Interventions for Increasing Girls' and Women's Participation and Advancement in STEM Education and Careers: 10 International Case Studies

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Research assistance from PSYC 2201 and PSYC 3800

Presentation prepared for the U.S. Department of State, Office of Science and Technology Cooperation, Bureau of Oceans and International Environmental and Scientific Affairs "Who Run the World? Girls (& Women) in STEM" Diplomacy Lab

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UNIMA Summer Bridge Programs in Malawi

Background and Aims

- Stakeholders: Malawi Ministry of Education and University of Malawi (UNIMA)

- National commitment to increasing women in STEM

- Project Aim: Increase women's participation in STEM education at the tertiary level by providing academic bridging programs between high school and university

Mbano & Nolan, 2015

UNIMA Summer Bridge Programs in Malawi

Methods

Program 1: 2-week course with 36 average-performing, low SES girls in upper secondary school (Year 11) and 18 science teachers from the same schools as the girls

- Program content: STEM coursework, role-modeling, gender responsive pedagogy, field trips, group collaboration

Program 2: 1-week university pre-entry course at two sites –one with 12 women science majors and one with 14 women technical education majors who had low math and science grades in high school

- Program content: STEM learning modules, role-modeling from women in the National Statistics Office, public health, and university technical education program

Mbano & Nolan, 2015

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UNIMA Summer Bridge Programs in Malawi

Outcomes

- Program 1 Outcomes: After 3 years, students had higher pass rates on STEM subjects of the Malawi School Certificate of Education (MSCE) exams, compared to national average pass rate; positive perceptions of program

- Program 2 Outcomes: Students who attended the bridge programs had higher pass rates than women at the colleges who did not attend the programs; positive perceptions of programs

Mbano & Nolan, 2015

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Science & Technical Education at Post-Basic Levels (STEPB) in Nigeria

Background and Aims

- Stakeholders: Federal Ministry of Education in Nigeria, World Bank-funded initiative

- Project Aim:

  - Support efforts to enhance S&T research

  - Supply grant funding for S&T proposals

  - Improve the education and graduation rates of more qualified students from post-basic institutions

- Assessed impact on women in S&T education

Independent Evaluation Group, 2014

Science & Technical Education at Post-Basic Levels (STEPB) in Nigeria

Methods

- Duration: 2007 –Project approval date to 2013 –Project closing date

- Supported S&T education and research, developed entrepreneurship and tech incubation, and established Centers of Excellence

- Accepted proposals from polytechnic schools, universities, and Centers of Excellence

Science & Technical Education at Post-Basic Levels (STEPB) in Nigeria

Outcomes

- Compared to the baseline year 2007, in 2013 there was a:
  - 32% increase in the number of women S&T graduates from STEPB beneficiary institutions
  - 31% increase in number of women enrolling in S&T at beneficiary institutions
  - 54% increase in number of senior secondary school girls who obtained at least 5 credits in S&T subjects on the national examination at beneficiary schools
- However, only 30% of Innovators of Tomorrow grants were awarded to women by 2011

Independent Evaluation Group, 2014

Hello Café in New Zealand

Background and Aims

- Stakeholders: NZ Ministry of Business, Innovation, and Employment (MBIE), UNESCO University Twinning Network (UNITWIN) at Massey University, Institution of Professional Engineers New Zealand Futureintech initiative
- Hello Café: Creative Problem-Solving Workshops for Girls is a program that reframes engineering as a way to serve communities and solve real-world problems
- Project aim: Encourage interest in engineering among girls to address the gender gap in NZ engineering (women comprise just 10% of NZ engineers)

Goodyer & Soysa, 2017

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Hello Café in New Zealand

Methods

- Recruitment
  - 104 girls aged 10-13 living in low SES neighborhoods
  - Branding avoided "techy" masculine associations with STEM
  - Emphasized welcoming environment
- Program
  - 10 90-minute workshops over 10 weeks
  - Small group collaboration
  - Social benefits of engineering
  - Futureintech Ambassadors program women engineer role models

- Outcomes assessment
  - Preintervention questionnaire on interest in, perceptions of, and knowledge of engineering
  - Postintervention questionnaire (same as pretest)

