

IGNITE THE FUTURE OF PHYSICS

Learn more at
STEPUP4WOMEN.ORG

Introductory Workshop

Alma Robinson
Virginia Tech



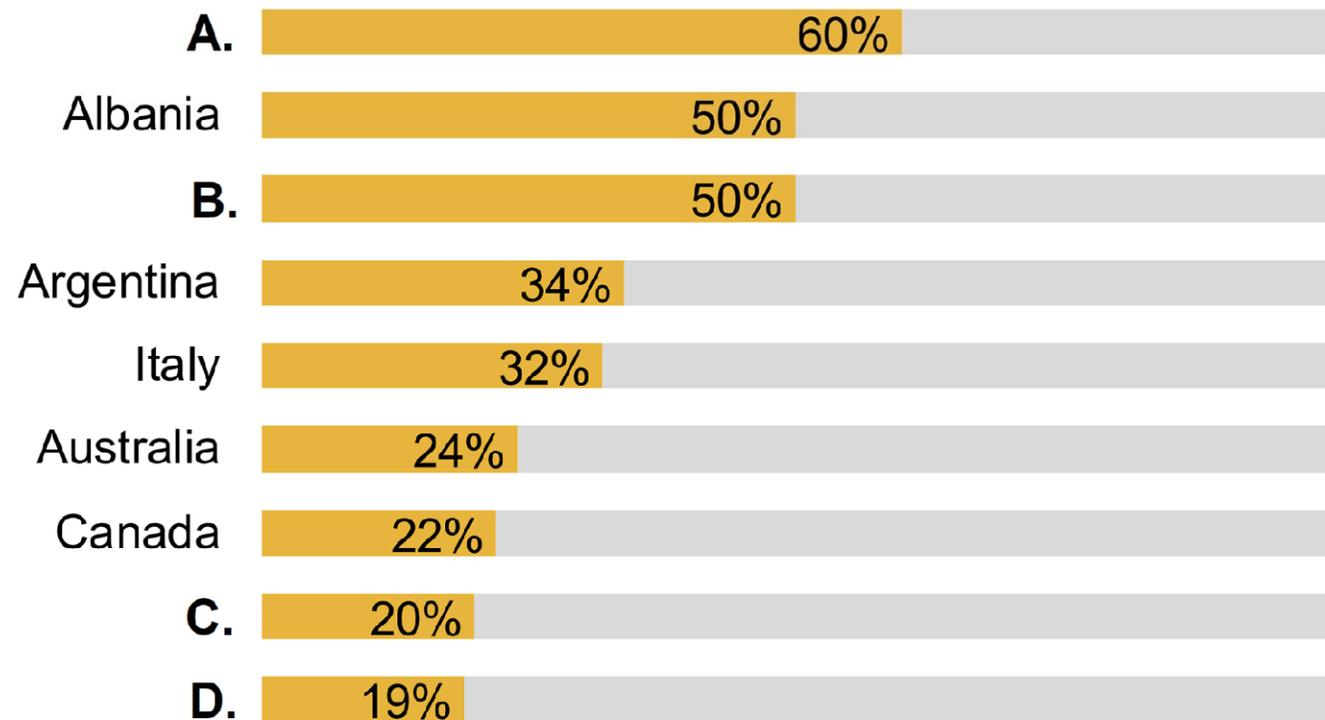
Why STEP UP 4 Women?

Predict: Which countries are A, B, C, and D?

Percentage of Undergraduate Degrees
Awarded to Women

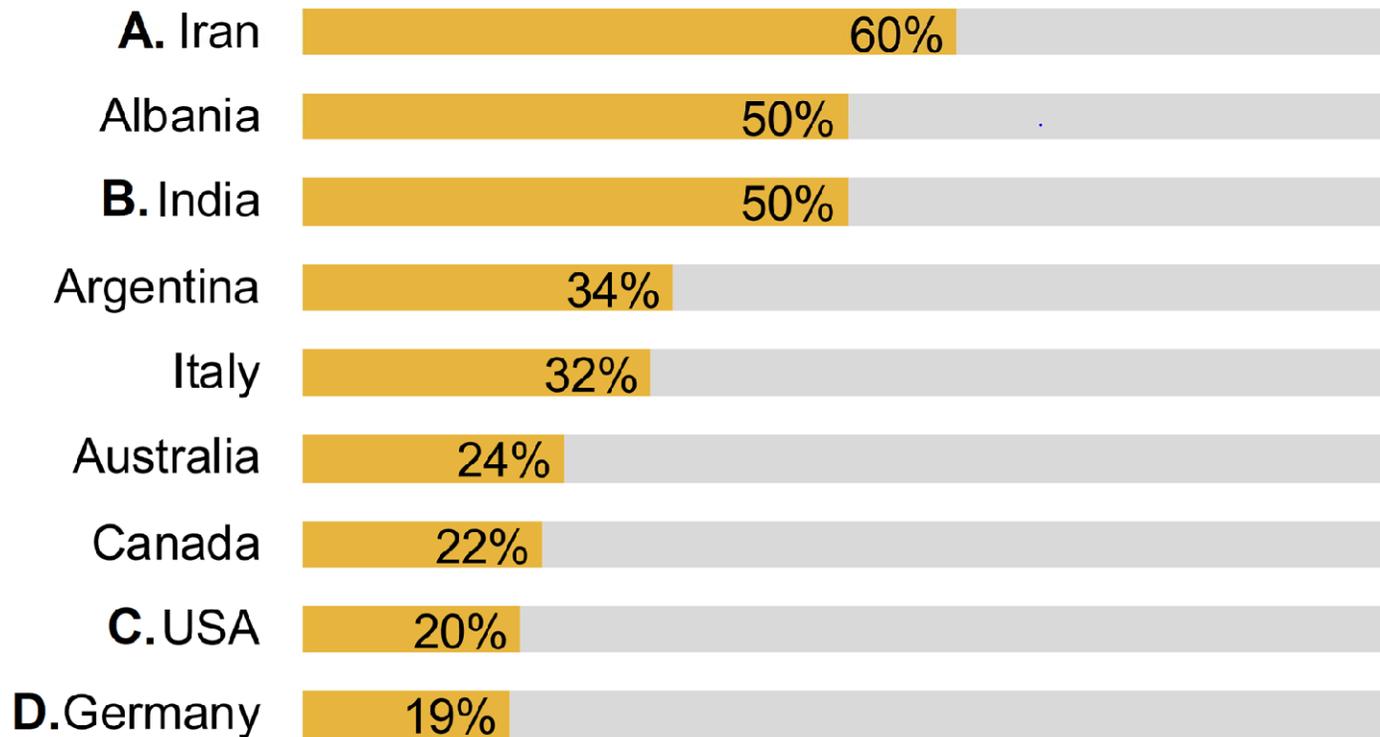
Hint: The
countries
missing are:

Germany
India
Iran
U.S.



