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Realities of mentoring high school students from inner city public schools vs. private schools in STEM research at an R1 University

Ms. Christine Newman, Johns Hopkins University

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Ms. Margaret Hart, Johns Hopkins University

Margaret Hart, Ed. M is the STEM Outreach Advisor at the Johns Hopkins Whiting School of Engineering's Center for Educational Outreach. She works closely with student groups and leads our robotics outreach efforts. Margaret has a bachelor's degree in Astronomy from Boston University and a Masters in Teaching and Curriculum from Harvard University. She has worked as a software test engineer, run a high-school outreach program at the MIT Kavli Institute for Astrophysics and Space Research, and taught physics, astronomy and engineering in Cambridge, MA and at Baltimore City Public Schools in Baltimore MD. One of her passions is photography which she has taught to both middle and high school students.

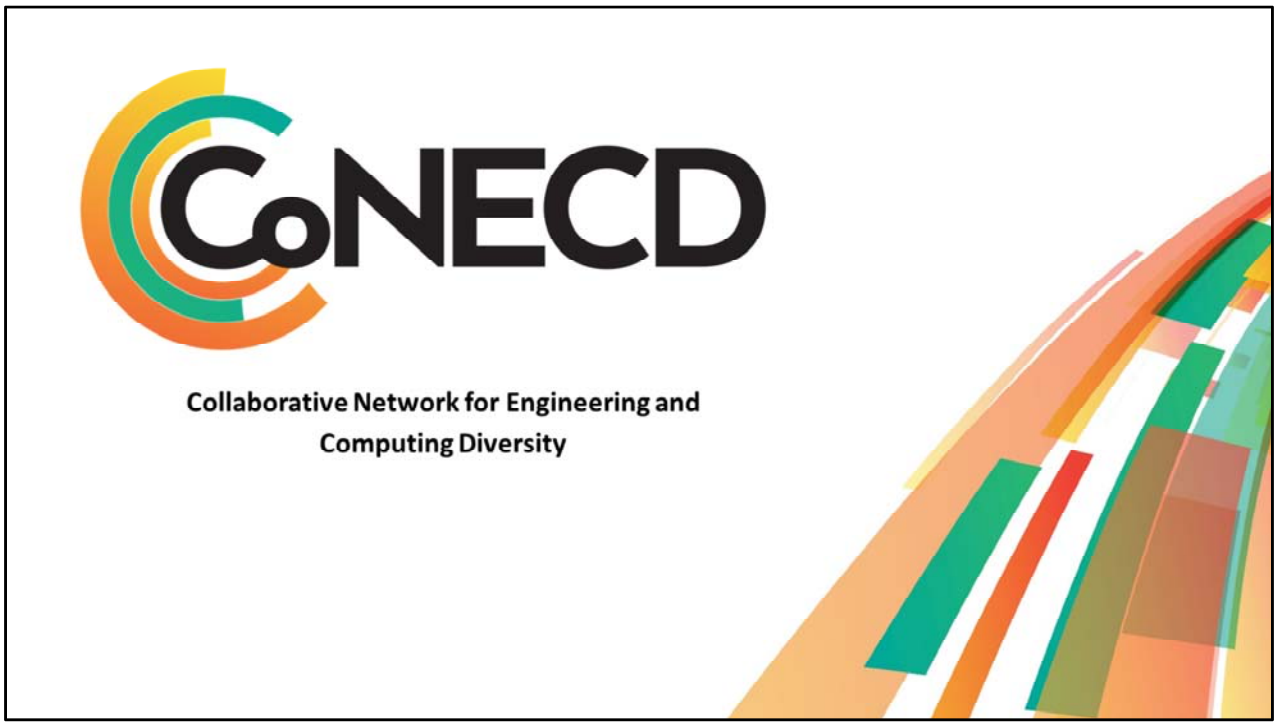
Ms. Andrea M Perry, Garrison Forest School

Ms. Perry has directed the Women in Science and Engineering (WISE) program at Garrison Forest School, an independent pre-K through 12 college preparatory school outside Baltimore, since its inception in 2005. The GFS WISE program partnership with the Johns Hopkins University's Whiting School of Engineering has placed over 225 GFS high school women in research labs and settings throughout the University. Ms. Perry helped with WISE program development and implementation upon coming to GFS after 19 years working in student affairs at Johns Hopkins. As Dean of Special Programs and Director of the James Center, Ms. Perry currently directs efforts at GFS aimed at public purpose and experiential education.