Goodyer & Soysa, 2017

Hello Café in New Zealand

Outcomes

- Preintervention:
  - ~50% participants had knowledge of engineering
  - 3% identified 6 types of engineering
- Postintervention:
  - 84% had knowledge of engineering
  - 62% identified 6 types of engineering
  - Interest in **engineering** careers increased
  - Interested in **science** careers decreased

Goodyer & Soysa, 2017

"Attracting Girls to SET," an ASISTM Project in Australia

Background and Aims

- Stakeholders: Australia Department of Education, Employment and Workplace Relations, Boosting Innovation in Science, Technology and Mathematics Teaching (BISTMT), Australian School Innovation in Science, Technology and Mathematics (ASISTM), University of Tasmania School of Engineering Outreach Team, school project partners
- National commitment to increasing women's participation in engineering
- Project Aim: Foster middle and high school girls' positive perception of and interest in engineering

Little & León de la Barra, 2009

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"Attracting Girls to SET," an ASISTM Project in Australia

Methods

- Assessed 74 girls in Years 5-9 who attended all-girls' schools in urban Tasmania and who were exposed to the ASISTM project
- Outreach Teams and school project partners developed training workshops and learning modules focusing on inquiry-based learning of engineering topics (e.g. robotics, electronics); created a borrowing system for instructional resources; classroom visits by female engineers; developed a website for resources, established a science and engineering expo
- Preintervention and postintervention surveys completed by participants

Little & León de la Barra, 2009

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"Attracting Girls to SET," an ASISTM Project in Australia

Outcomes

- Preintervention survey: attitudes towards pursuing a career in engineering, understanding of concepts in engineering and technology, preferred learning contexts and styles
- Postintervention survey: same as pretest
- Findings:
  - Girls preferred hands-on activities, experiments, and constructive projects
  - Girls perceived that they could create objects and devices to solve practical problems
  - No significant overall changes in attitudes towards engineering
  - No significant improvement of knowledge of engineering and technology concepts

Little & León de la Barra, 2009

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CyberMentor in Germany

Background and Aims

- Stakeholders: CyberMentor –free, online mentorship platform connecting secondary school girls with female STEM professionals and graduate student mentors
  - Weekly mentor-mentee communication over yearlong period
  - Mentoring takes place over email, discussion boards, and chat platform
- Project Aim: Increase girls' STEM networks, interactions with STEM mentors, peer-to-peer interactions and determine whether a "many-to-many" mentoring structure is more effective than "one-to-one" mentorship

Stoeger, Hopp, & Ziegler, 2017

CyberMentor in Germany

Methods

- Participants: high-achieving girls (11-18 years old) in German secondary schools
- Assessed mentees' STEM networks, communication with mentors, and intentions to pursue STEM education and careers

2011: Original one-to-one mentoring structure (one mentee paired with one mentor)

- 156 mentees

2014: New group mentoring structure (two mentees with two mentors)

- 191 mentees

Stoeger, Hopp, & Ziegler, 2017

CyberMentor in Germany

Outcomes

- Group mentoring model resulted in more benefits for mentees, compared to one-one-one mentoring:
  - Significantly more emails exchanged, with more STEM content in communication
  - Larger STEM networks
  - Greater intentions of taking STEM courses and pursuing STEM careers at the halfway point of the program

Stoeger, Hopp, & Ziegler, 2017

Athena SWAN Charter in the United Kingdom

Background and Aims

- Stakeholders: Athena SWAN Charter (Athena Project and Scientific Women's Academic Network) and the University of Oxford

- Institutions can achieve Athena SWAN awards based on the degree to which they address gender equality in STEM and medical fields
  - Three award tiers: Bronze, Silver, and Gold
  - As of 2011, the UK National Institute for Health Research made grant funding contingent on receiving the Silver Award

- Project Aim: Assess employee attitudes towards Athena SWAN

Ovseiko, Chapple, Edmunds, & Ziebland, 2017

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Athena SWAN Charter in the United Kingdom