Check your prediction

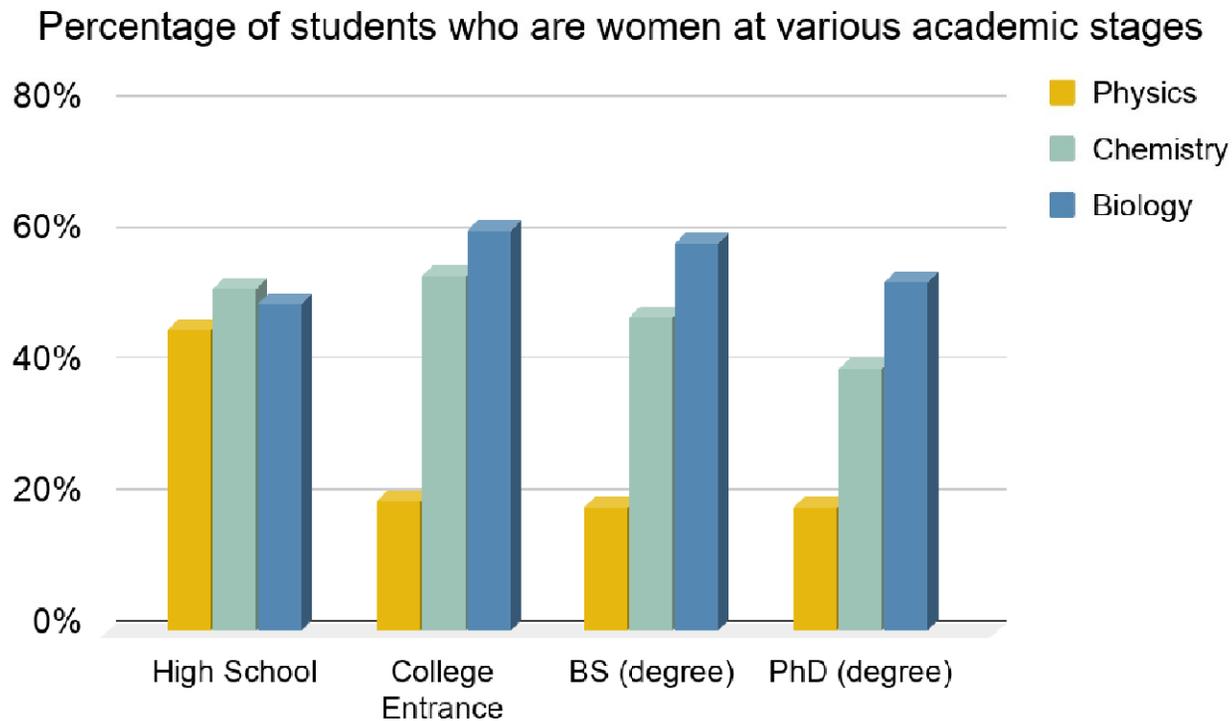
Percentage of Undergraduate Degrees
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Any comments
or thoughts?

Why STEP UP 4 Women?

Examine: What trends do you see?

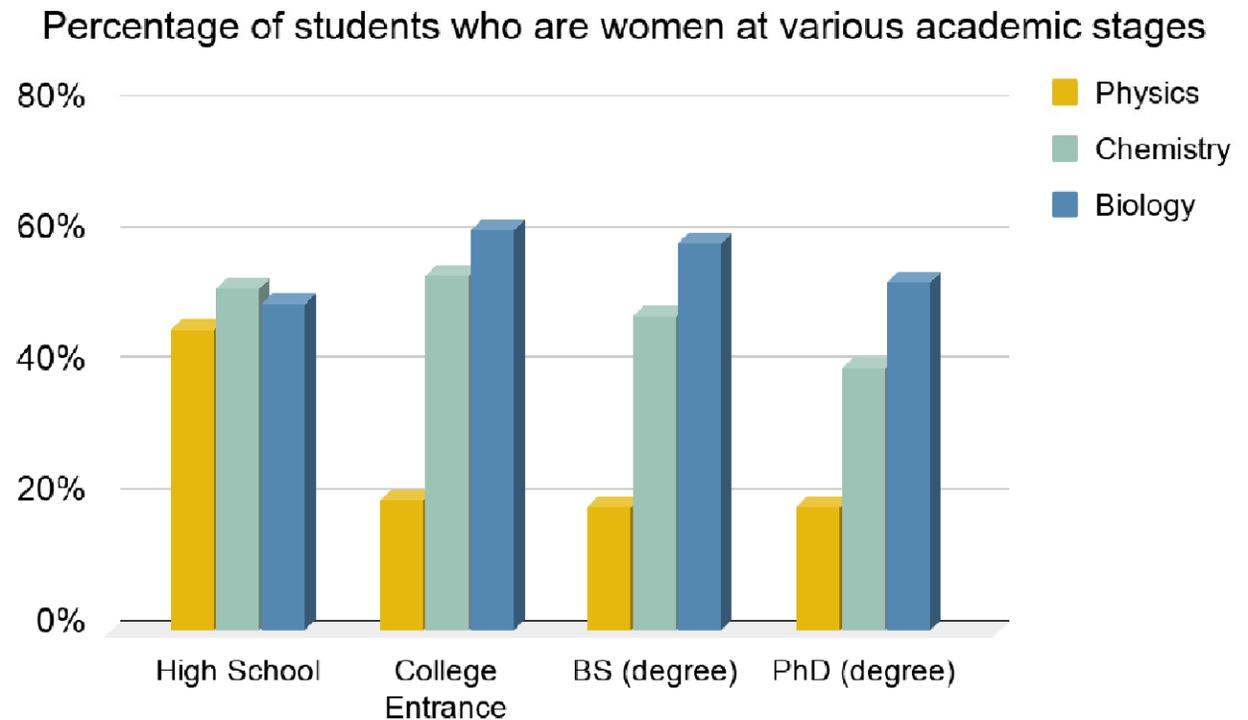


Source: [AIP](#), [HERI](#), [IPEDS](#)

Why STEP UP 4 Women?

Examine: What trends do you see?

Although women make up nearly 50% of enrollments in high school physics, less than 20% of post-secondary physics majors are women.