Ms. Anitra Michelle Washington, Western HS

Anitra Washington is a lifelong educator who has a passion for increasing leadership skills in students and teachers. Anitra attended Drexel University, where she first began working with teenagers on math and science Projects. During her time at Drexel, she became the chairperson of the pre-college initiative program for the National Society of Black Engineers. This program gave her first hand experience in combining science and engineering content with activities and outreach programs. After completing her bachelor's degree in biology, she moved to Newark, NJ to teach at St. Benedict's Preparatory School. The

unique environment of working in an urban, all-boys school further ignited Anitra's interest in increasing student achievement in STEM and the number of her students pursuing college degrees in science in engineering. Her experience at St. Benedict's Prep led Anitra to pursue a master's degree in education with a concentration in science teaching, learning, and curriculum at the University of Pennsylvania. While attending the University of Pennsylvania, she completed her thesis on the impact of teacher expectations and norms on student interest in science as a career. In addition, she served as a science education consultant for the Drexel University School of Education/Philadelphia Public School System Partnership and helped create science-based after school programs for middle school students. In 2005, Anitra Washington returned home to Baltimore and continued her teaching career within the Baltimore City Public Schools System. Since then, she has taught various science courses in high schools and transitioned into her current position as Science Department Head at Western High School in 2008. Her professional goals are to increase student access into higher level science courses and their ability to attain higher education in STEM fields.More recently, Ms. Washington has expanded her work to include student leadership training through her summer work with Western High School student leaders who train for 5 weeks to become orientation leaders for the school's freshman orientation program. Her expertise in student leadership has allowed her to speak at conferences for organizations such as the Brooklyn Friends School and the Our Legacy Incorporated. In 2017, Ms. Washington completed in the New Leaders Emerging Leaders program where she was trained to coach instructional teams to create school and classroom environments to bolster high achievement for students in urban settings.


CoNECD
Collaborative Network for Engineering and
Computing Diversity

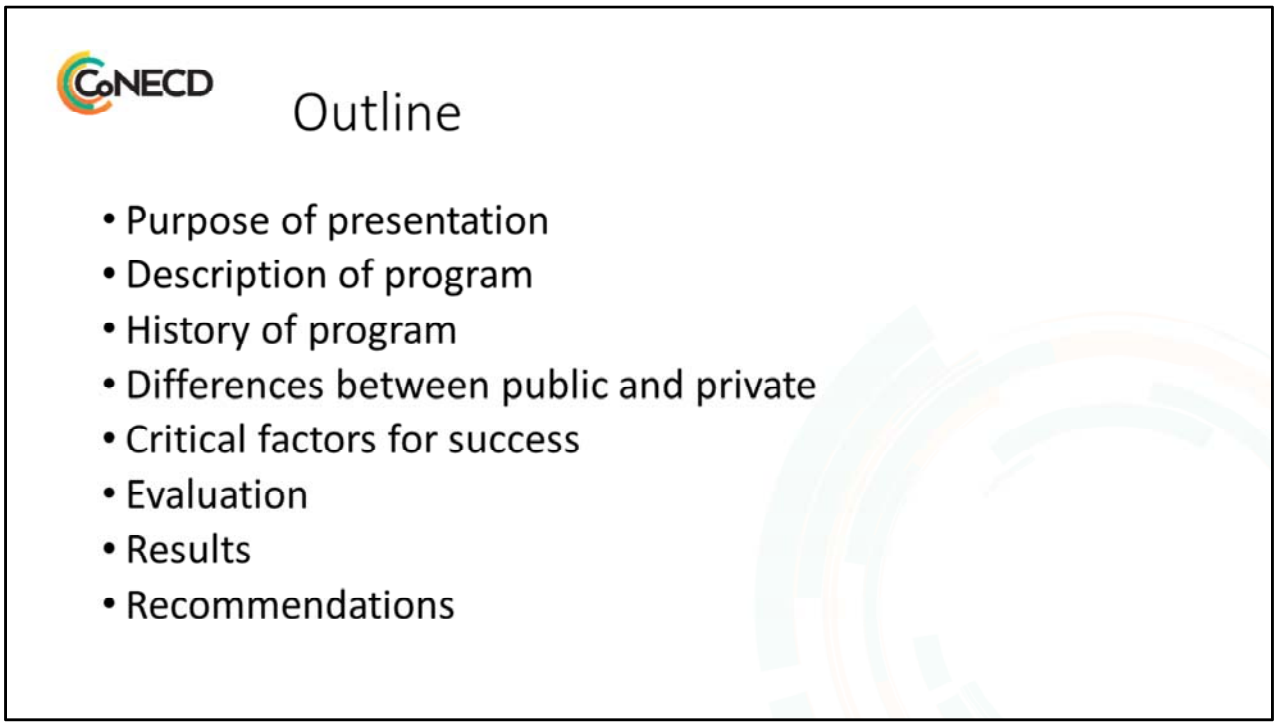
Good morning! My name is Christine Newman and I am the Assistant Dean running the Center for Educational Outreach at Johns Hopkins University Whiting School of Engineering.

