Can New Learning Opportunities Reshape Gender Attitudes for Girls?: Field Evidence from Tanzania

So Yoon Ahn, Youjin Hahn, Semee Yoon

Presenter: Ahn (University of Illinois at Chicago)

September 23, 2021

RISE Annual Conference

Motivation

- Gender inequality is widespread in developing countries.
  - Women in many developing countries are less educated, paid less, and have less decision-making powers than men (UN Statistics Division, 2018).
  - Enrollment rates in upper secondary education are 50% higher for boys than girls (Tanzania National Bureau of Statistics 2018).

- In particular, science, technology, engineering and mathematics (STEM) education is generally lacking even though it is crucial for economic and social development (Semali and Mehta, 2012).
  - Lack of resources limits opportunities to learn "practical skills".
  - Science is perceived as hard, which discourages female students from taking science subjects.

This Research

- Do practical STEM learning programs affect gender attitudes?
  - We analyze the effects of providing 5-day STEM bootcamp for elementary/secondary school students (Standard 7 to Form 3, Age 13-16) in Tabora, Tanzania.
    - Students learned how to code and build robots.
  - We collaborate with two NGOs, Compassion International and E3empower.
    - Compassion is a leading child sponsorship organization, sponsoring more than 100,000 children in Tanzania.
    - E3empower is a local social enterprise that provides various educational programs.

How Does a STEM Education Opportunity Affect Gender Attitudes?

- Through new hands-on learning experiences in STEM
  - More self-confidence and boost interest in STEM (Nourbakhsh et al., 2005; Rogers & Portsmore, 2004).
  - Changes in their attitudes towards further education opportunities and social participation for women.
  - Labor market aspirations and perceived earnings, if skills relevant to STEM are perceived to generate a higher return in the labor market (Jensen, 2012).
- Through female role models or instructors
  - Porter and Serra, 2020 in the U.S.; Kipchumba et al, 2021 in Somalia; Riley, 2017 in Uganda; Lim and Meer, 2020 in Korea; Carrell et al, 2010 in the U.S.
    the education aspirations and gender attitudes of male and female students.
- Through peer effects
  - Interactions with opposite sex students while solving STEM problems/ exercises (Markussen & Roed, 2017; Brenoe and Zolitz, 2020)

Related Literature

- Formation of gender-related preferences
  - Dhar et al. (2020) found a strong impacts of a gender-equality education on gender attitudes among both boys and girls.
  - Du et al. (2020) showed that a Chinese compulsory education reform that increased the years of education induced more egalitarian gender role attitudes.
  - Cable television; having female role models; having teachers who hold weaker gender stereotypes (Jenson & Oster 2009; Carlana, 2020; Porter and Serra, 2019; Beaman et al., 2012)
- Effects of the use of robots to teach in education literature
  - Promotes interests in math and science careers; Promotes learning of scientific and math principles through experimentation; Encourages problem solving; Promotes cooperative learning (Nourbakhsh et al., 2005; Robinson, 2005; Rogers & Portsmore 2004; Barker & Ansorge 2007; Karaahmetoglu & Korkmaz, 2019)

Outline

- Context
  - Country background
  - Intervention
- Study design
- Results
- Conclusion

Country Background: Tanzania

- Location: East Africa
- GDP per capita: $1,172 (2019)
- Official language: Swahili and English
- Computer access: 0.04 computers per student in secondary school (2016)
- Gender inequality
  - For the gender equality index, Tanzania ranked 140th out of 189 countries in 2019 (UNDP, 2019)
  - About 21% of boys and only 16% of girls who completed lower secondary schooling joined upper secondary in 2015-2018
  - Monthly income: 166k (in TZS) females, 279k (in TZS) for males

