

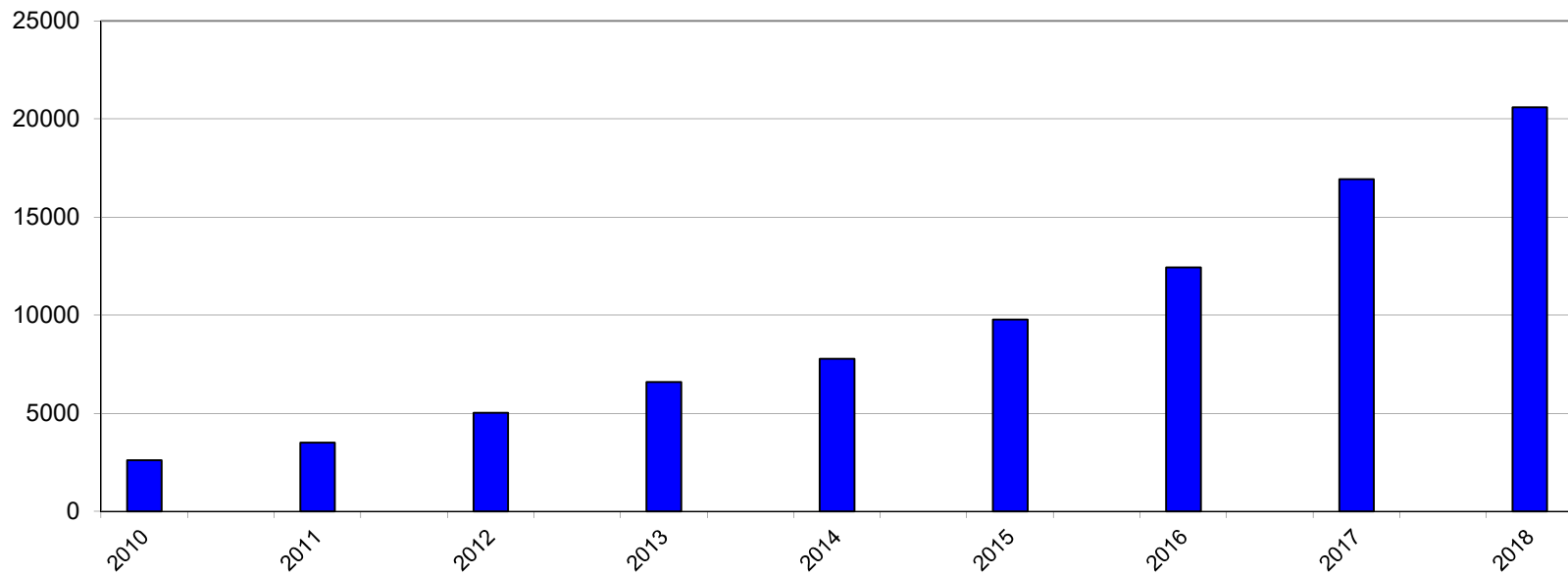
Jack Dieckmann, PhD  
Director of Research  
Stanford University, youcubed,

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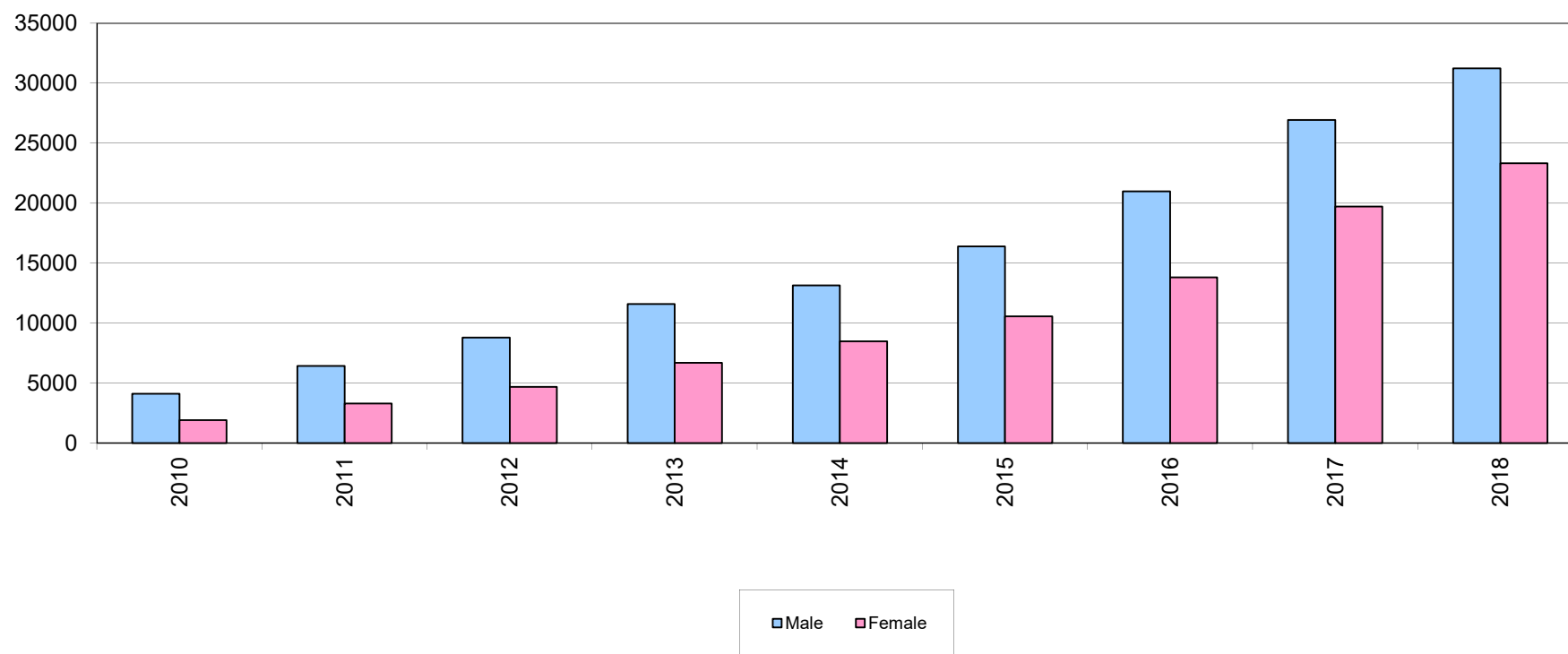
Study of Gender  
Equity in a Collegiate  
Mathematics  
Competition



**Total MCM/ICM Teams**



### Male vs. Female Students



<b>2018</b>	<b>Total Male</b>	<b>Total Female</b>	<b>Total Participants</b>
<b>Total Teams 20602</b>	<b>31245</b>	<b>23344</b>	<b>54589</b>
	<b>57%</b>	<b>43%</b>	