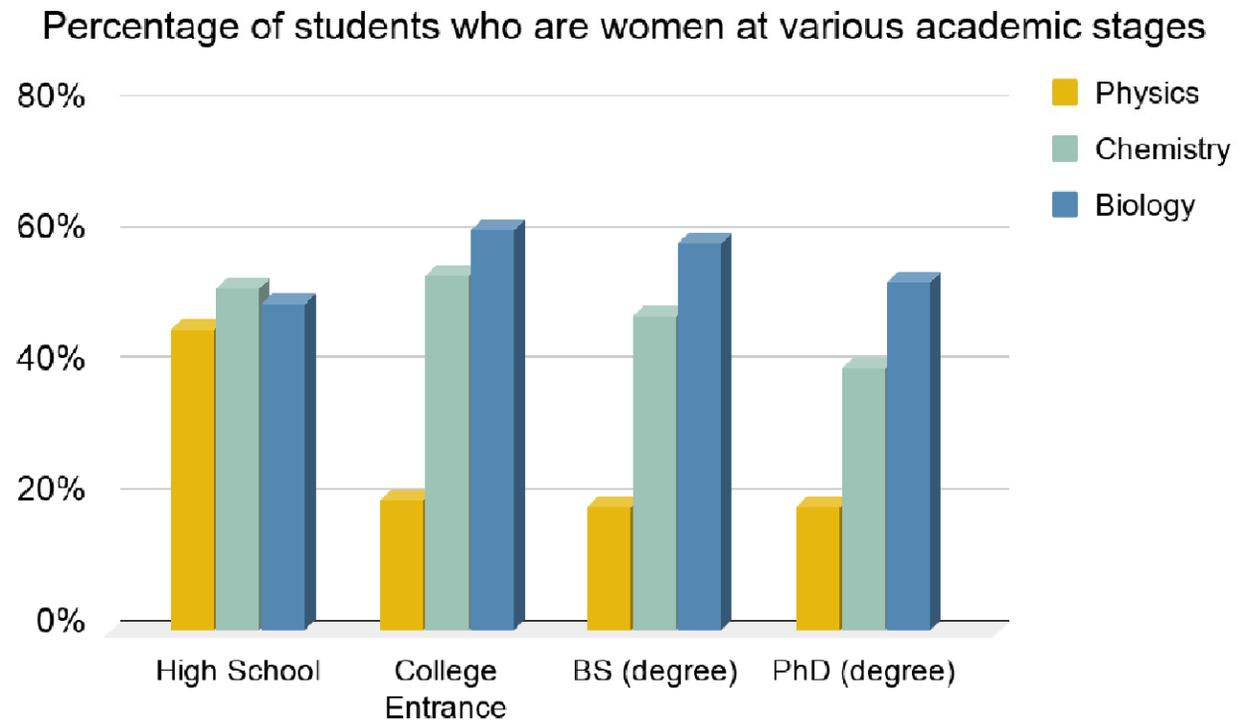


Why STEP UP 4 Women?

Examine: What trends do you see?

The leaky pipeline
is less leaky!

Once women
enter into
physics, they are
staying in physics
at rates
comparable to
men.



Source: [AIP](#), [HERI](#), [IPEDS](#)

Why intervene in high school?

- Most women physicists become interested at this time

Why intervene in high school?

- Most women physicists become interested at this time
- Compared to elementary school
 - teachers have greater content knowledge and are more vested in physics
 - students are closer to decision-making time for majors

Why intervene in high school?

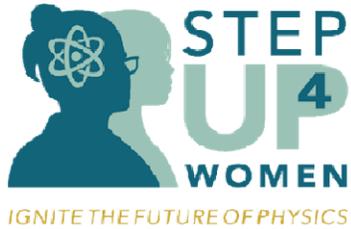
- Most women physicists become interested at this time
- Compared to elementary school
 - teachers have greater content knowledge and are more vested in physics
 - students are closer to decision-making time for majors
- Compared to college
 - classes are smaller and there is more time to build relationships



What is STEP UP 4 Women?

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- Supporting Teachers to Encourage the Pursuit of Undergraduate Physics for Women



What is STEP UP 4 Women?

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- **Goals**
 - Dramatically increase number of young women pursuing a bachelor's degree in physics in the U.S.
 - Shift deep-seated cultural views about who does physics

What is STEP UP 4 Women?

- Supporting Teachers to Encourage the Pursuit of Undergraduate Physics for Women
- **Goals**
 - Dramatically increase number of young women pursuing a bachelor's degree in physics in the U.S.
 - Shift deep-seated cultural views about who does physics
- Cooperative effort between multiple institutions



What is STEP UP 4 Women?

STEPUP4WOMEN.ORG

Guidelines and Lessons available for educators

Guidelines and Lessons available for educators

- **Everyday
Actions Guide**

EVERYDAY ACTIONS SELF-REFLECTION
On a scale of 1-5, how would you rate your use of the everyday actions?

When you... Talk to students individually	NOT AT ALL					VERY MUCH
Discuss with students why they would be a good fit for physics	0	1	2	3	4	5
Direct other students to female students for help	0	1	2	3	4	5
Direct students toward clubs, camps, internships, or other programs	0	1	2	3	4	5
Encourage students to take advantage of academic opportunities in physics	0	1	2	3	4	5
Connect with students about what they value and are interested in	0	1	2	3	4	5
Provide for students' different needs with support and feedback	0	1	2	3	4	5
When you... Facilitate group work/labs	NOT AT ALL					VERY MUCH
Avoid isolating women in a group of mostly men	0	1	2	3	4	5
Ensure women are taking active roles	0	1	2	3	4	5
Bolster confidence around lab equipment	0	1	2	3	4	5
Teach collaboration skills during or before initial group activities	0	1	2	3	4	5
When you... Address the whole class	NOT AT ALL					VERY MUCH
Set expectations for success	0	1	2	3	4	5
Promote a sense of community	0	1	2	3	4	5
Promote a growth mindset	0	1	2	3	4	5
Value many different types of skills, such as communication and teamwork	0	1	2	3	4	5
Distribute attention during class discussions	0	1	2	3	4	5
When you... Plan and assess	NOT AT ALL					VERY MUCH
Incorporate real world physics examples	0	1	2	3	4	5
Connect physics to other disciplines	0	1	2	3	4	5
Establish clear grading rules	0	1	2	3	4	5
When you're... Outside the classroom	NOT AT ALL					VERY MUCH
Find out which teachers have the students who feed into physics	0	1	2	3	4	5
Talk to school counselors	0	1	2	3	4	5
Have open doors of communication with parents	0	1	2	3	4	5
Support students who want to start a physics club, or take part in physics/science organizations and competitions	0	1	2	3	4	5
Find out about outreach and community activities for student engagement	0	1	2	3	4	5

What is STEP UP 4 Women?

Guidelines and Lessons available for educators

- Everyday Actions Guide
- Careers in Physics Lesson

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CAREERS IN PHYSICS
Lesson Plan

Guidelines and Lessons available for educators

- Everyday Actions Guide
- Careers in Physics Lesson
- Women in Physics Lesson

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STEP UP 4 WOMEN

CAREERS IN PHYSICS
Lesson Plan



WOMEN IN PHYSICS
Lesson Plan



How can you play a role?

If you are a high school teacher:

- **Use these lessons in your classroom**
- **Follow the Everyday Actions guide**
- **Encourage your colleagues to do the same!**

If you are a college professor:

- **Tell your future physics teachers and local HS physics teachers about STEP UP 4 Women**
- **Follow the Everyday Actions guide**
- **You can use these lessons in your classroom, too! (I do in my first year seminar course)**

Sample Lesson

Careers in Physics

Please engage in “student mode”

- Imagine it is the beginning of October
- HS physics class (juniors & seniors)

Lesson Introduction

Careers in Physics

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Name a career (or careers) you can have with a physics bachelor's degree.

You can answer at [Pollevo.com/alma](https://www.pollevo.com/alma) or you can text ALMA to 37607 once to join, then text your message.