Intervention: The STEM bootcamp

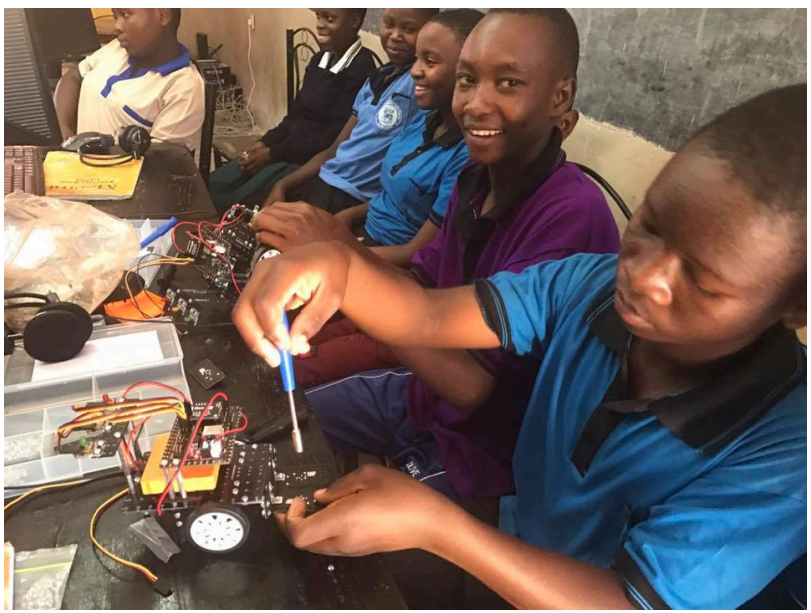
- STEM bootcamp: 5-day intensive program offered by e3empower, a local social enterprise
  - At Compassion centers in Tabora
    - GDP per capita: 19th out of 23 regions in Tanzania
  - Was offered to children who have basic math knowledge (who were finishing or completed primary school)

Intervention: The STEM boot camp (cont'd)

- Exposed students to STEM through experiential learning curriculum.
- Provided sessions to assemble robots, use basic coding to create robots, and also use coding to create a simple app.
- Each boot camp was intensively conducted from 8:30 am to 6:00 pm for 5 days.
- A total of nine boot camps were conducted on the sites of AICT Kiete (Site 1), Morvaian Chemchem (Site 2) and Anglican Isevya (Site 3) from November 12 to 30, 2018.

▸ First day schedule

Site photos



Timeline

- Baseline surveys: Nov 8 to 10, 2018
- STEM boot camp: Nov 12 to 30, 2018
- Endline surveys: Dec 2018/Jan 2019

Selection Criteria for STEM Bootcamp

- 180 students were chosen among 829 students (Std7 - Form3) in Compassion centers
- Children were randomly chosen from each Compassion center with some consideration for the class year and their attendance to the centers.
- Given some imbalances observed between participants and non-participants, we take the selection-on-observable approach under the conditional independence assumption (CIA).

Summary Statistics

	STEM		Non-STEM		Diff		Diff (w/ center FE)	
	Mean	SD	Mean	SD	Coef	SE	Coef	SE
Age	15.032	1.609	14.930	1.530	0.102	0.174	0.120	0.164
Female	0.517	0.501	0.494	0.500	0.023	0.055	0.019	0.053
Grade:								
Standard7	0.209	0.408	0.256	0.437	-0.047	0.040	-0.043	0.037
Form 1	0.339	0.475	0.350	0.478	-0.011	0.051	-0.014	0.050
Form 2	0.256	0.438	0.240	0.428	0.016	0.044	0.018	0.045
Form 3	0.196	0.398	0.153	0.361	0.042	0.057	0.038	0.050
Religion:								
Christianity	0.695	0.460	0.641	0.476	0.054	0.051	0.048	0.048
Islam	0.305	0.460	0.359	0.476	-0.054	0.051	-0.048	0.048
Household Characteristics:								
Father in household	0.591	0.453	0.594	0.449	-0.004	0.050	-0.007	0.048
Mother in household	0.830	0.363	0.816	0.369	0.014	0.036	0.014	0.035
Father years of education	9.828	3.322	9.658	3.240	0.170	0.369	0.117	0.312
Mother years of education	8.841	3.024	8.702	3.395	0.138	0.334	0.101	0.293
Piped water source	0.735	0.437	0.722	0.445	0.013	0.048	0.011	0.044
Electricity or solar energy source	0.695	0.456	0.680	0.463	0.016	0.048	0.011	0.044
Flush toilet	0.457	0.494	0.425	0.490	0.032	0.056	0.028	0.055
Number of rooms in HHs	3.147	1.520	3.134	1.465	0.014	0.134	0.015	0.131
P-value for joint test of orthogonality					0.997		0.997	
Number of observations	174		494					