# Stanford Research Study: Methods



## What factors account for the high participation of women?

- Interviews university math faculty (n = 8)
- Surveys university math faculty (n = 59) 20 US universities
- Study of competition, 2 teams, 42 hours of observation
- Interviews with 2 teams
- Online survey 2018 competition participants (n=1,327, 10 countries)



# Results Part 1:

A Case Study of the Competition

# Location



Team



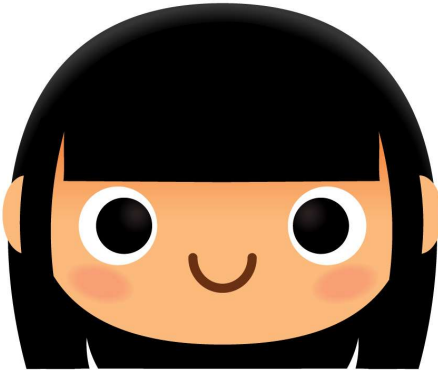
Samuel



# Team



Samuel

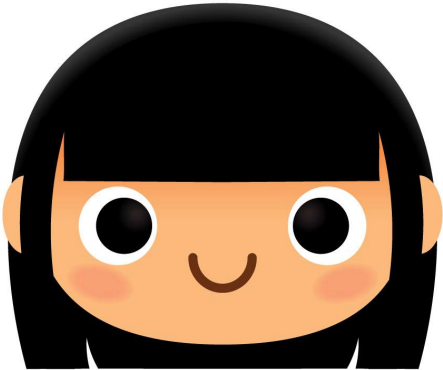


Monique

# Team



Samuel



Monique



Frank

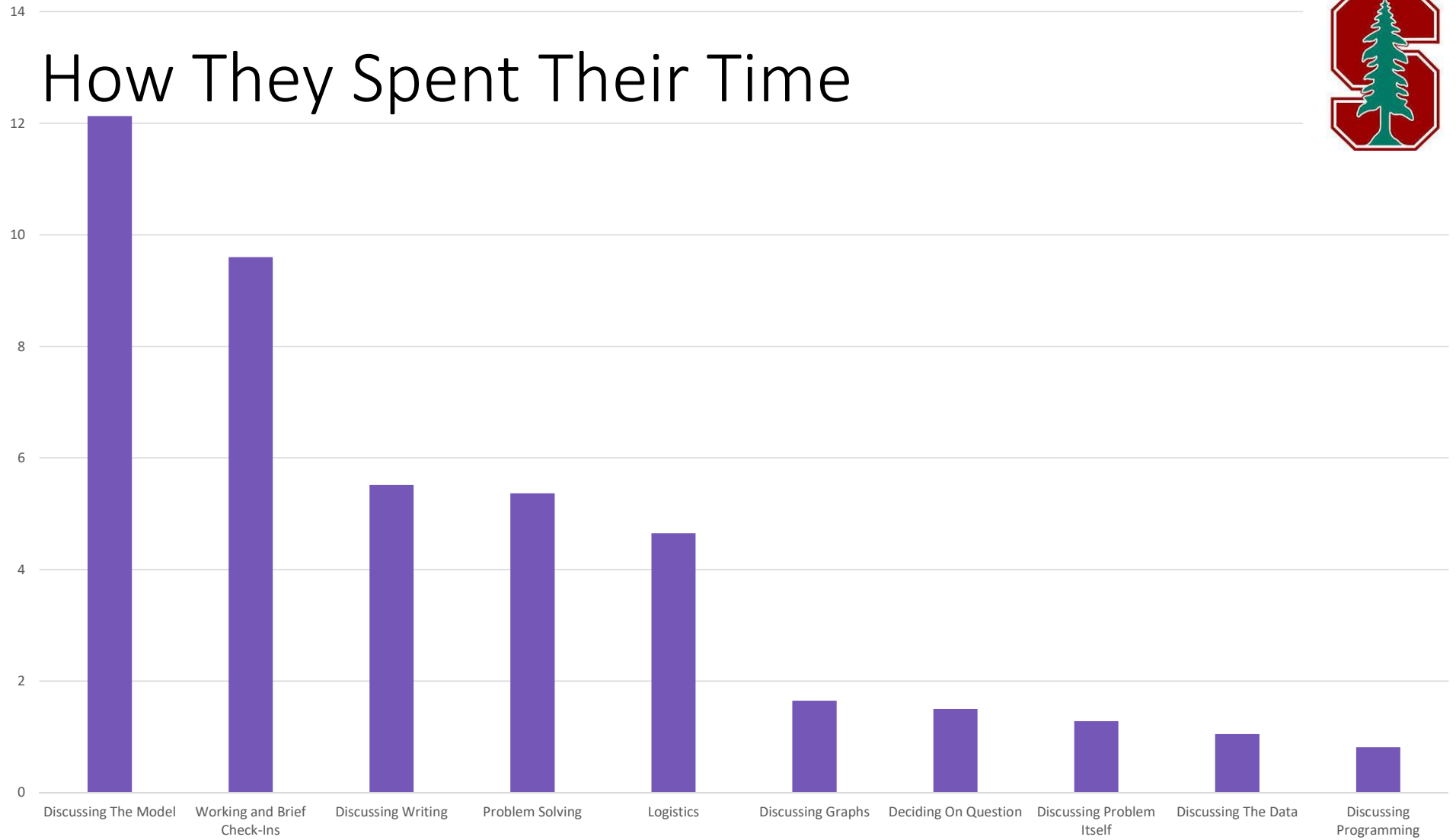
# Problem C: Energy Production

	A	B	C	D
1	<b>MSN</b>	<b>StateCode</b>	<b>Year</b>	<b>Data</b>
2	ABICB	AZ	1960	0
3	ABICB	AZ	1961	0
4	ABICB	AZ	1962	0
5	ABICB	AZ	1963	0
6	ABICB	AZ	1964	0
7	ABICB	AZ	1965	0
8	ABICB	AZ	1966	0
9	ABICB	AZ	1967	0
10	ABICB	AZ	1968	0
11	ABICB	AZ	1969	0
12	ABICB	AZ	1970	0
13	ABICB	AZ	1971	0
14	ABICB	AZ	1972	0
15	ABICB	AZ	1973	0
16	ABICB	AZ	1974	0
17	ABICB	AZ	1975	0
18	ABICB	AZ	1976	0
19	ABICB	AZ	1977	0
20	ABICB	AZ	1978	0
21	ABICB	AZ	1979	0
22	ABICB	AZ	1980	0
23	ABICB	AZ	1981	1.2888
24	ABICB	AZ	1982	1.97998
25	ABICB	AZ	1983	0
26	ABICB	AZ	1984	0
27	ABICB	AZ	1985	0





# How They Spent Their Time



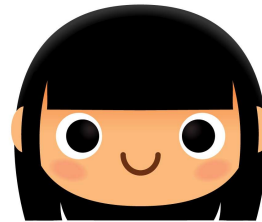
# Reactions



I thought it was interesting working so long with people and looking at how far we got after the competition. It definitely exceeded my expectations. We had like a 40 page paper!

