Ardila M.

AMS Committee on Education
Washington DC, October 30, 2015

Axioms.

- Mathematical talent is uniformly distributed, irrespective of geographic, demographic, and economic boundaries.
 - Growing and harvesting it is the right/smart thing to do.
- Everyone can have meaningful and rewarding mathematical experiences.
 - Mathematics needs users, fans, and ambassadors.

Familia:



- > 200 students, 2 groups with many similarities + differences:
 - 60% are Colombian undergraduates
 - 40% are SFSU undergrad/master's students
(30% underrepresented minorities, 50% women)
 - a handful are Berkeley Ph.D. students

SFSU-Colombia Combinatorics Initiative.

San Francisco State University

(urban, public university - undergraduate and Master's)
("minority majority campus", > 50% 1st gen. college students)

very diverse group of students, strong student research

- very strong combinatorics group
- integration of research, teaching, and service

Universidad de Los Andes (Bogotá, Colombia)

(elite, private technical university - mostly undergraduate)
(homogeneous student population by Colombian standards)

very strong group of students, little student research

- no combinatorics tradition
- a very young country in terms of mathematical research

(Two unlikely partners. Who helps whom?)

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De donde vengo yo... (or, "Why Colombia/SFSU"?)



Bogotá, 1985

De donde vengo yo...

The math community I grew up with:



Bogotá, 1990s

De donde vengo yo...



MIT, 1995

De donde vengo yo...



MIT, early 2000s

US Latinos / foreign Latinos:

"The distinction is critical because foreign Latinos do not have the same life experiences that we domestic Latinos have had. They did not experience [...] being told our kind can't do this or do that, or that we won't make it." (Prof. Richard Tapia, Rice U.)

Prehistory

2003: [Universidad de Los Andes](#)

- **very strong** students
- no combinatorics tradition
- taught Enumerative Combinatorics
- began advising 2 undergraduate theses

2006: [San Francisco State University](#) (California)

- preparing to teach my first graduate class

2006: Felipe Rincón's Los Andes combinatorics course

Prehistory

2003: [Universidad de Los Andes](#)

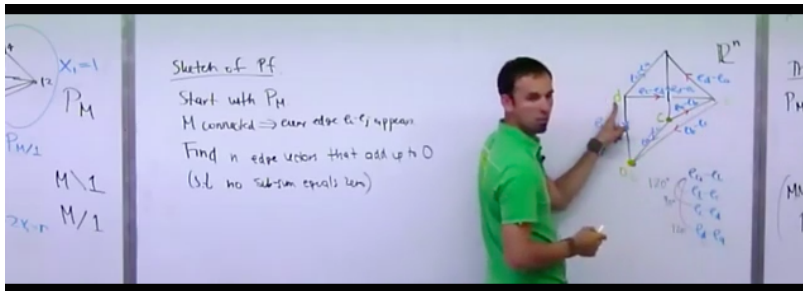
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2007: SFSU / Los Andes joint course: Matroid Theory



- taught in SF, broadcast to Los Andes
- DIY video technology, pioneered by ice skaters
- pre-MOOCs, this felt like a wild experiment

2007: SFSU / Los Andes joint course: Matroid Theory

Some general principles:

- deep material, accessible to all
- very high standards, very strong support
- no exams: place emphasis on depth, not speed
- very challenging, interesting, inspiring homework
- share student solutions and discussions online



HOPF ALGEBRAS
AND COMBINATORICS

To end the semester . . .

I just wanted to share this picture. (I took this picture earlier last week at Rosamunde in San Francisco.) Happy end of semester to everyone. Cheers!

May 19, 2012 / 2 comments

Class Notes

Hello everyone, I TeX'd up a bunch of notes from the lectures and lecture notes and thought others might be interested in getting a copy of them. Use with caution – these notes are not complete and there may be

May 15, 2012 / 5 comments

Hopfication sensation across the nation

We have said that non-finite dimensional Hopf algebras may not have a linear dual, but that if they are graded we can fake it with a graded dual. For the non-graded case, how much information is lost if we define

May 11, 2012 / 9 comments

group of characters

In our lecture notes, it says that the group of characters of a hopf algebra is the set of algebra maps from H to k . The operation of this group is the convolution product which is related to the algebra's coproduct. Do the

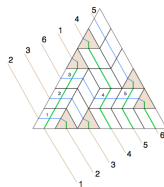
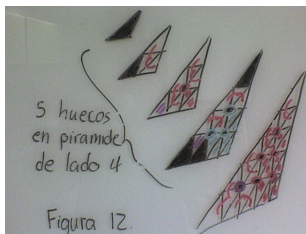
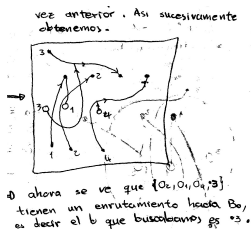
May 6, 2012 / 3 comments

2007: SFSU / Los Andes joint course: Matroid Theory

A key feature:

Research projects

- in pairs, mostly international
- encourage agency, collaboration
- projects led to 8 undergraduate/Master's/Ph.D. theses
- 4 of the 11 projects led to journal papers (3 international)



$p = (4, 2, 3, 5, 6, 6)$. We have $u = 236145 =$
 \cdot . In the other direction we have $q =$
 $\cdot s_4(s_5) = (11)(22)(33)(4321)(54)(65)$.