My colleagues here are Anitra Washington from Western High School, Andrea Perry from Garrison Forest School, Margaret Hart from our center, and Laura Garcia, a former WISE Western student.

Today we're here to share a practice that has been working well for us in getting young women interested in Science, Technology, Engineering and Math (STEM) fields.

The program is called WISE—Women in Science and Engineering

We want to share the realities of mentoring high school students from inner city public schools versus private schools in STEM research at an R1 University.



First we'll discuss the purpose of our presentation, then we'll go into a detailed description of our program, provide some history about the program and changes that have happened along the way. We'll highlight the differences we've found in implementing this program successfully at private girls schools and public schools.

Then we'll describe the critical factors we've learned for success, our evaluation process, and our results.

And finally we'll make recommendations for others who want to start a similar program.

Purpose of presentation

Share lessons learned for effective research program for young women

The purpose of our presentation is to share lessons learned for other organizations, especially colleges and universities with research labs or possibly corporations with R&D facilities, to start an effective high school research program for young women—whether they be from private or public schools.

Women in Science and Engineering (WISE)

Goal – Increase numbers of women in science and engineering

How – through semester-long research internships

Who – female high school juniors and seniors

When – two afternoons per week

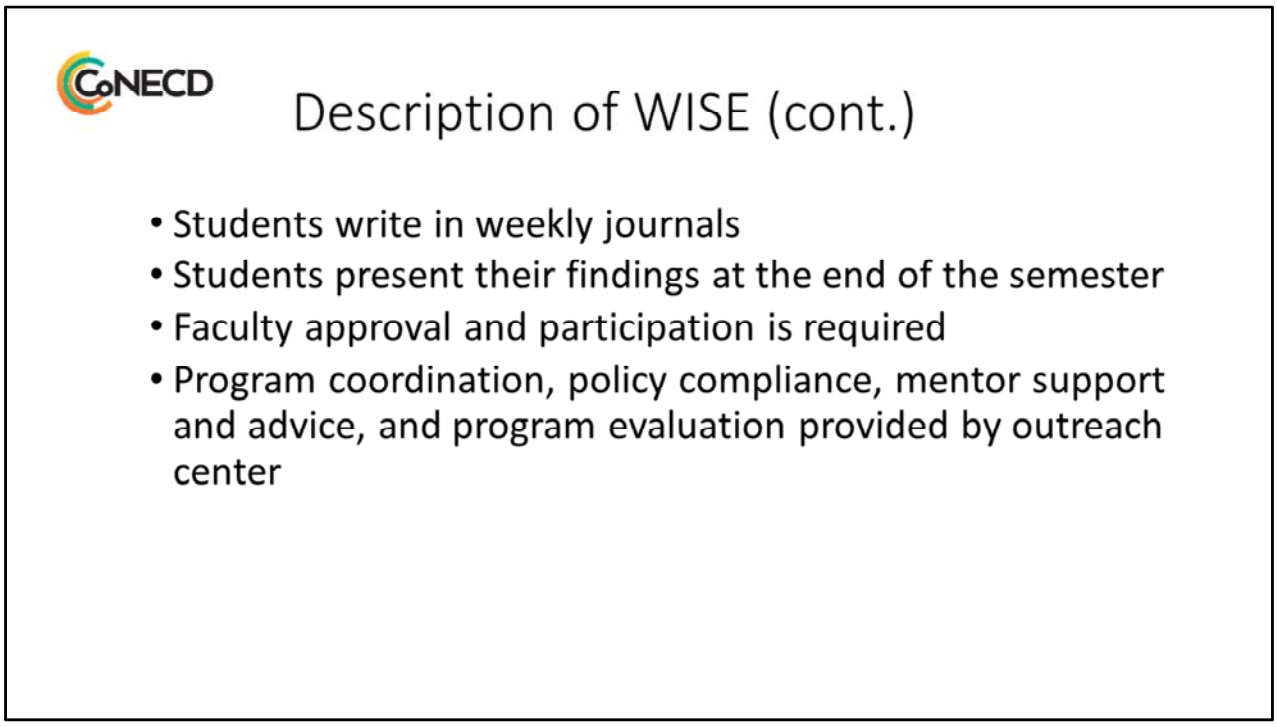
The Women in Science and Engineering (WISE) program's goal is to increase women in science and engineering fields (to address their underrepresentation) through exposure to hands-on research under the guidance of a faculty advisor and a graduate student (or postdoctoral fellow) mentor in a university campus setting.