I enjoyed getting all of our ideas down. I think that was the most satisfying part, having everything come together. Having a model that we really believed in.

This is kind of how I imagined engineering would be. You kinda get to know your team, late nights eating dinner while thinking about your problem, that's super fun. I love that.





# Results Part 2:

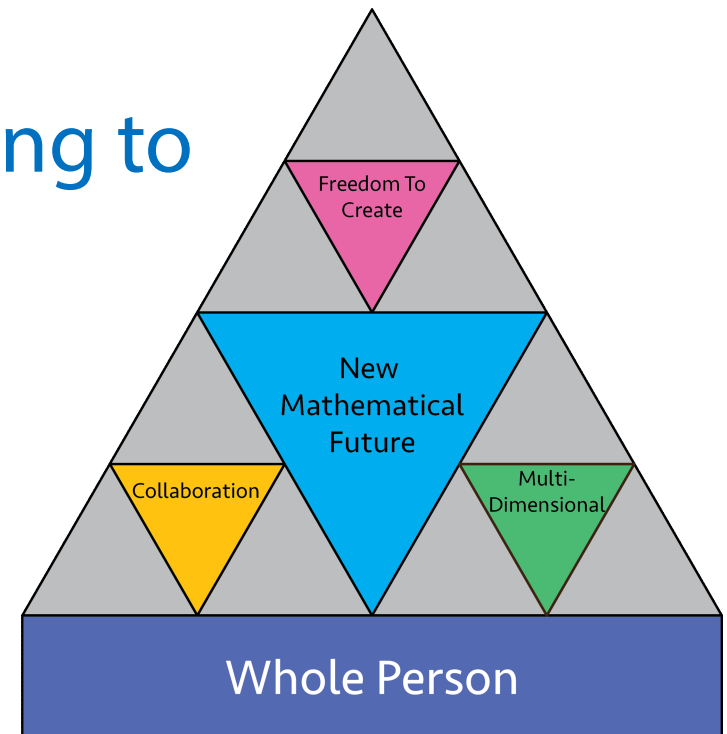
Drawing from Student Surveys and Interviews



## Student Results Part 2: What did students most value?

Why is the competition appealing to women?

Analysis of interviews, surveys, observations produced 3 themes.





## Why did students enter the competition?

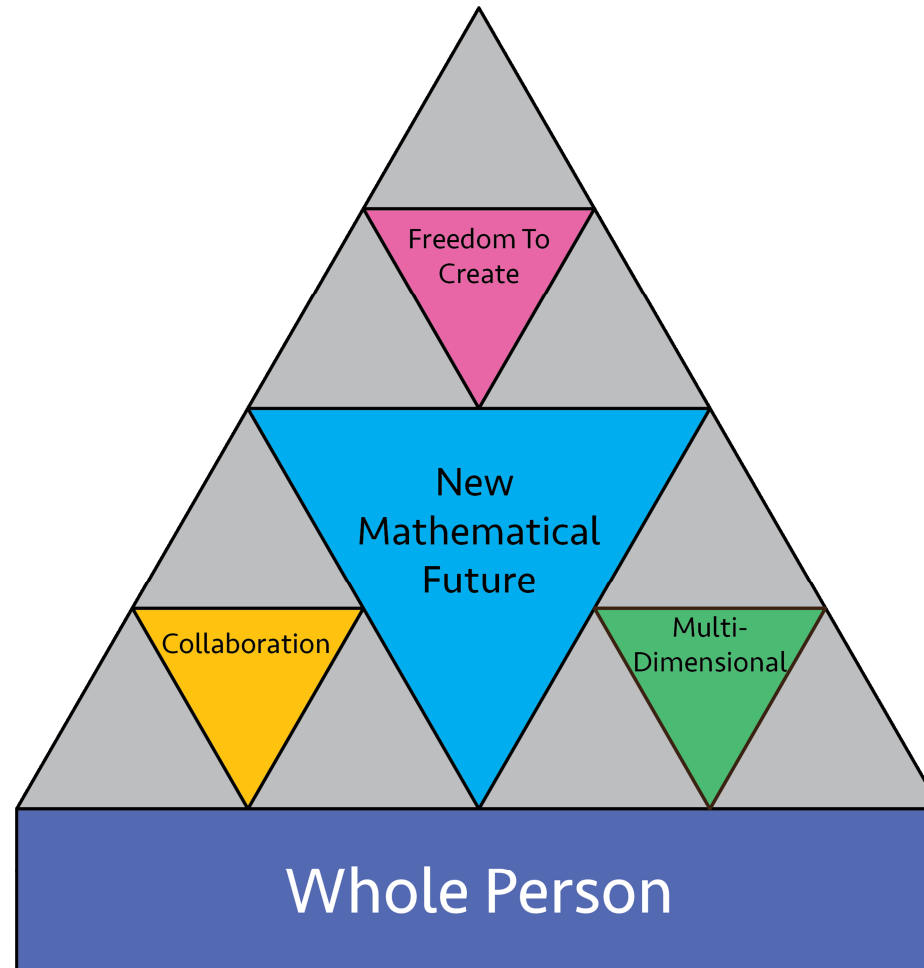
- A word cloud of results from student interviews