2007: SFSU / Los Andes joint course: Matroid Theory

The 22 students:



PhDs (14): Berkeley (4), Berlin, Binghamton, Chicago, Cornell, Duke, Lyon, Missouri, Stanford, Tokyo, York.

Math Postdocs (12): Duke, Fields, Harvey Mudd, Los Andes, Michigan State, North Carolina State, Oslo, Texas A+M, UI Urbana Champaign, Vienna, Warwick, York.

Math Faculty (6): New Mexico State, Queen Mary London, San Francisco State, Sonoma State (2), U San Diego.

Teaching, Industry, and Government: HS and CC teaching, economics, technology, urban planning, music, baseball, ...

2007: SFSU / Los Andes joint course: Matroid Theory

A main, explicit goal: **Building community.**



Jeffrey Doker shared a link via Federico Ardila.
about an hour ago

Out of all the math classes I've taken over the years one of them affected my life more than any of the others. Federico Ardila (who became my coauthor, dissertation advisor, and friend) started a fire in our crew of lovable eccentrics and when it was all over we had published original research and made lifelong friendships across continents. We all became mathematicians and we all loved each other and we all still do.

That class was recorded, and here it is.



Federico Ardila: Matroids

A Spring 2007 course on Matroids at SFSU and Los Andes taught by Federico Ardila. ** A lecture index is coming soon.** I have taught 5 joint courses: - Matroids (2007) - Coxeter

Observations and lessons learned.

- **Every** student did deep work, even those “weak” on paper.
Focus on what students can do, not on what they cannot do.
- Most groups were international; those were most productive.
Bridges help! Curiosity towards and accountability to strangers.
- A sense of community helped students lift each other up.
More competitive students benefitted less from this model.
- Two worldviews:
SFSU: Los Andes students are so smart and know so much!
Los Andes: SFSU students work so hard and do original work!
- Asynchronicity is far from ideal, makes class lecture-centric.
Creating a coherent shared experience takes very hard work!!!

One-time intervention → **Long-term collaboration**

Funding:

SFSU research office → NSF CAREER Grant

Activities:

- Keep offering **advanced and accessible** yearly courses.
- Advise SFSU, Los Andes, and Berkeley theses.
- Fund trips to national and international conferences.
- Facilitate electronic meetings.
- Fund research visits for a few SF and Bogotá students.
- **Encuentro Colombiano de Combinatoria.**

Encuentro Colombiano de Combinatoria. (biyearly)

- Minicourses:
 - Taught by world experts.
 - Great expositors and mentors.
 - Very current and accessible.
- Problem sessions:
 - Vertically integrated learning.
- Research talks
- Career panel.



Warm, welcoming atmosphere

Encuentro.

Students first.

Keep it small, keep it personal.

Rich social program.

40 Col. students

10 US students

(5 men, 5 women)

(mostly underrep. groups)

A few explicit goals:

- **Doing very high quality mathematics.**
- **Building community.**
- **Shifting culture.** Defining our own mathematical culture.

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Online resources.

All videos, HW, projects, lecture notes are freely available.

2012: **YouTube channel:** `federicoelmatematico`

Playlists by Federico Ardila



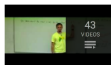
Federico Ardila: Enumerative Combinatorics



Liked videos



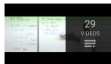
Federico Ardila: other math videos



Federico Ardila: Matroids



Federico Ardila: Coxeter Groups



Federico Ardila: Hopf Algebras and Combinatorics



Federico Ardila: Combinatorial Commutativ...



Federico Ardila: Polytopes

- 6 full courses, > 240 hours of video
- $> 10,000$ hours watched in 155 countries

Before we get too excited about this:

- Average view duration: 8:33
- Later videos have 50-100 views, mostly in US, India, Europe.
- 81% men, 19% women

I am excited about the possibilities technology offers, but **this is not the future of education**. Also, I doubt it increases equity.

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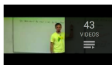
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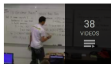
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SFSU-Colombia Combinatorics Initiative.

After 7 years:

~ 200 students

81 US students

(42 women, 24 URM)

45 Ph.D. bound

(26 women, 20 URM)

42 thesis students

29 US thesis students

(14 women, 16 URM)

25 PhD bound

(11 women, 15 URM)

4 did not finish PhD

(3 women, 0 URM)

> 20 student papers

(Duke, Advances, IMRN, JCTA,...)



I think this worked:

Community.

- Broaden + deepen representation.
- Intentional community building:
Mathemastas
(CM)², Math Circles
- Collaboration, not competition.

Constant affirmation and support.

- Listen and learn.
- Care. Show you care.
- Create a safe environment.
- Encourage introspection.
Growth mindset, impostor syndrome.

High quality mathematics.

- We need a strong, active, connected research environment.

Focus on strengths, not weaknesses.

- (Growing and harvesting) vs (selecting and weeding out).



Challenges and future projects:

Resources.

- **Funding.**

MCTP, GK-12

- **Emotional support.**

All the work falls on a few faculty members.

Emotional intelligence and cultural competence.

- Unconscious bias and discrimination.
- Impostor syndrome and stereotype threat: signaling safety.
How we talk and present things matters.
Never tell a student they cannot do something.

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math 301
midterm

name:

Please answer all questions in the blank paper, and **justify all your answers.**

1. [5 points] Take a deep breath. Slowly write "I got this!":

Back to the axioms.

- Mathematical talent is uniformly distributed, irrespective of geographic, demographic, and economic boundaries.
- Everyone can have meaningful and rewarding mathematical experiences.

Thank you very much.

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