To input a multi-word career, a hyphen works well, e.g., high-school-physics-teacher

Lesson Introduction

Careers in Physics

Let's look at our responses!

Lesson Introduction

Careers in Physics

Sample responses

Name a career you can have with a physics bachelor's degree.



Complete *Career Goals Pre-Survey*

- 2 questions

Complete *Career Goals Pre-Survey*

- 2 questions

Refer to *Profile Matching Matrix* (Appendix 2)

- Find the name of at least one matching physicist profile
- Retrieve this physicist's card, read, and reflect

Careers in Physics (student mode!)

How to use the *Profile Matching Matrix* (Appendix 2)

Q2↓	Q1 Responses →	Q1a	Q1b	Q1c	Q1d	Q1e	Q1f	Q1g	Q1h
Profiles↓									
Q2e	Sara Wenger - Astronomer	✓	-	-	-	-	✓	✓	-
Q2e	Kelle Cruz - Astrophysics	✓	-	-	-	✓	✓	-	-
Q2e	Gabriela Gonzalez - Astrophysics	✓	-	✓	-	✓	-	-	-
Q2j	Laura Kasian - Film Producer	✓	-	-	✓	-	✓	-	-
Q2j	Dianna Cowern - YouTuber	-	✓	-	-	-	✓	✓	-

Careers in Physics (student mode!)

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Careers in Physics (student mode!)

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Q2j	Dianna Cowern - YouTuber		-	-	-	-	-	-	-	-

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Q2j	Dianna Cowern - YouTuber		-	✓	-	-	-	✓	✓	-

Body of Lesson

Careers in Physics

Share with nearest neighbors focusing on:

- What does your physicist **personally value** about their degree or career?
- Who **benefits** from their work?
- What did they **gain** from their physics degree?

Please share out

Focus

- What does your physicist **personally value** about their degree or career?
- Who **benefits** from their work?
- What did they **gain** from their physics degree?

Student Prompt-after discussion

What new careers emerged from researching the physicist's profiles?

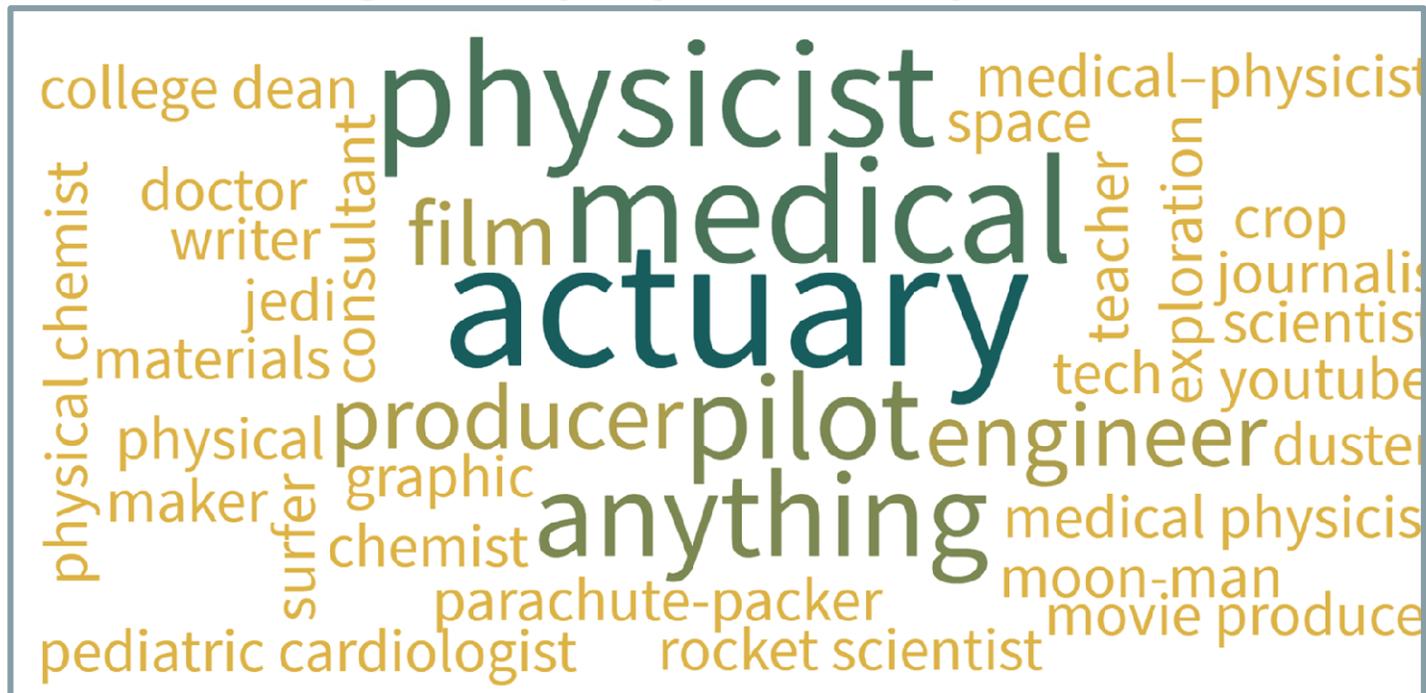
You can answer at [PollEv.com/alma](https://www.pollevo.com/alma) or you can text ALMA to 37607 once to join, then text your message.

Now let's see our responses!

What new careers emerged from researching the physicist's profiles?

Sample responses-after discussion

What new careers emerged from researching the physicist's profiles?



Students then create their own Career Profile to display

Profile elements-Part I

- I want to pursue a career in _____
- In this career I will focus on _____
- What do you hope to accomplish or contribute by pursuing this career?
- How can a degree in physics lead you into this career or support your growth in this career?

Personal Profile (for display)

Profile elements-Part II

- **Name | Career Title | Picture**
- Who I am
- Why physics
- Using physics
- Advice for students

Body of Lesson

Careers in Physics

Personal Profile

Profile elements

- Name | Career
- Who I am
- Why physics
- Using physics
- Advice for students



Master teachers have found the preparation of their personal career profile is a key and transformational part of this lesson for students.

We'll do this if we have time at the end!



Alma Robinson, Physics Teacher



Who I am

I'm an outdoor enthusiast who grew up in a suburb of Washington, DC and loves living in the mountings of Southwest Virginia. It is important to me to have a career where I feel like I'm making a positive impact on the world.

Why Physics

As a kid, I always loved science, but I became disinterested in school after years of memorization and tedious worksheets. Physics was different. It encouraged my curiosity, challenged me to solve difficult problems, and gave me tools to understand the world around me from everyday experiences like riding my bike to the big questions such as how the universe began. I pursued my bachelor's degree in physics and a master's degree in science education.

Using Physics

As a physics teacher, I help students learn how to think critically and solve problems through the discipline of physics. By helping students learn physics, I hope they learn how to apply mathematics to complex ideas, approach a problem with a can-do attitude, and make evidenced-based decisions. By helping them hone their scientific inquiry skills, I hope to give them the tools they need to become successful in their professional and civic lives. I now also work with future physics teachers and hope I can help them inspire the next generation of students to love, understand, and appreciate science.