It engaged the students as whole people

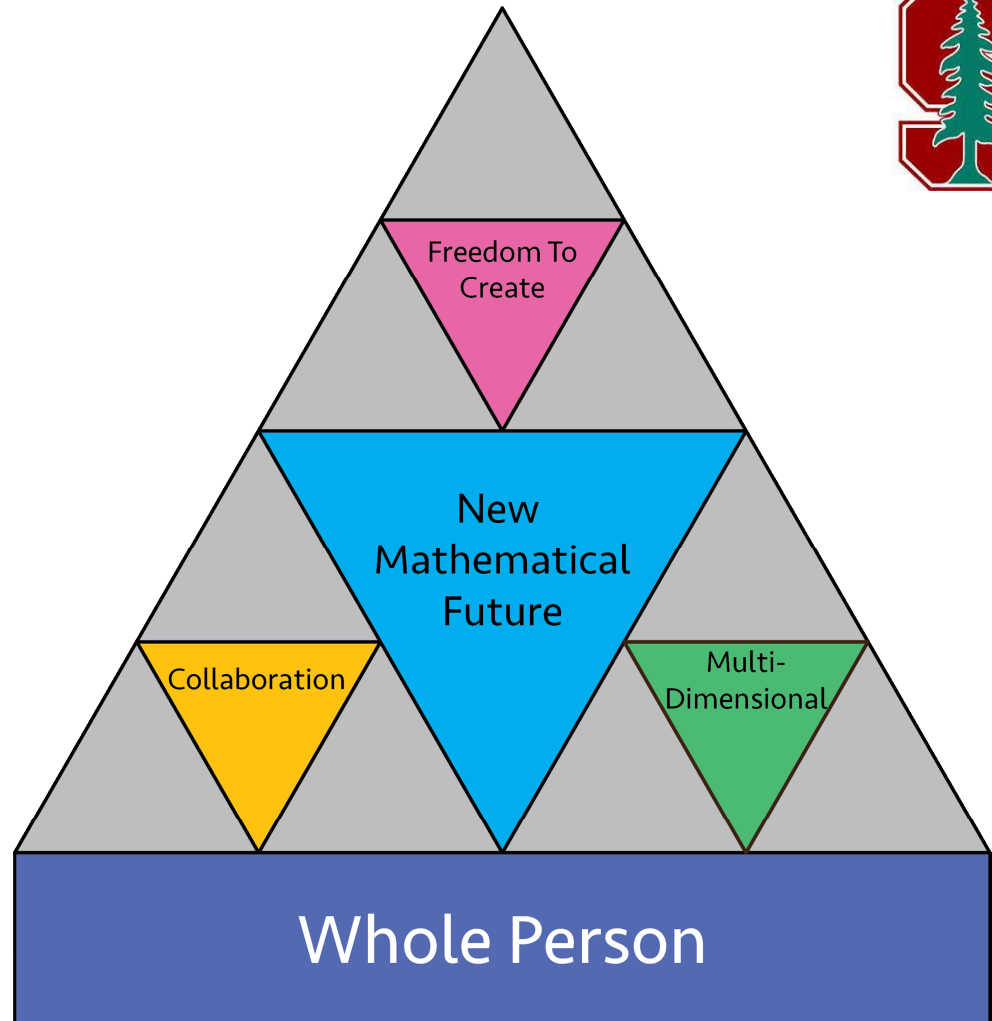


What factors account for the high participation of women?



# Collaboration

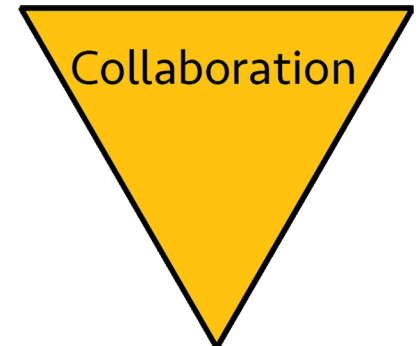
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# Collaboration

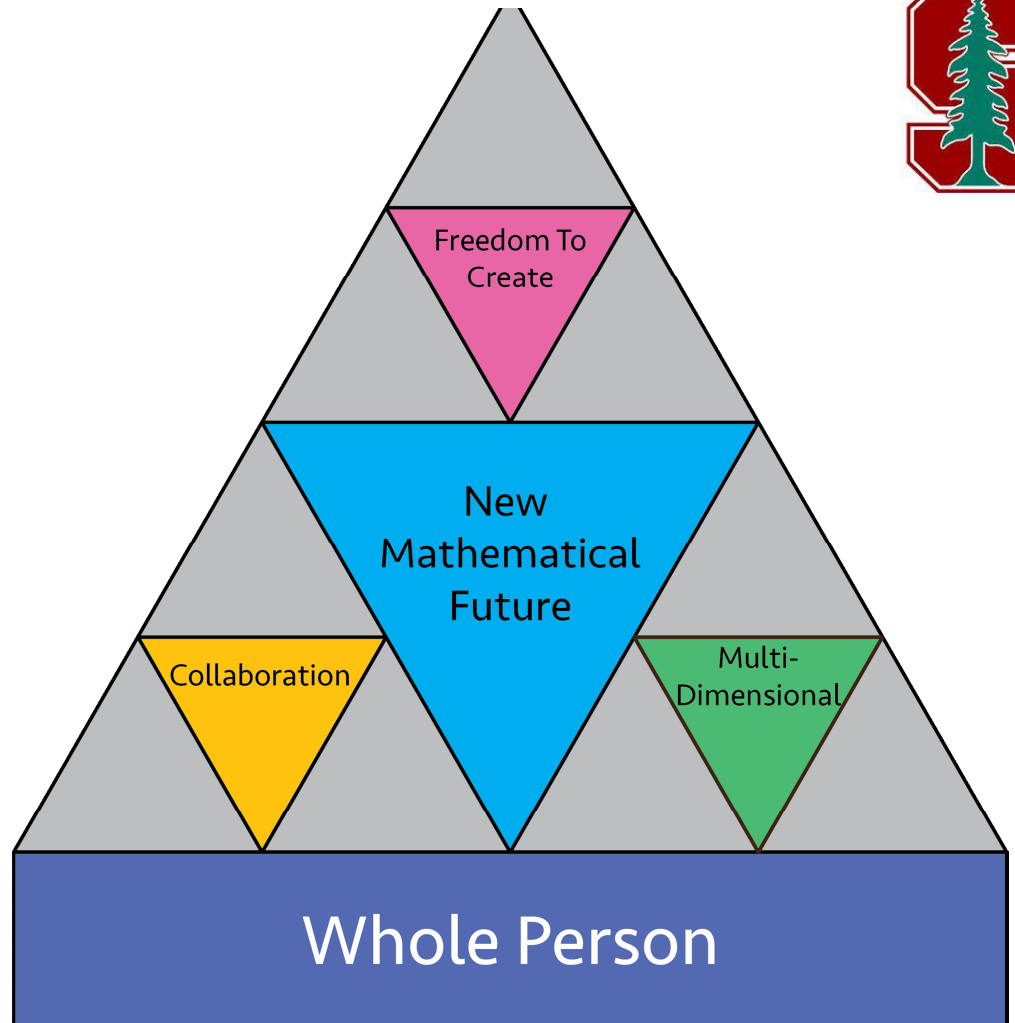
After reading a question, we'd read it three different ways or have three different approaches to the problem(...) A lot of times we'd have the whiteboard completely filled up trying to explain our views on the problem. And eventually you gotta step back and open your mind and realize, fully interpret the other people's ideas.

It involves a lot of collaborative work, allowing multiple people to have input in the solution to a problem. I'm a firm believer that better solutions are created when people work together.