Summary Statistics

	STEM		Non-STEM		Diff		Diff (w/ center FE)	
	Mean	SD	Mean	SD	Coef	SE	Coef	SE
Computer use:								
Ever used a computer at school	0.216	0.398	0.172	0.359	0.044	0.056	0.038	0.050
Hours on math and science per week	6.325	6.251	6.027	6.579	0.298	0.795	0.301	0.712
Educational goal:								
Senior secondary or below	0.041	0.193	0.058	0.227	-0.018	0.019	-0.018	0.019
Technical/ vocational	0.153	0.357	0.111	0.306	0.042	0.054	0.038	0.047
Higher education	0.806	0.390	0.830	0.365	-0.025	0.055	-0.020	0.047
Expected occupation:								
Clerical, sales and services	0.013	0.109	0.017	0.124	-0.004	0.009	-0.005	0.009
Education sector	0.128	0.331	0.137	0.332	-0.009	0.033	-0.007	0.032
Engineering/science/technology sector	0.296	0.451	0.305	0.446	-0.009	0.046	-0.011	0.047
Health and social/community work	0.088	0.281	0.090	0.277	-0.002	0.026	-0.001	0.026
Professional/ managerial (government)	0.331	0.465	0.337	0.457	-0.005	0.050	-0.001	0.046
Professional/ managerial (non-government)	0.061	0.238	0.060	0.230	0.001	0.028	-0.001	0.026
Agriculture/domestic service/manual job	0.082	0.273	0.054	0.219	0.028	0.051	0.025	0.043
P-value for joint test of orthogonality					0.997		0.997	
Number of observations	174		494					

Summary Statistics

	STEM		Non-STEM		Diff		Diff (w/ center FE)	
	Mean	SD	Mean	SD	Coef	SE	Coef	SE
Desired marriage age (male)	27.439	5.006	27.559	4.526	-0.121	0.704	-0.186	0.704
Desired marriage age (female)	28.385	3.375	27.940	4.817	0.446	0.509	0.263	0.499
Standardized gender attitudes	0.129	1.156	0.112	0.992	0.017	0.182	0.020	0.166
Standardized self-esteem index	0.130	0.922	0.054	0.970	0.076	0.102	0.071	0.097
Big 5 personality:								
Extroversion	0.053	0.916	0.023	0.970	0.030	0.090	0.020	0.089
Agreeableness	0.097	0.882	0.043	0.952	0.055	0.089	0.040	0.089
Conscientiousness	0.091	0.859	0.044	0.951	0.047	0.085	0.041	0.085
Neuroticism	0.081	0.831	0.036	0.954	0.045	0.083	0.041	0.083
Openness	0.096	0.857	0.035	0.956	0.061	0.082	0.053	0.078
P-value for joint test of orthogonality					0.997		0.997	
Number of observations	174		494					

▸ Gender attitudes ▸ Self esteem

Empirical Specification

- We use the following model to estimate the impact of the STEM program with the IPW:

$$Y_{ict} = \alpha + \beta STEM_{ic} + \delta Y_{ic,t-1} + \theta X_{ic,t-1} + \gamma_c + \epsilon_{ict} \qquad (1)$$

  where i, c, and t indicate individual students, Compassion centers, and time of the survey. $t-1$ and t indicate the time before and after the treatment.

- Y_{ict} is the outcome. The vector $X_{ic,t-1}$ comprises control variables, including all the variables in the baseline survey.

- The propensity score is estimated (probit) using these variables, and the inverse of the weight from propensity scores is applied in each regression.

The effect of STEM bootcamp on gender attitudes

	Dependent variable: Gender attitudes		
	(1)	(2)	(3)
	OLS	OLS	Inverse probability weighting
STEM	0.189**	0.183**	0.163**
	(0.079)	(0.084)	(0.077)
Control baseline gender attitudes	Yes	Yes	IPW
Control covariates	No	Yes	IPW
Control group mean	0	0	0
R-squared	0.128	0.240	
Observations	668	668	668

Note: Significance levels: * 10%, ** 5%, *** 1%.

- Comparable to Dhar et al. (2020): 20 hours discussion program on gender equality (45 minutes every 3 weeks, over 2.5 years): 0.18 std