Advice for Students

My advice for any student who is pursuing a physics degree is to be humble and approach every situation as an opportunity for learning. Anytime you are faced with a problem that doesn't make sense, don't just rush through it and try to get the right answer without understanding it fully. Seek out help from a classmate or a professor until you can explain it confidently to someone else. Learning to think critically about a situation and becoming comfortable asking questions will help you in so many areas of your life.

Bachelor's Degrees in Physics: What you (and/or your students) might not know

Based on National Surveys

- High employment rates (95%)
- High job satisfaction (71% to 93%)
- Multiple job opportunities

Lesson Closure

Careers in Physics

Predict: What majors do you think do the best on the MCAT (Medical College Admission Test)?

What about the LSAT (Law School Admission Test)?

Lesson Closure

Careers in Physics

Physics majors get high scores on assessments for both medical and law school

Scores on MCAT by major	
Degree Field	Average
Economics	10.5
Physics	10.4
Biomedical Engr	10.4
Mathematics	10.1
Electrical Engr	10.1
Neuroscience	10.1
English	10.0
Biochemistry	9.8
Chemistry	9.5
Microbiology	9.4
Psychology	9.3
Biology	9.1
Premedical	9.5
All Majors	9.5

Medical

Scores on LSAT by major	
Degree Field	Average
Mathematics	162.2
Physics	162.1
Economics	159.1
Engineering	157.3
Chemistry	156.7
History	156.7
English	155.8
Biology	155.2
Political Science	154.3
Psychology	153.3
Computer Sci	152.3
Pre-Law	149.0
Criminal Justice	145.6
All Majors	153.6

Law

Source: Tesfaye & Mulvey, 2013

Lesson Closure

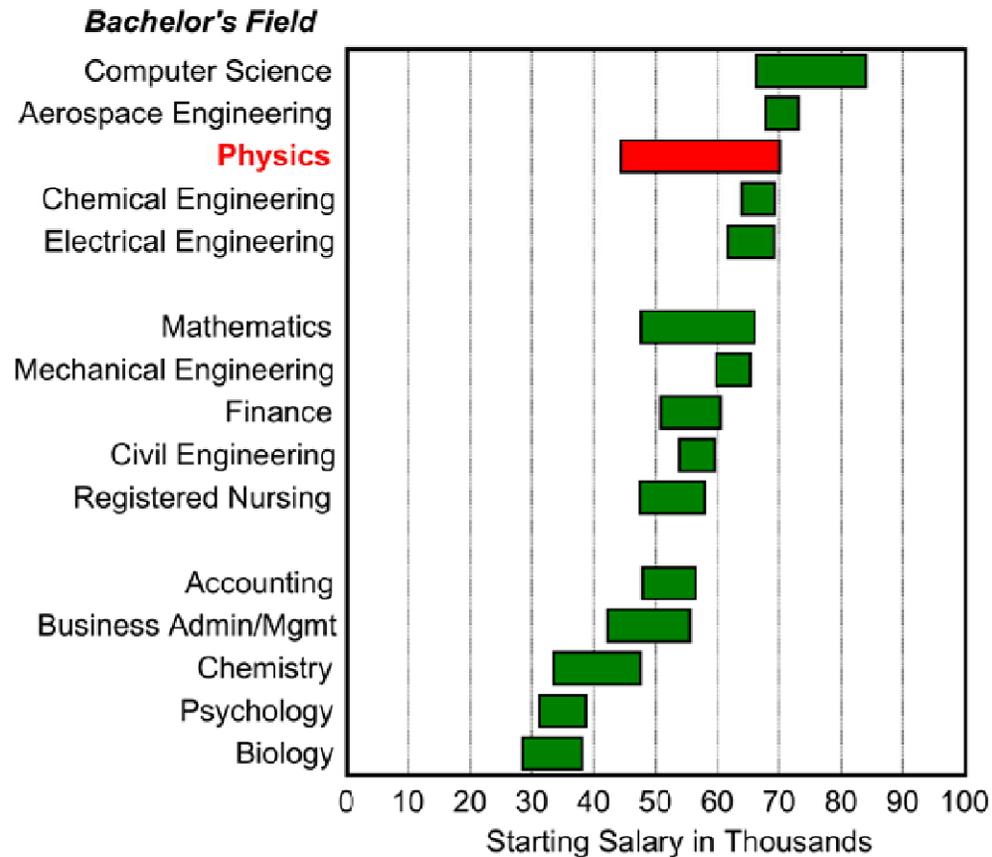
Careers in Physics

Predict: How do starting salaries for students with bachelor's degrees in physics compare to other fields?