# Modelling & Multi- Dimensional Mathematics

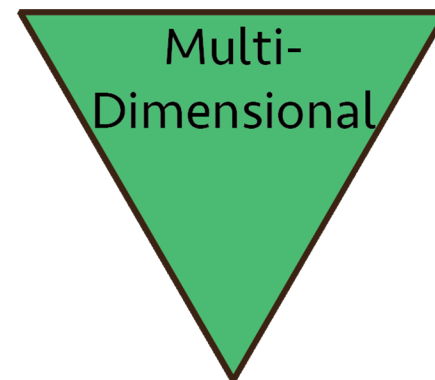
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## Multi-dimensional Mathematics & Modelling

The problems are more creative and closer to life. The competition motivates us to think more and deeply about the world we live in, which can't be achieved in other competitions.

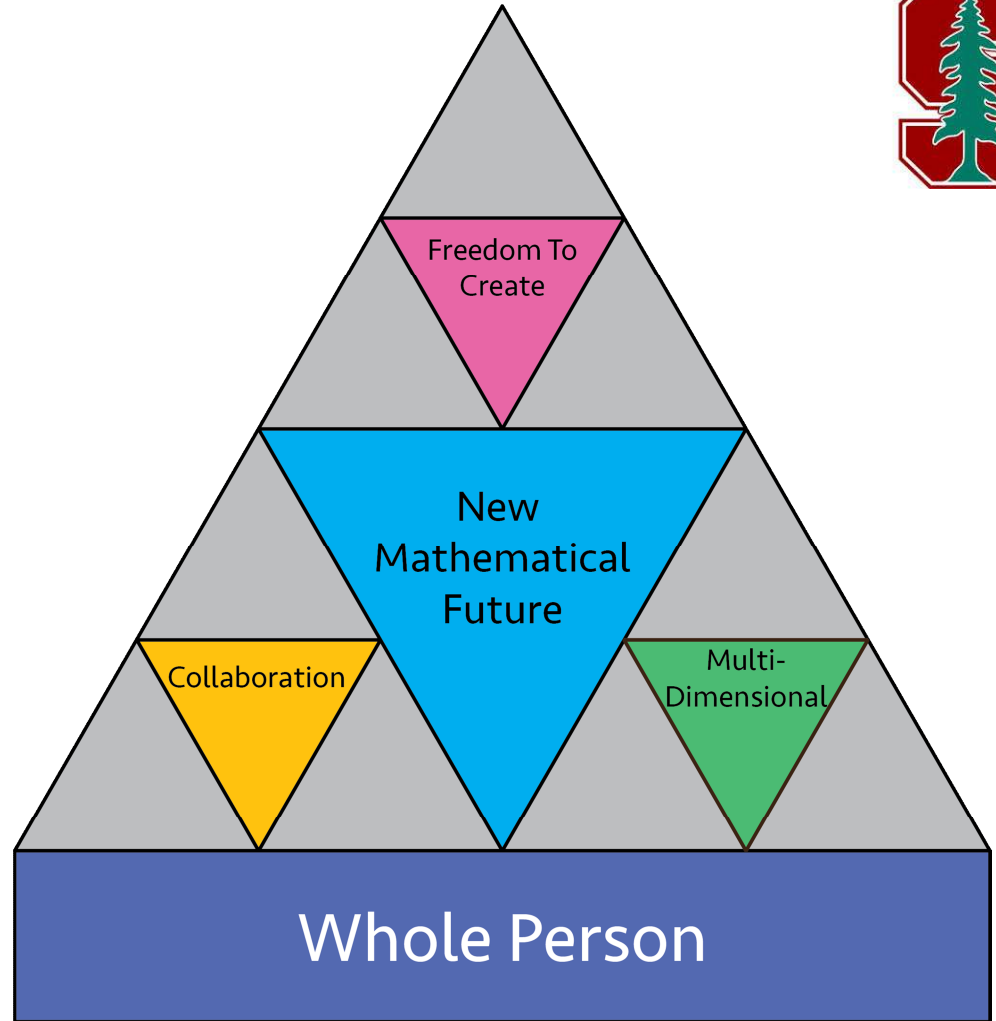
We were using knowledge from a bunch of different classes. And math classes overlap a little bit, but you don't really see the actual overlapping until you have to apply something like that.



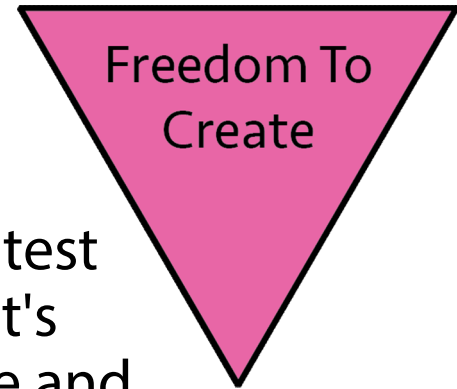


# Freedom to Create

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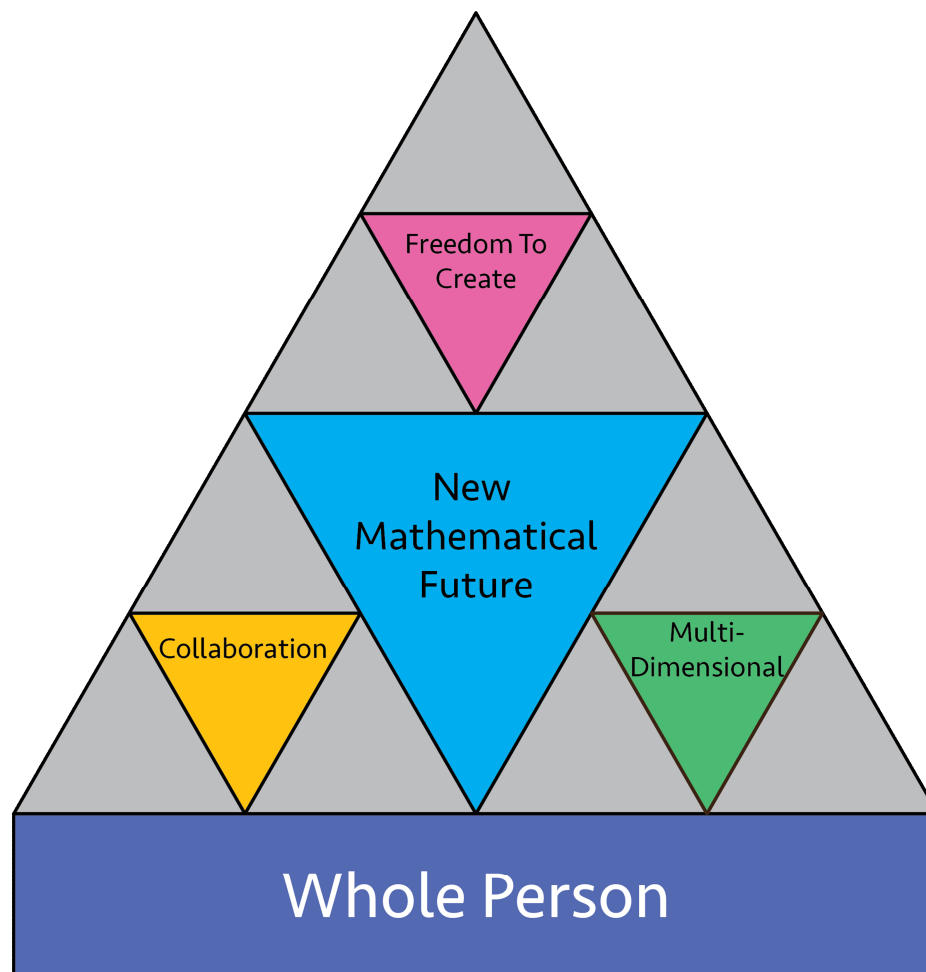