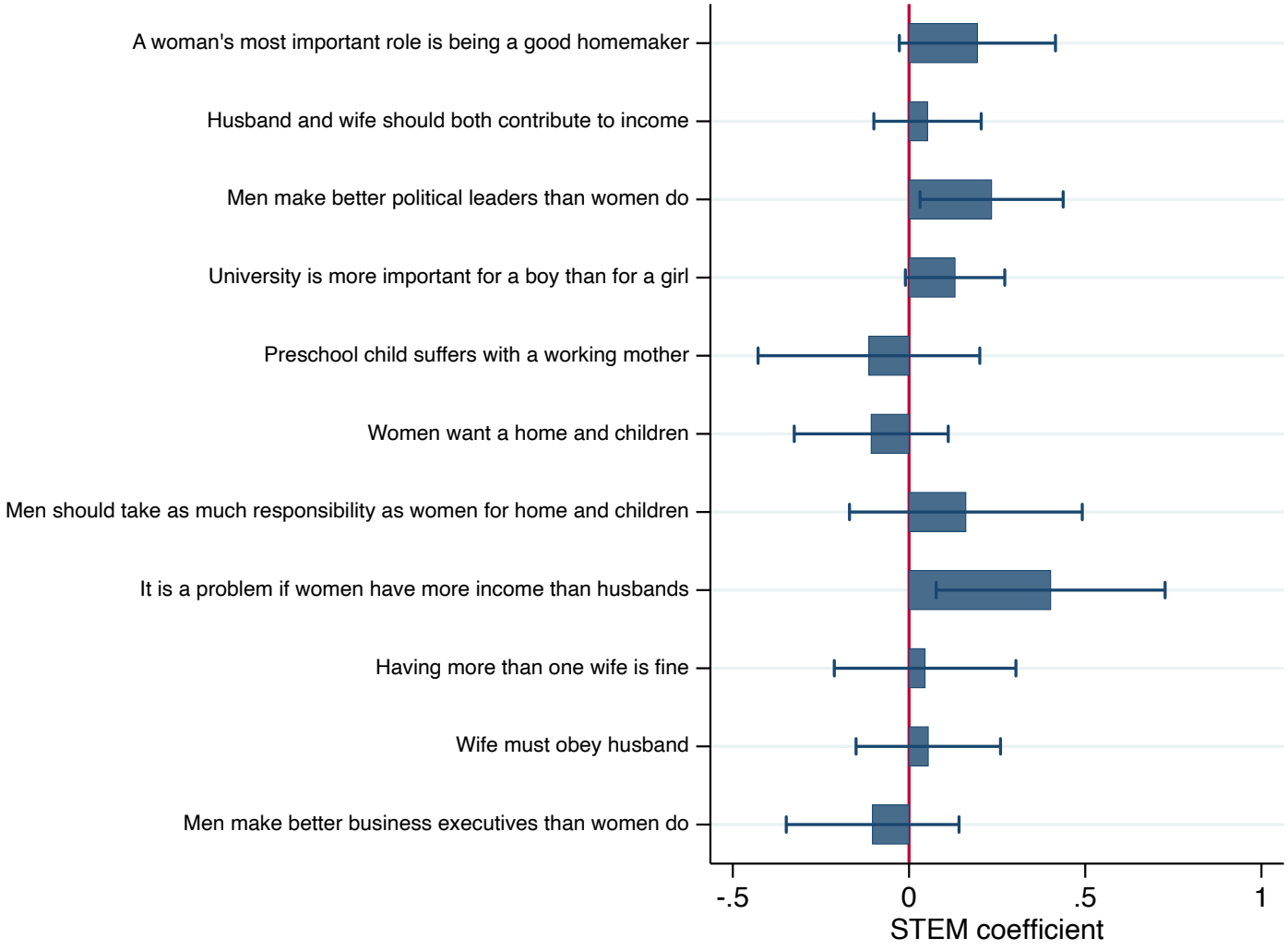
The effect of STEM bootcamp by gender

	Dependent variable: Gender attitudes	
	(1)	(2)
	Males	Females
STEM	0.035	0.294***
	(0.119)	(0.101)
Control group mean	-.211	.464
Observations	339	329

Note: Significance levels: * 10%, ** 5%, *** 1%.

- In Dhar et. al (2020), the effects on gender attitudes for boys were larger.

Girls' results on disaggregated gender attitude outcomes



- The largest impact on the traditional gender view that women should not earn more money than their husbands. Also large improvements in gender attitudes on women's role, political participation, and tertiary education opportunities.