Lesson Closure

Careers in Physics

Physics majors earn comparatively higher salaries than other fields

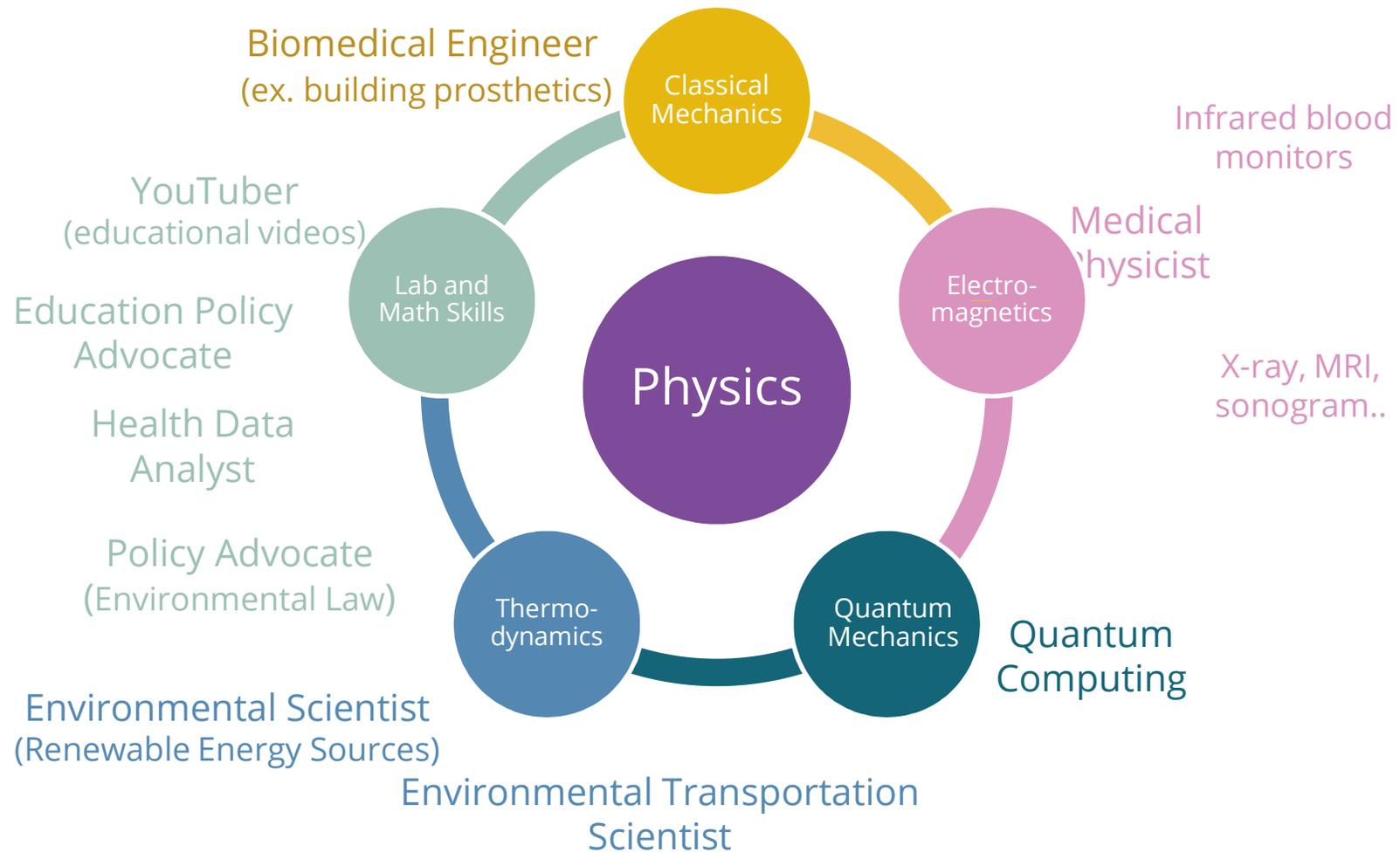


Source: AIP, 2016

Lesson Closure

Careers in Physics

Careers that use physics help society



Lesson Evidence

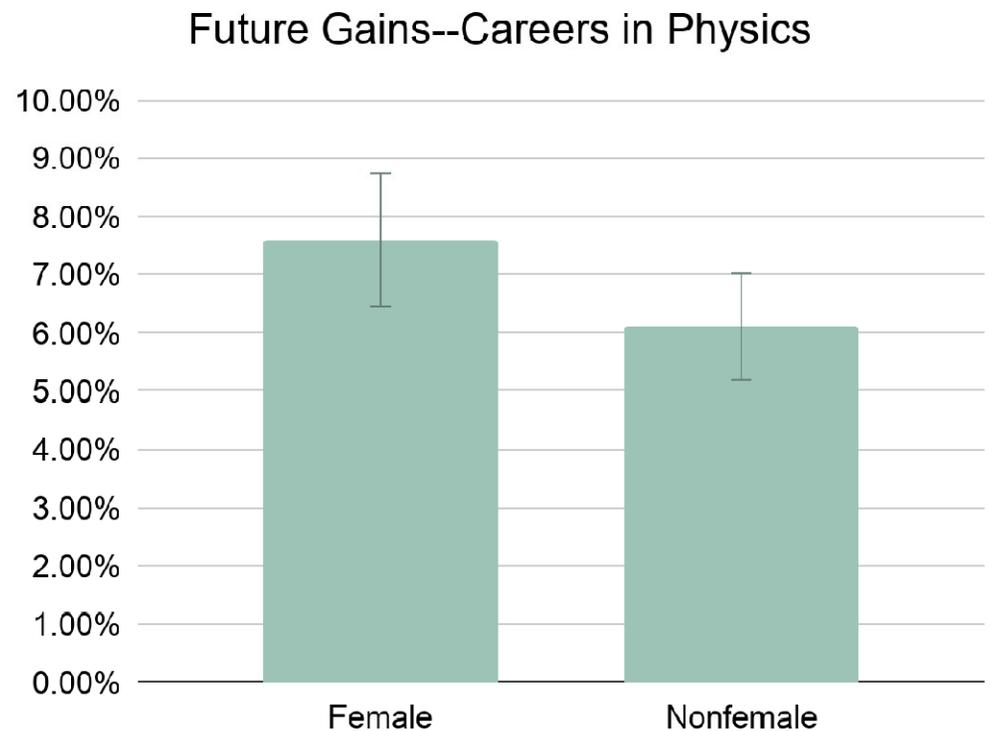
Careers in Physics

What is the effect of this lesson on students?

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Shown to improve students' future physics intentions

- majoring in physics in college
- intention to pursue physics-related careers



N = 823

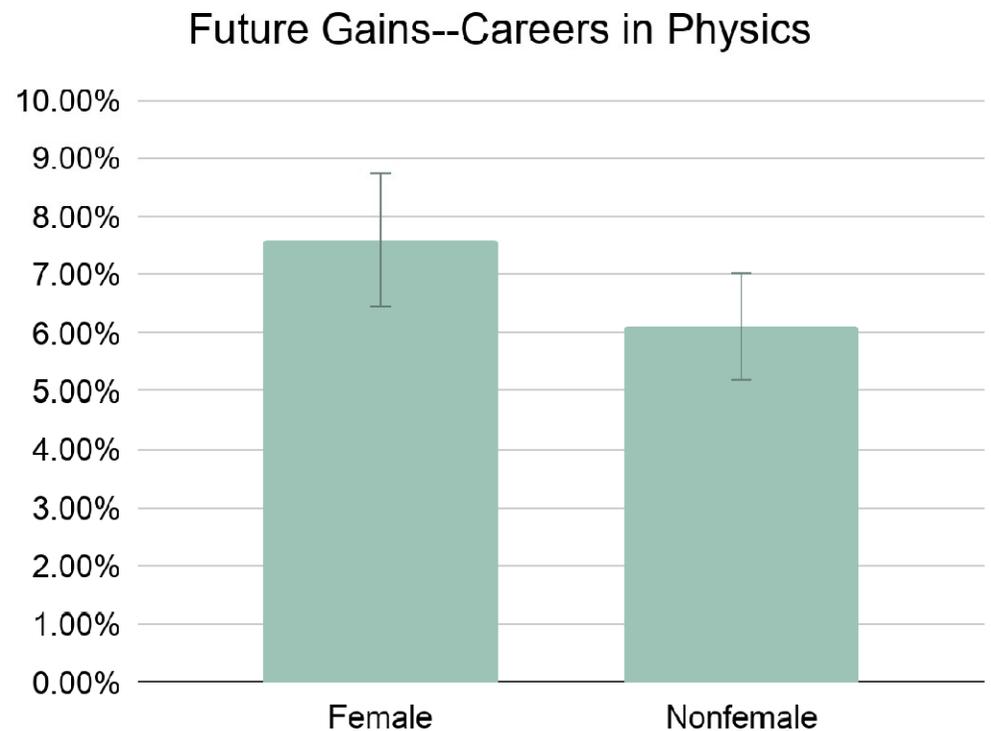
Source: Cheng et al., 2018

What is the effect of this lesson on students?