## Freedom to Create



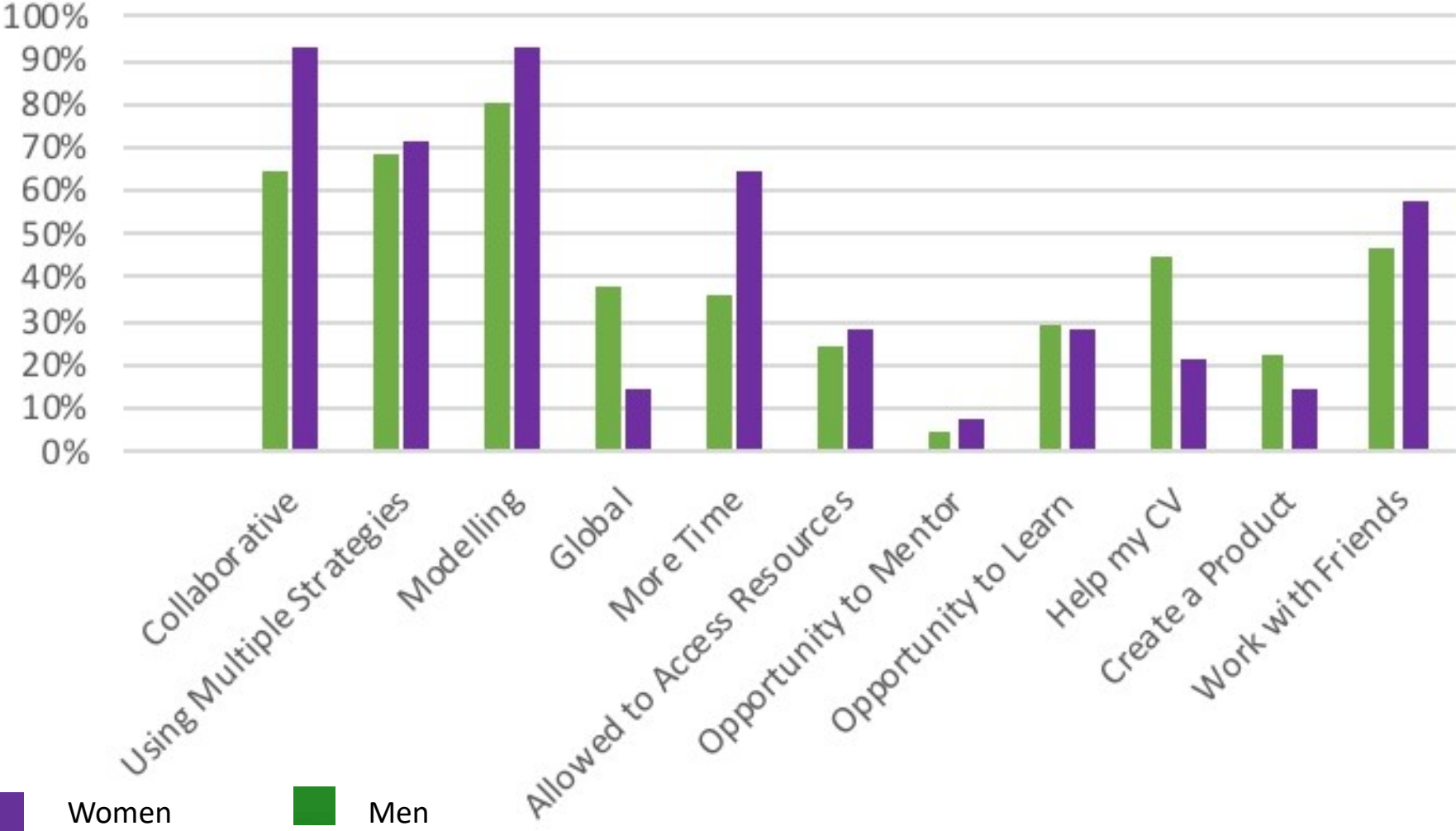
I've been a student my whole life. And so it's kind of nice to test our skills, but not being in such a harsh grading criteria. That's definitely different. It makes you think about the effort more and you're more willing to take risks, I feel.