Background and Aims

- Stakeholders: Athena SWAN Charter (Athena Project and Scientific Women's Academic Network) and University of Oxford
  - Increase women's advancement and leadership in STEM and medical fields
- Institutions can achieve Athena SWAN awards based on the degree to which they address gender equality through institutional structure, goals, and action plans
  - Three award tiers: Bronze, Silver, and Gold
  - UK National Institute for Health Research grant funding is contingent on receiving the Silver Award
- Project Aim: Assess employee attitudes towards Athena SWAN

Ovseiko, Chapple, Edmunds, & Ziebland, 2017

Athena SWAN Charter in the United Kingdom

Methods

- Qualitative assessment of employee responses

  - 59 women and men respondents of an online survey of organizational culture at the University of Oxford who had written about Athena SWAN in the comments of the survey

  - 37 women interviewees, all senior scientists in the University of Oxford Medical Sciences Division and Mathematical, Physical and Life Sciences Division

Ovseiko, Chapple, Edmunds, & Ziebland, 2017

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Athena SWAN Charter in the United Kingdom

Outcomes: Key Themes

Structural support for women

- Mentorship
- Career development
- Women in science seminars

Cultural changes in time use

- Parental leave policy and reintegration after leave
- Flexible scheduling

Link to funding

- Positive: strengthens institutional commitment to gender equality
- Negative: award application process is time-consuming, "checking off boxes"

Concerns

- Limited ability to address broader social/cultural disparities
- Tokenism
- Resentment about "positive discrimination"

Ovseiko, Chapple, Edmunds, & Ziebland, 2017

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BAMOT Mentorship Program in Israel

Background and Aims

- Stakeholders: BAMOT Program (Girls for Science and Technology), Israeli Ministry of Education, Israeli technology company partners, women scientist and engineer volunteers

- Project Aim: Use adult women scientist role models and a school trip intervention to promote girls' interest in STEM education and careers

Bamberger, 2014

BAMOT Mentorship Program in Israel

Methods

- Participants were 9th grade girls attending a Jewish modern-orthodox all-girls' secondary school

- All students completed postintervention questionnaires of intended major and career, confidence in STEM careers, perception of women in STEM

Intervention Group

- 69 students
- Two, four-hour visits to a local technology company
- 12 women scientists and engineers at the company described their personal background, education, research
- Q/A session on work-family balance, gender stereotypes, overcoming challenges
- Tour of company, laboratories

Control Group

- 30 students
- Experienced regular school instruction in science

Bamberger, 2014

BAMOT Mentorship Program in Israel

Outcomes

- In the intervention group, compared to the control group, girls reported:
    - Significantly lower perceptions of ability to cope with STEM careers
    - Significantly less positive views of women scientists and engineers
    - Decreased number of students interested in STEM careers
- Potential explanations:
    - Cognitive gap: exposure to advanced demonstrations and concepts that were unfamiliar
    - Developmental gap: wide age difference between mentors and students
    - Lack of long-term mentorship relationship

Bamberger, 2014

Digital Learning and Gamification of Science Courses in Pakistan
Background and Aims

- Stakeholders: A low-cost private school in Pakistan

- Digital game-based learning (DGBL): incorporate aspects of computer game play (e.g. progression, feedback, rewards, milestones) into classroom learning

- Project Aim: Use DGBL pedagogy to increase girls' attentiveness, confidence, and achievement in STEM learning

Khan, Ahmad, & Malik, 2017

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Digital Learning and Gamification of Science Courses in Pakistan
Methods

- Researchers developed DGBL content for a chemistry class; content was aligned with the Pakistan National Curriculum of Science's learning outcomes for chemistry

- 72 8th grade students (boys and girls) were spot into two control groups and two intervention groups
  - Control groups received regular conventional lecture instruction
  - Intervention groups completed five 30-minute sessions of DGBL chemistry lessons over three weeks

- Preintervention and postintervention assessment of learning outcomes; teacher observation of student behaviors

Khan, Ahmad, & Malik, 2017

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Digital Learning and Gamification of Science Courses in Pakistan

Outcomes

- Girls in the intervention groups performed significantly better than boys in the same groups on the chemistry learning assessment