Shown to improve students' future physics intentions

- majoring in physics in college
- intention to pursue physics-related careers

Overall gains from the lesson across all students are positive



N = 823

Source: Cheng et al., 2018



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Lesson Evidence

Careers in Physics

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Quotes from teachers who used the lesson



IGNITE THE FUTURE OF PHYSICS

Lesson Evidence

Careers in Physics

STEPUP4WOMEN.ORG

Quotes from teachers who used the lesson



"Students don't realize all the things they can do with a physics degree."

Quotes from teachers who used the lesson



"Students don't realize all the things they can do with a physics degree."



"It helps students see that physicists can help the world and work with others."

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"The posters students make as part of the lesson help recognize students and who they are."

Quotes from teachers who used the lesson



"Students don't realize all the things they can do with a physics degree."



"It helps students see that physicists can help the world and work with others."



"The posters students make as part of the lesson help recognize students and who they are."



"As a student, I wish I had the opportunity of envisioning my future with physics."

Teacher debrief thought and comments

- Is this usable?
- Talk to nearest neighbor about what you would/would not use and why
- Class share out

Everyday Actions

...to inspire future physicists

Classroom practices that promote the pursuit of physics

- Research-based and usable everyday in every classroom

Everyday Actions

...to inspire future physicists

Classroom practices that promote the pursuit of physics

- Research-based and usable everyday in every classroom
- Compiled into *Everyday Actions Guide*

Classroom practices that promote the pursuit of physics

- Research-based and usable everyday in every classroom
- Compiled into *Everyday Actions Guide*
- How to...
 - talk to students individually
 - facilitate group work/labs
 - address the whole class
 - plan and assess
 - promote physics outside the classroom



Talk to Students Individually

Encourage students individually, especially young women. Promote self-confidence through explicit reinforcement of student abilities – female students tend to have less self-confidence in their abilities – they tend to have less confidence.



Student Story



“One of the hardest classes that I’ve ever taken was physics. I was stuck out my teacher for help. The teacher shared with me that he didn’t know the subject until he started teaching. This was encouraging for me to know I was capable despite my self-doubt.”



Facilitate Group Work/Labs

Ensure all students have equal opportunity to assume active roles and contribute to discussions. Female students are often marginalized in group work.



Researcher Story

“Groups comprised of two males and one female tended to be dominated by the male students... even when the female member was articulate and the highest contributor in the group.” [8]



Researcher Story

“[Women in the physics laboratory] complained of domineering par-

[8] Heller, P., & Hollabaugh, M. (1992). Teaching problem solving through cooperative grouping. Part 2: Designing problems and structuring groups. *American Journal of Physics*, 60(7), 637-644.

[9] Laws, P. W., Rosborough, P. J., & Poodry, F. J. (1999). Women's responses to an activity-based introductory physics program. *American Journal of Physics*, 67(2), 222-227.

Everyday Actions



Address the Whole Class

Class

Promote a positive attitude towards physics. Set expectations for success, distribute attention during discussion, and encourage a growth mindset. Students often have a fixed mindset

growth mind
often have a



Teacher Story



I've seen teachers use popsicle sticks or index cards with every st go through the whole list of names every class period to ensure e



Plan and Assess

Connect lessons to topics that resonate with students' values and lower the anxiety related to grades. Female students' interests are less likely to be incorporated in physics classes

interests are incorporated i



Teacher Story



I highlighted the existing examples in the textbooks that connect physics to disciplines like medicine, climate change, communication, and



Outside the Classroom

Communicate with people who influence students outside of the classroom setting. Female students who persist in physics are strongly influenced by others but often have fewer suggestions for

influenced by
have fewer



Teacher Story



I organize a Science Night with tables where students do experiments, observe and circulate. The parents become proud of the students' the experiments, and it is a real sense of recognition for the students.

Everyday Actions to *INSPIRE THE FUTURE OF*



Talk to Students Individually

Encourage individually, especially women. Promote confidence through reinforcement of abilities – females tend to have less confidence



Facilitate Group Work/Labs

Ensure all students have opportunity to take on different roles and contribute to discussions. Females are often marginalized in group settings



Address the Whole Class

Promote a positive attitude towards persistence and high expectations; distribute attention during discussion, and encourage a growth mindset. Females often have a fixed mindset about their abilities



Plan and Assess

Connect lessons to students' interests and lower the barrier to entry to grades. Female students' interests are less often incorporated in curriculum

Which of these Everyday Actions are you already doing?

How do students respond to them?

Which will you start doing?



IGNITE THE FUTURE OF PHYSICS

Women in Physics Lesson

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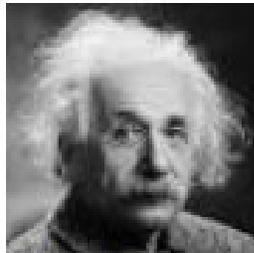
Students examine the conditions for women in physics

We begin the lesson by Googling: famous physicist

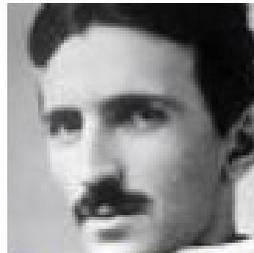
What do you notice?