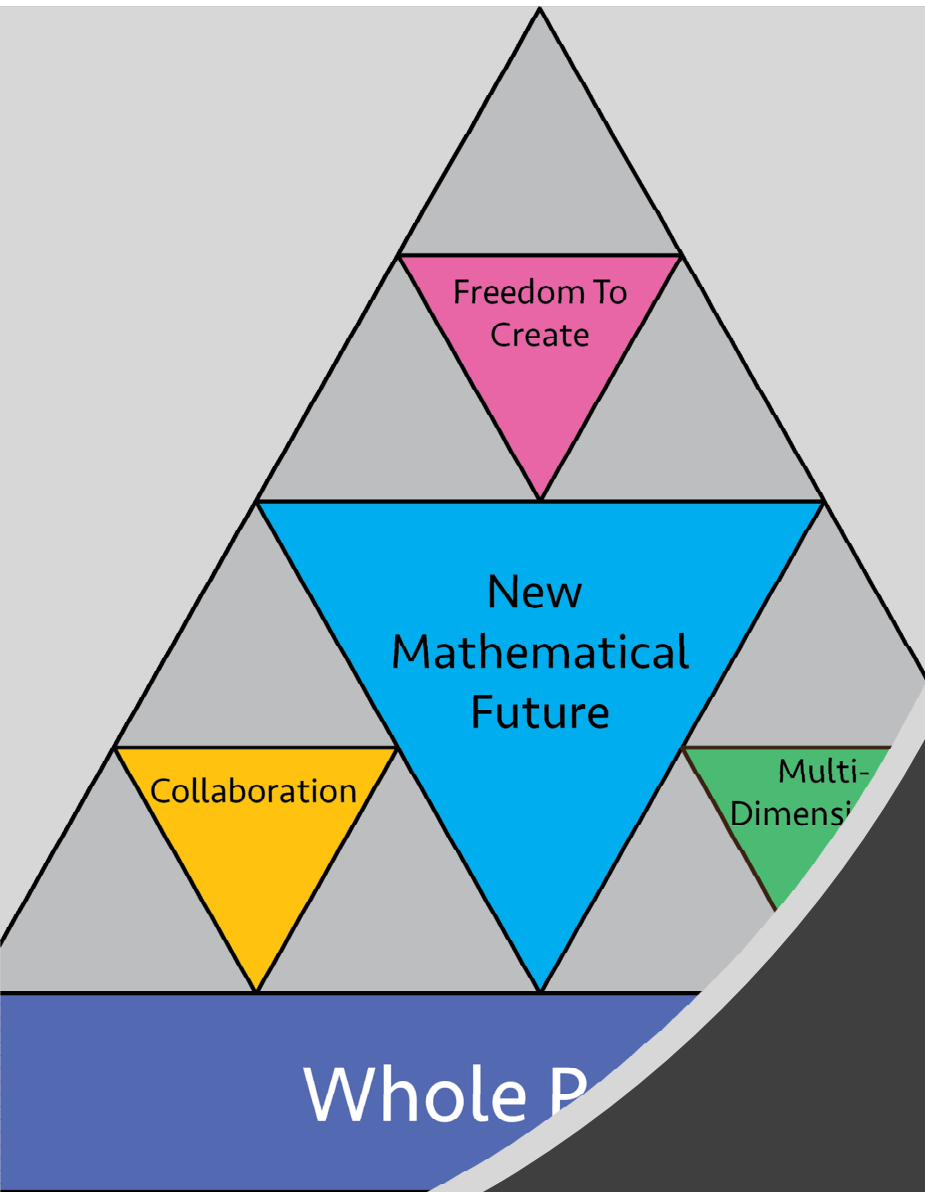
My favorite thing was definitely the feeling of using all of our resources that we've learned in our school for something that's not a test and not a graded project. But it was really interesting because we're really testing our skills that we know and that we've learned without being in that testing schedule. And that was a huge thing for me 'cause I've never done anything like that. And that was definitely, by far, the best part for me, is just getting to do those practical things. It kinda shows them what you know.





# Which aspects of the competition were particularly appealing to you? By gender





New  
Mathematical  
Future

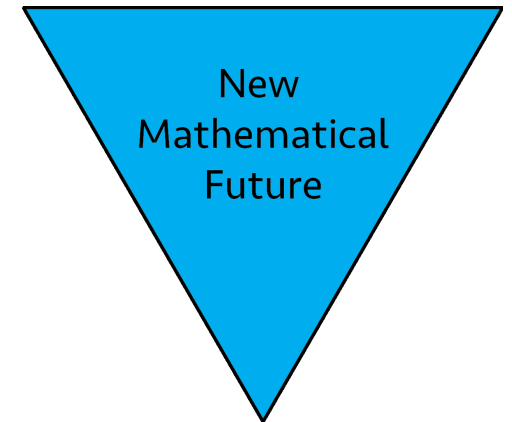


67% of students say it will change  
their future pathways (n=1327)

## New Mathematical Future

I got an unforgettable memory during those 4 days. As a student who majored in math, it's the first time I have applied the knowledge to solving problems that are so close to real life which makes me very excited!

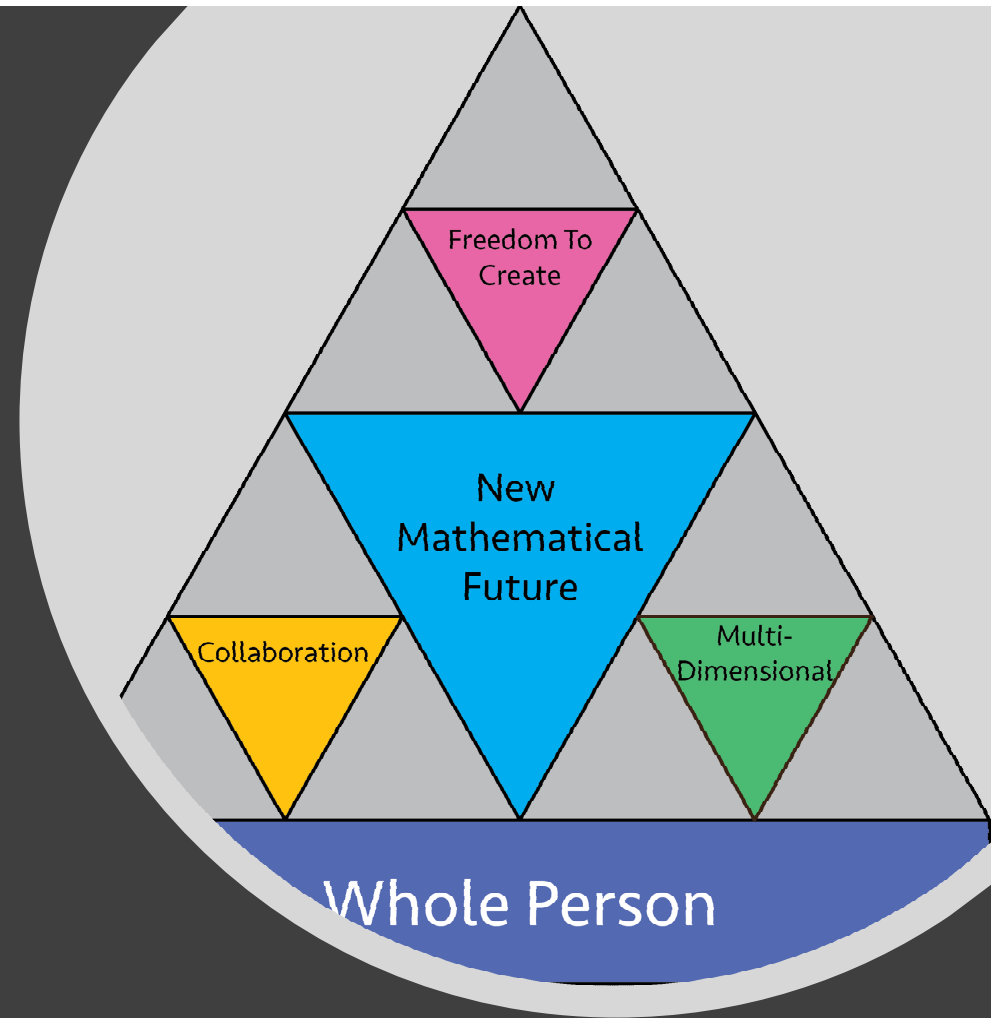
That was awesome. So going through this and putting together a paper and where I'm at now, it's just... I'm on the right track now, and I know that. It's no longer a questioning: "What am I gonna do after college?" It's I have an idea, I know that's what I wanna do, and I feel good about it.