Heterogeneous effects for girls

	Dependent variable: Gender attitudes					
	(1)	(2)	(3)	(4)	(5)	(6)
STEM	0.174	0.256*	0.144	0.297***	0.230	0.267*
	(0.129)	(0.142)	(0.183)	(0.102)	(0.161)	(0.158)
STEM × 1(Below median baseline gender attitudes)	0.194					
	(0.192)					
STEM × 1(Below median mother's education)		0.023				
		(0.194)				
STEM × 1(Below median number of rooms in the HHs)			0.209			
			(0.216)			
STEM × 1(Baseline education goal ! = higher education)				-0.015		
				(0.199)		
STEM × 1(Never used computer before)					0.086	
					(0.170)	
STEM × 1(Below median weekly study hours on math and science)						0.032
						(0.200)
p-value: STEM + STEM × 1(Below median mother's education)=0		.0353				
p-value: STEM + STEM × 1(Below median number of rooms in the HHs)=0			.0024			
p-value: STEM + STEM × 1(Never used computer before)=0					.0032	
p-value: STEM + STEM × 1(Below median weekly study hours on math and science)=0						.0156
Control mean	.464	.464	.464	.464	.464	.464
Observations	329	329	329	329	329	329

Note: Significance levels: * 10%, ** 5%, *** 1%.

Inspecting mechanisms

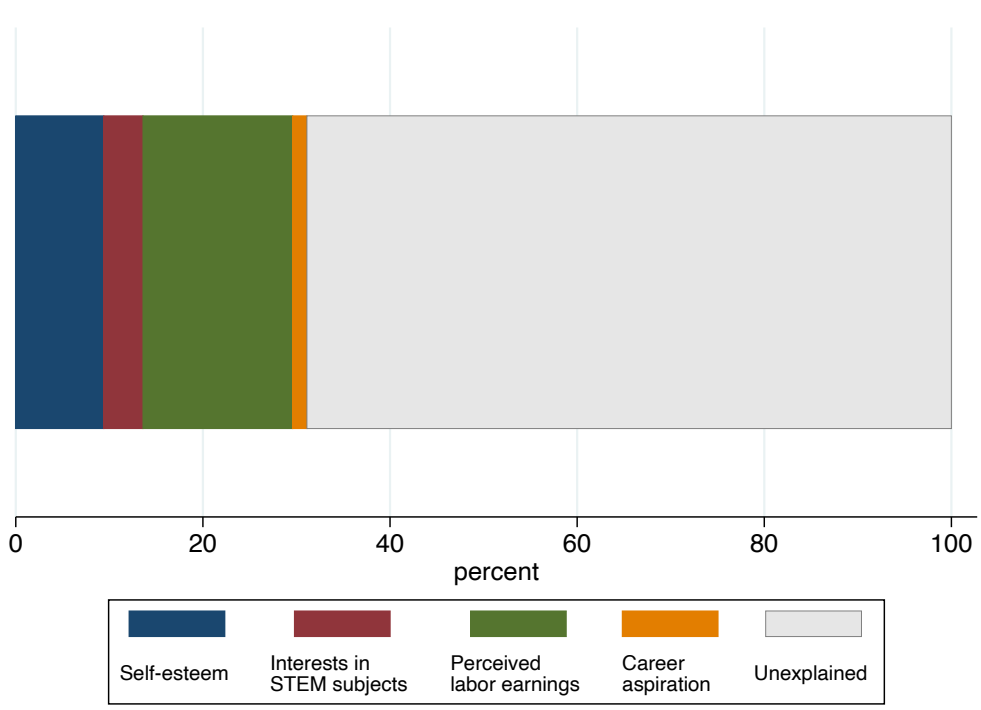
- The intervention induces progressive gender attitudes among girls.
- We investigate several channels.
  - Self-esteem
  - Interests in STEM subjects, potentially affecting gendered stereotypes.
  - Perceived earnings in labor markets and career aspirations.

Potential channels for girls

Dependent variable	STEM	SE	Control mean
A. Self-esteem			
Standardized self-esteem index	0.296*	0.164	-0.022
B. Interests in STEM subjects			
1st favorite subject-math and science	0.132**	0.059	0.589
2nd favorite subject-math and science	0.164**	0.065	0.437
3rd favorite subject-math and science	-0.075**	0.033	0.166
C. Perceived labor earnings			
Earnings compared to others at 25 (max10)	0.922***	0.301	6.689
Earnings compared to others at 35 (max10)	0.580***	0.223	7.782
D. Career aspiration			
Standardized career aspiration pca	0.072	0.166	0.281
Number of observations	329		

Note: Significance levels: * 10%, ** 5%, *** 1%.