Stephen



Albert



Nikola Tesla



Isaac



Galileo



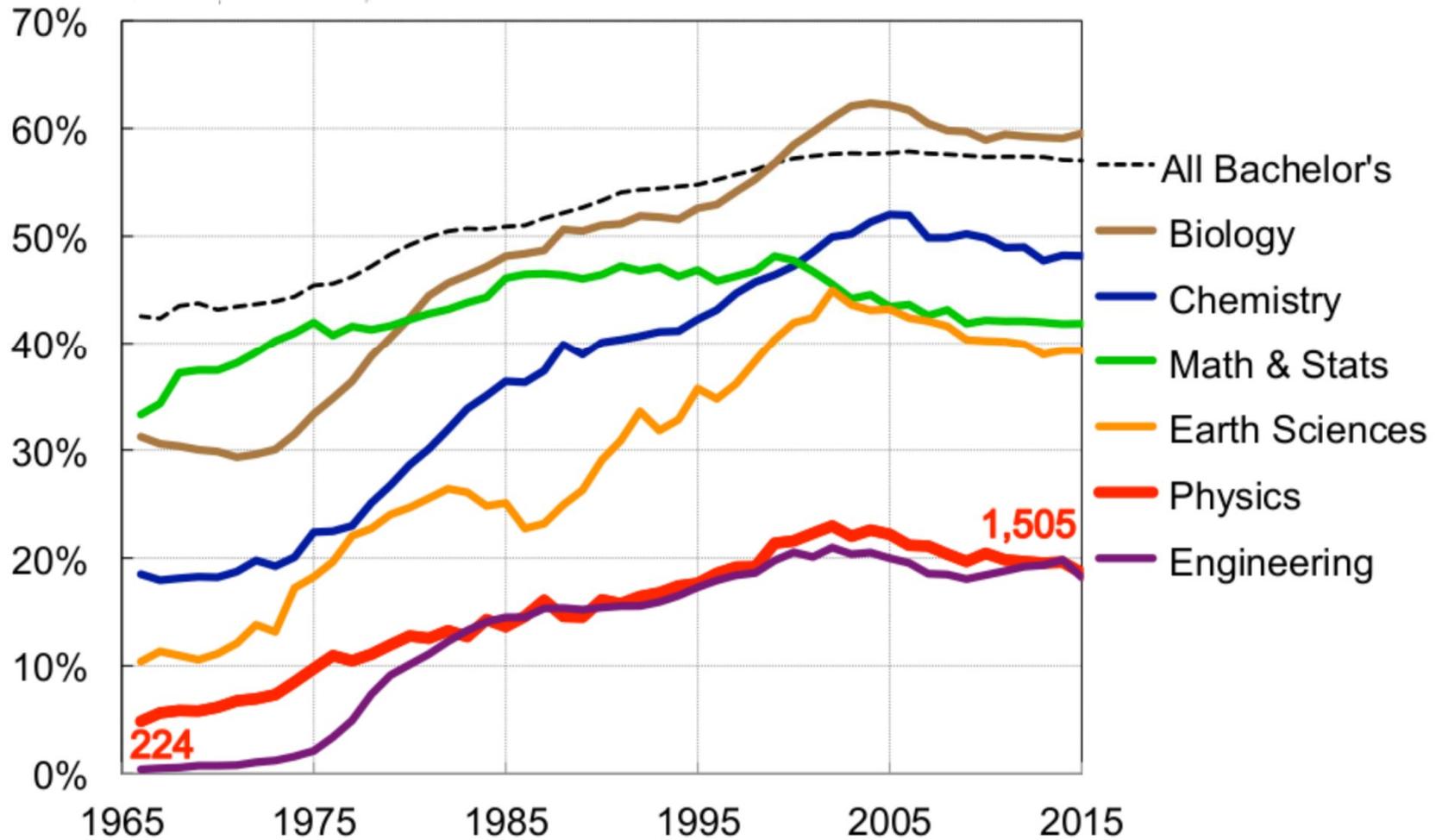
Marie Curie



IGNITE THE FUTURE OF PHYSICS

Percentage of Bachelor's Degrees Earned by Women, by Major

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Source: APS and IPEDS Completion Survey 61

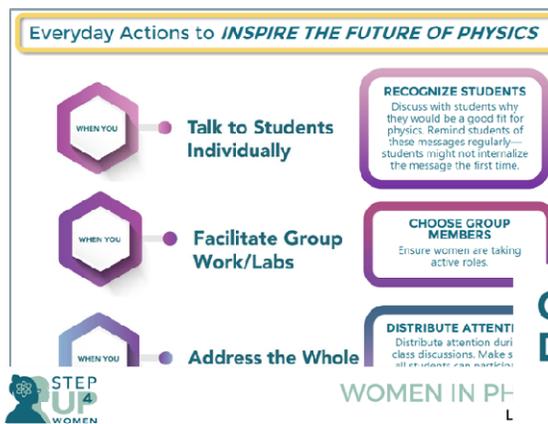
Students examine the conditions for women in physics

- Research famous physicists and analyze trends and stereotypes
- Discuss gender issues with respect to famous physicists
- See data about women in physics around the world and consider the role of culture and society
- Leverage personal experiences to neutralize the effect of stereotypes and bias

Resources available

- **Everyday actions guide**
- **Careers in Physics Lesson**
- **Women in Physics Lesson**
 - **Includes Classroom Guidelines Poster** – I have one for you today!

Everyday Actions to *INSPIRE THE FUTURE OF PHYSICS*

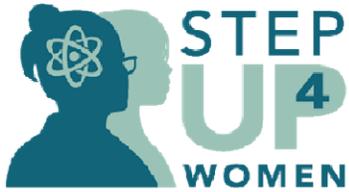


- WHEN YOU **Talk to Students Individually**
RECOGNIZE STUDENTS
 Discuss with students why they would be a good fit for physics. Remind students of these messages regularly—students might not internalize the message the first time.
- WHEN YOU **Facilitate Group Work/Labs**
CHOOSE GROUP MEMBERS
 Ensure women are taking active roles.
- WHEN YOU **Address the Whole**
DISTRIBUTE ATTENTION
 Distribute attention during class discussions. Make sure all students are participating.



Guidelines for Conduct During Discussions





IGNITE THE FUTURE OF PHYSICS

How can you help?

STEPUP4WOMEN.ORG

1. Register NOW at STEPUP4WOMEN.org



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2. Learn about and implement effective strategies using the EVERYDAY ACTIONS guide.



Everyday Actions to *INSPIRE THE FUTURE OF PHYSICS*

 <p>WHEN YOU</p>	<ul style="list-style-type: none"> • Talk to Students Individually 	<p>Encourage students individually, especially young women. Promote self-confidence through explicit reinforcement of student abilities - female students tend to have less self-confidence in physics.</p>
 <p>WHEN YOU</p>	<ul style="list-style-type: none"> • Facilitate Group Work/Labs 	<p>Ensure all students have equal opportunity to assume active roles and contribute to discussions. Female students are often marginalized in group work.</p>
 <p>WHEN YOU</p>	<ul style="list-style-type: none"> • Address the Whole Class 	<p>Promote a positive attitude towards physics. Set expectations for success, distribute attention during discussion, and encourage a growth mindset. Students often have a fixed mindset about their abilities in physics.</p>
 <p>WHEN YOU</p>	<ul style="list-style-type: none"> • Plan and Assess 	<p>Connect lessons to topics that resonate with students' values and lower the anxiety related to grades. Female students' interests are less likely to be incorporated in physics classes.</p>
 <p>WHEN YOU</p>	<ul style="list-style-type: none"> • Outside the Classroom 	<p>Communicate with people who influence students outside of the classroom setting. Female students who persist in physics are strongly influenced by others but often have fewer experiences for building these relationships.</p>


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<p>WHEN YOU'RE</p>	<ul style="list-style-type: none"> • Outside the Classroom 	<p>Communicate with people who influence students outside of the classroom setting. Female students who persist in physics are strongly influenced by others but often have fewer experiences for building these relationships.</p>

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3. Inspire women! Teach lessons on careers and women in physics.

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	• Talk to Students Individually	Encourage students individually, especially young women. Promote self-confidence through explicit reinforcement of student abilities - female students tend to have less self-confidence in physics.
	• Facilitate Group Work/Labs	Ensure all students have equal opportunity to assume active roles and contribute to discussions. Female students are often marginalized in group work.
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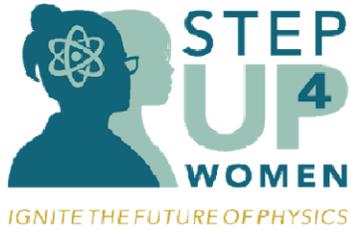
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4. Provide feedback. Tell us how it went!

Thank you!

If you are interested in following up with me about STEP UP and whether or not you were able to do any of the lessons/everyday actions, please sign up on the sign up form!

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Career Profile

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Imagine you are your high school self and create a career profile using the template given.