Graduate students and postdocs were identified as the best primary supervisory mentors, in part due to demands on faculty time, in part because they were nearer in age to the young women, but also to give them a valuable teaching experience.

WISE is a research internship program with mentoring graduate students (or postdocs) in the School of Engineering (and sometimes School of Arts and Sciences, Medicine or Public Health) which gives WISE students access to a "near peer" able to share insights about making decisions about majors and career paths, and an accessible role model. Many universities offer STEM programs for women and many faculty are willing to take high school students into their labs. But this program is unique in that it provides structure and support for both the young women and the mentor for a full semester.

The WISE program is for promising female high school juniors and seniors. We look for completion of relevant science and math courses with grades of at least a B.

In general the internship lasts for one semester (13-15 weeks) and the students come to campus in the afternoon, 2 days a week on school days for about 3 hours a day.



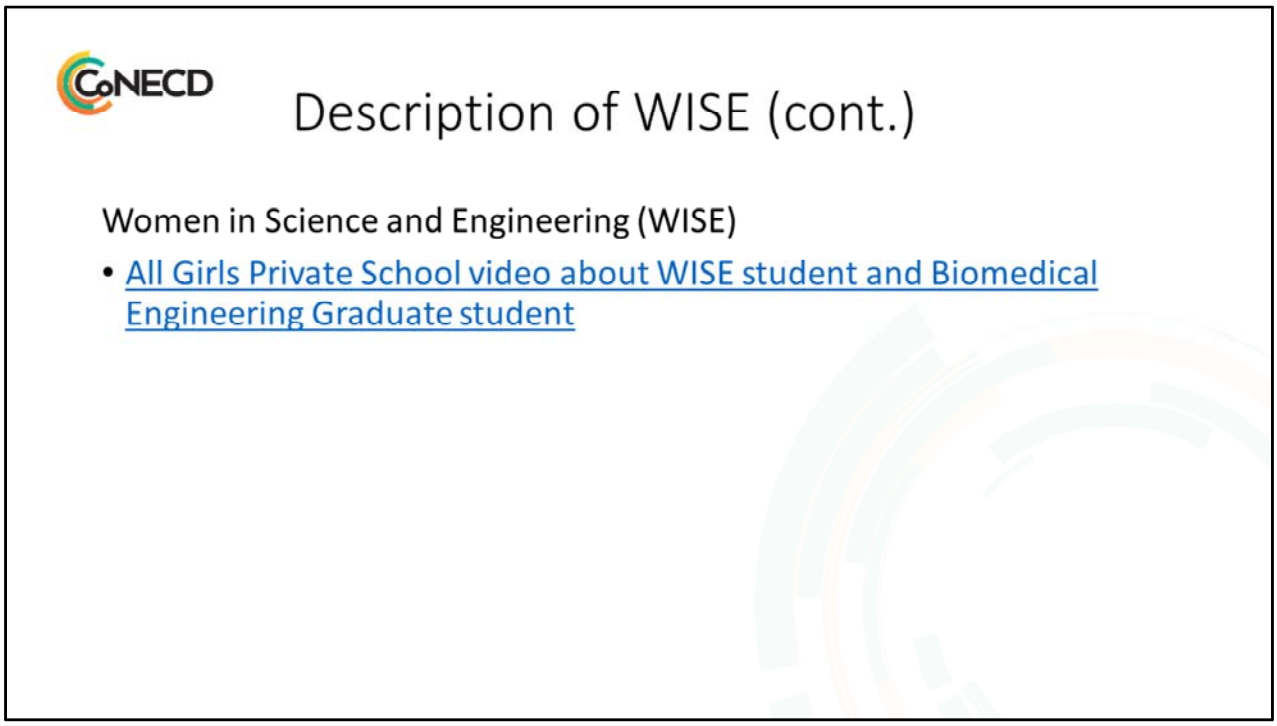
Each student is asked to write briefly in their journals on a weekly basis to document their learning and their challenges. These are read by staff who include comments and questions for students. Staff intervene if they think it is needed to improve the situation for the student. In most cases the students are advised to advocate for themselves—ask questions, for example.

At the end of the semester of research, the student develops a presentation that shows what she has done during her research, what she has learned, how the research will be impactful if successful, and if this research opportunity has influenced her future plans.

They get to make their presentation to an audience of their peers, theirs and others' mentors and faculty advisors, and the CEO staff. Families are also invited to attend and sometimes they do.