# What do these results mean?

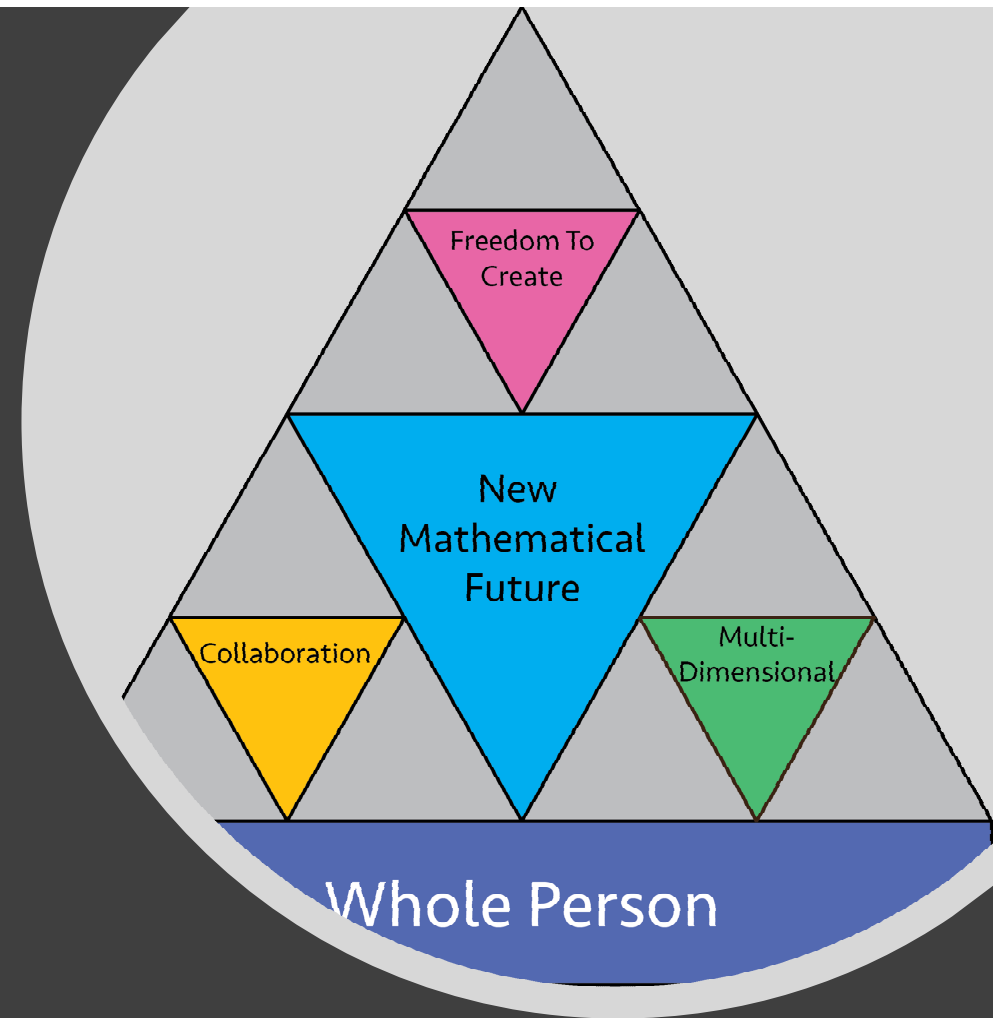
Every year the US sends a team of 6 high school students to the International Math Olympiad based on various qualification rounds.

In the past 11 years, USA has sent 0 girls to IMO



# What do these results mean?

- Students need Collaborative & Multi-dimensional Mathematics:
- This is appealing to both women and men, but particularly important for women
- Why is Collaboration so important?



# Collaboration

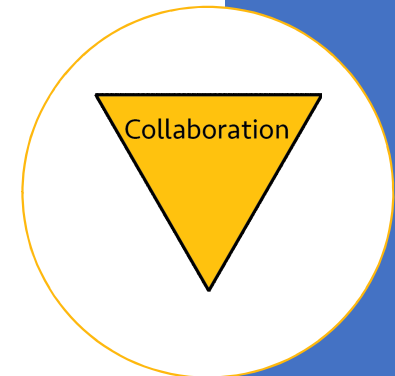


Collaboration

- In 2012 International PISA mathematics tests, boys achieved at significantly higher levels in 38 countries
- When anxiety was factored in achievement differences disappeared
- Also in 2012 PISA conducted a test of collaborative problem solving
- Students interacted with a computer agent, building upon “their” ideas and solving complex problems
- Girls achieved at significantly higher levels in all 51 countries

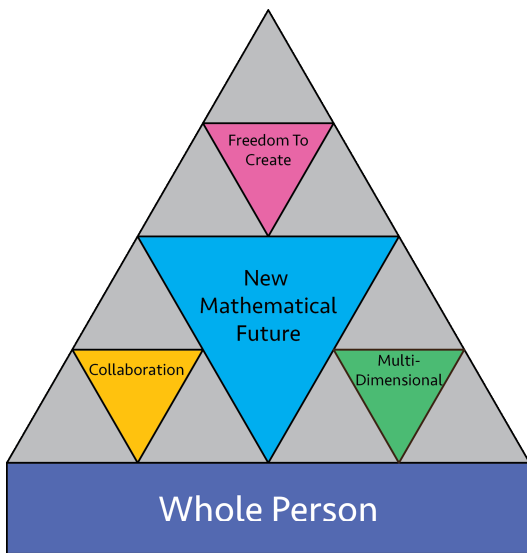
# Collaboration

- When you connect with another person's mathematical idea it both requires and encourages a higher level of understanding





## Why is this important?



- In the mathematical modelling competition 43% of participants are women, 43% of award winners are women
- Most math competitions exclude women & girls
- They offer a culture of anxiety, speed, singularity, performance pressure.
- This is not how most women want to experience mathematics
- This is also not 21<sup>st</sup> century mathematics

## Faculty comment

- MCM/ICM is a different kind of experience compared to math competitions like the Putnam. In my opinion, it is a more accurate reflection of what professional and academic mathematicians do (reading, writing, working in a team, exchanging mathematical ideas, attacking problems that are not initially well-defined, spending time on a problem instead of having a shorter time period, etc.). Among other reasons, I recommend this competition for students who want to get a taste of what math "research" is like, and I recommend it to students who want to go to industry jobs directly after graduation





# Questions and Answers