Decomposition results



- Quantify contribution of each channel to the main effects using a method by Heckman et al. (2013) and Gelbach (2016).
  - Self-esteem (9.4%)
  - Interests in STEM subjects (4.1%)
  - Perceived labor market earnings (16%)
  - Career aspirations (1.5%)

The effect of STEM bootcamps on behavior and long-term expectations for girls

Dependent variable	STEM	SE	Control mean
A. Weekly study hours			
Weekly hours of study	5.276***	1.947	12.232
Kiswahili/English weekly hours of study	1.174*	0.656	3.798
Math/Science/Computer weekly hours of study	2.202***	0.701	4.372
Geography/Civics/History weekly hours of study	1.900***	0.665	4.061
B. Educational goal			
Senior secondary or below	0.036	0.057	0.070
Technical/ vocational	-0.014	0.042	0.078
Higher education	-0.022	0.070	0.853
C. Preferred major in college			
Business	-0.101**	0.047	0.250
Engineering/Technology	0.189***	0.053	0.103
Other majors	-0.013	0.068	0.571
Number of observations	329		

Note: Significance levels: * 10%, ** 5%, *** 1%.

The effect of STEM bootcamps on behavior and long-term expectations for girls

Dependent variable	STEM	SE	Control mean
D. Expected occupation			
Clerical, sales and services	-0.058***	0.022	0.087
Education sector	0.006	0.057	0.121
Engineering/science/technology sector	0.067	0.063	0.341
Health and social/community work	0.028	0.041	0.085
Professional/ managerial (gov)	-0.030	0.043	0.230
Professional/ managerial (non-gov)	0.049	0.045	0.058
Agriculture/domestic service/manual job	-0.062***	0.023	0.078
E. Household outcomes			
Desired marriage age	0.089	0.472	26.729
Number of children wanted	-0.259*	0.141	3.516
Number of observations	329		

Note: Significance levels: * 10%, ** 5%, *** 1%.

Long-term effects

	Dependent variable: Gender attitudes
	(1)
STEM	0.338**
	(0.143)
STEM × 1(Above median days btw STEM camps and post surveys)	-0.077
	(0.183)
Control group mean	.464
Observations	329

Note: Significance levels: * 10%, ** 5%, *** 1%.

- We exploit variations in the differences in the timing of the intervention and the post-survey to test the heterogeneous effect by time.

Conclusion

- We study how educational opportunities change adolescents' gender attitudes, using an experiential education program focused on STEM.
- The STEM bootcamp had a significant positive impact on gender attitudes for girls but not for boys.
- Improved labor market opportunities appear to be an important channel to explain the observed changes in girls ' attitudes.
- The intervention also increased girls' weekly hours of studying and boosted interests in STEM-related subjects and occupations.
- Our results suggest that an indirect approach of providing practical STEM education opportunities can be as effective as direct interventions at changing gender attitudes for girls.

Sample of First Day Schedule at STEM boot camp

- 8:30 - 9:30 intro, survey, growth mindset
- 9:30 - 11:00 intro to block programming, graph paper programming, debugging
- 11:00 - 11:30 break
- 11:30 - 12:00 change the world video
- 12:00 - 12:30 block coding: star wars coding
- 12:30 - 13:30 amazing robots video
- 13:30 - 14:00 Q n A
- 14:00 - 15:00 lunch
- 15:00 - 15:30 arduino robot video
- 15:30 - 17:00 assembling racebot part I
- 17:00 - 18:00 wrap-up and close the day

Go back

Measure of Gender Attitudes

3C: Gender norms

1 Agree Strongly 2 Agree 3 Disagree 4 Strongly Disagree

321. A woman's most important role is being a good homemaker _____

322. Husband and wife should both contribute to income _____

323. Men make better political leaders than women do _____

324. University is more important for a boy than for a girl _____

325. Pre-school child suffers with working mother _____

326. Women want a home and children _____

327. Men should take as much responsibility as women for home and children _____

328. Problem if women have more income than husband _____

329. Having more than one wife is fine _____

330. Wife must obey husband _____

331. Men make better business executives than women do _____

- Aggregated the answers for these questions using PCA so that higher number indicates more progressive gender attitudes
- Normalized the control group's mean and std as 0 and 1

Go back

Measure of Self Esteem

3B: Self esteem index

1 Agree Strongly 2 Agree 3 Disagree 4 Strongly Disagree

311. Overall, I am satisfied with myself _____

312. I feel that I have a number of good qualities _____

313. I am able to do things as well as most other people _____

- Aggregated the answers for these questions using PCA so that higher number indicates more progressive gender attitudes
- Normalized the control group's mean and std as 0 and 1

Go back