- Overall, students in the intervention groups were more attentive and excited compared to students in the control groups

Khan, Ahmad, & Malik, 2017

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Single-Sex Schooling in Trinidad and Tobago

Background and Aims

- Single-sex schools are considered an educational environment that potentially attenuates negative stereotypes about gender and STEM
- Standardized exam scores determine placement into secondary schools in Trinidad and Tobago; single-sex schools are generally better resourced
- Project Aim: Understand whether single-sex education is linked to girls' achievement in STEM and enrollment in STEM courses

Jackson, 2011

Single-Sex Schooling in Trinidad and Tobago

Methods

- Econometric simulation of the impact of single-sex schooling during lower secondary education on gender differences in 10th grade exam performance and course selection using linked student school and assessment data

- Data gathered from 219,849 students across 123 schools on Trinidad and Tobago
  - Secondary Entrance Exam (SEA) scores and subject text scores
  - Caribbean Secondary Education Certification (CSEC) scores
  - Demographic data and students' school preferences

Jackson, 2011

Single-Sex Schooling in Trinidad and Tobago

Outcomes

- Single-sex education was associated with:

  - Higher performance on SEA and CSEC –especially by girls

  - Reduced likelihood of girls selecting STEM courses in secondary school

- Girls who attended mixed-sex schools were significantly more likely to select STEM courses

Jackson, 2011

STEP Social Belonging and Affirmation Training in Canada
Background and Aims

- Skills for Transitions to Engineering Project (STEP)

- Stakeholders: Social Sciences and Humanities Research Council of Canada, University of Waterloo School of Engineering

- Social identity factors influence women's perception of and participation in STEM
  - Association of STEM with masculine gender identity
  - Stereotype threat (concern about confirming negative stereotypes about women in STEM)

- Project Aim: Assess the impact of two nonacademic interventions (social belonging and affirmation training) on women engineering students' GPA, attitudes towards engineering, confidence, perceptions of stress, gender identity, perceptions of women engineers, self-esteem, and friendships

Walton, Logel, Peach, Spencer, & Zanna, 2015

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STEP Social Belonging and Affirmation Training in Canada
Methods

- Three cohorts of University of Waterloo first year engineering students: 92 women and 136 men (matched to women based on major and ethnicity)
- Preintervention survey: feelings of belonging, enjoyment of engineering, engineering self-efficacy, implicit bias against women engineers, confidence in future success in engineering, identification with gender, percentage of friends who are engineers
- Randomly assigned students to one of three approx. 45 min-1 hour conditions: social belonging, affirmation training, or control
- Postintervention survey:
  - In the following 12 days after the intervention: daily stressors, sources of stressors, self-esteem, confidence in managing stress
  - 4 months later: identification with gender, percentage of friends who are engineers, implicit bias against women engineers, and attitudes towards engineering

Walton et al., 2015

STEP Social Belonging and Affirmation Training in Canada

Methods –Intervention Conditions

Social-belonging intervention	Affirmation training intervention	Control
• Read reports and listened to recordings of engineering students' initial struggle and eventual feeling of belonging • Wrote reflection on content of student recordings • Wrote letter to future student about initial difficulty and eventual feelings of belonging • Received Engineering School keychain	• Read reports and listened to recordings of engineering students' strategies for coping with stress • Wrote reflection on content of student recordings • Wrote letter to future student about strategies for managing and coping with stress • Received keychain with customized coping strategy	• In Cohort 1, participants read about how engineering skills develop over time • In Cohort 2 and 3, participants completed outcome measures

Walton et al., 2015

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STEP Social Belonging and Affirmation Training in Canada
Outcomes

- Social-belonging and affirmation training interventions had positive effects for **women in male-dominated majors** in the engineering school
  - Significantly higher GPA, compared to women in male-dominated majors in the control group
  - Perceived stressors were less important, felt more confidence in own ability to manage stress, had higher self-esteem compared to control group
  - 4 months later, significantly more positive attitudes towards engineering and more confidence in future success in engineering
- Effects were weak or nonsignificant for women in gender-diverse majors

Walton et al., 2015

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