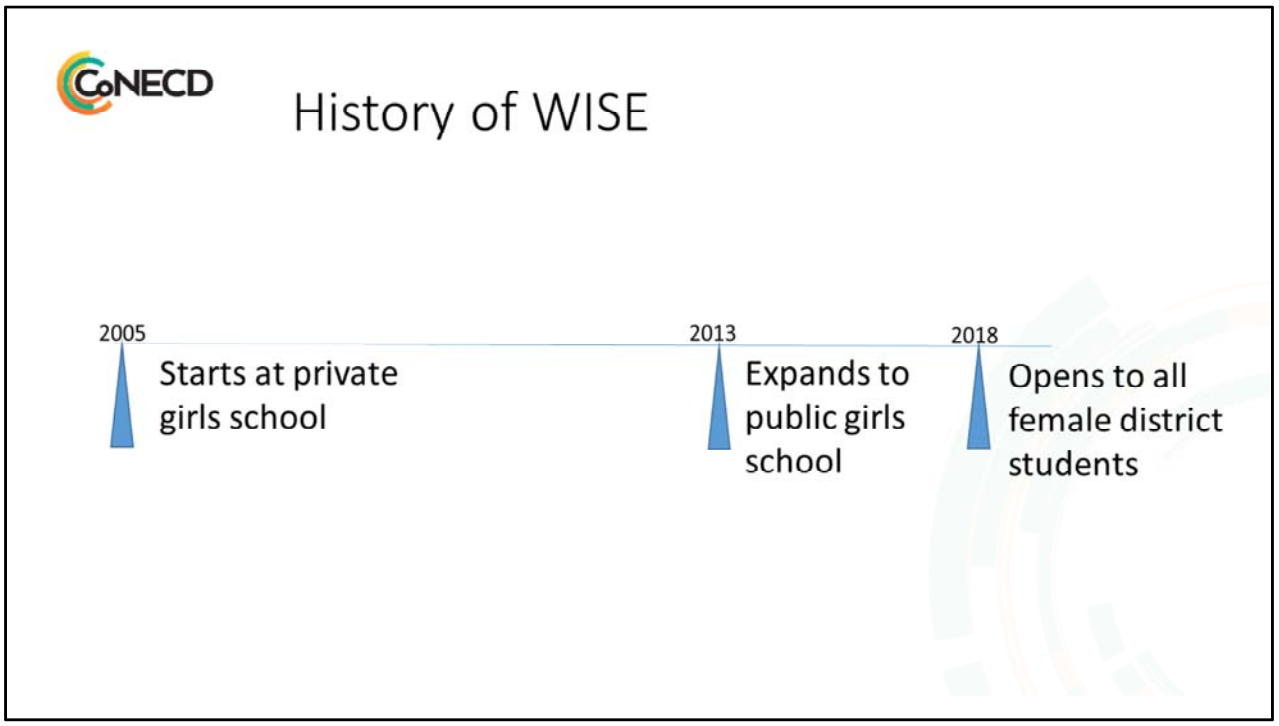
We request that faculty meet with the WISE students at least once and at a minimum, to welcome the high school student into their lab, agree to be fingerprinted and complete child safety training for themselves and the mentor (mentors are required to complete fingerprinting and child safety training) and to allow some flexibility for the mentor to do the mentoring while at the same time continuing their research and their studies, if applicable.

Our center ensures that faculty and mentors comply with the university's child safety policy, that students are registered as visiting students, that public school students are set up to be paid, and that mentors to private school students are set up to be paid a stipend. We also meet with the mentors multiple times to allow for a peer learning community of mentors and to share strategies for engaging the high school students.



Now I'm going to show a video that describes one student and her mentor's thoughts on the WISE program.

music
Madison Haywood: In my lab we focus on glycoengineering for cancer and this semester I focused on the techniques that we use in this lab.
My name's Madison Haywood. I'm in the 11th grade and this is my 12th year at Garrison Forest School. I really enjoy having a mentor 'cause they're so knowledgeable in um their topic and they're really, they easily can explain it to me and make sure that I understand it.
Vrinda Dharmarha: Hi, uh I'm Vrinda Dharmarha I'm a master student in the biomedical engineering department here at Johns Hopkins University.
It's hard to look at, to realize, you know, what your end goal can be. Uh and a program such as this kind of opens your horizons to that and makes you understand what for example, what research is actually like and takes away from it being like an abstract concept to something real.
Madison Haywood: This is truly a unique opportunity, I mean, to be able to be introduced to this type of, this level of research at such a renowned um university like Johns Hopkins. Um it's something you really can't pass up and you really should just um learn about it.
music fades



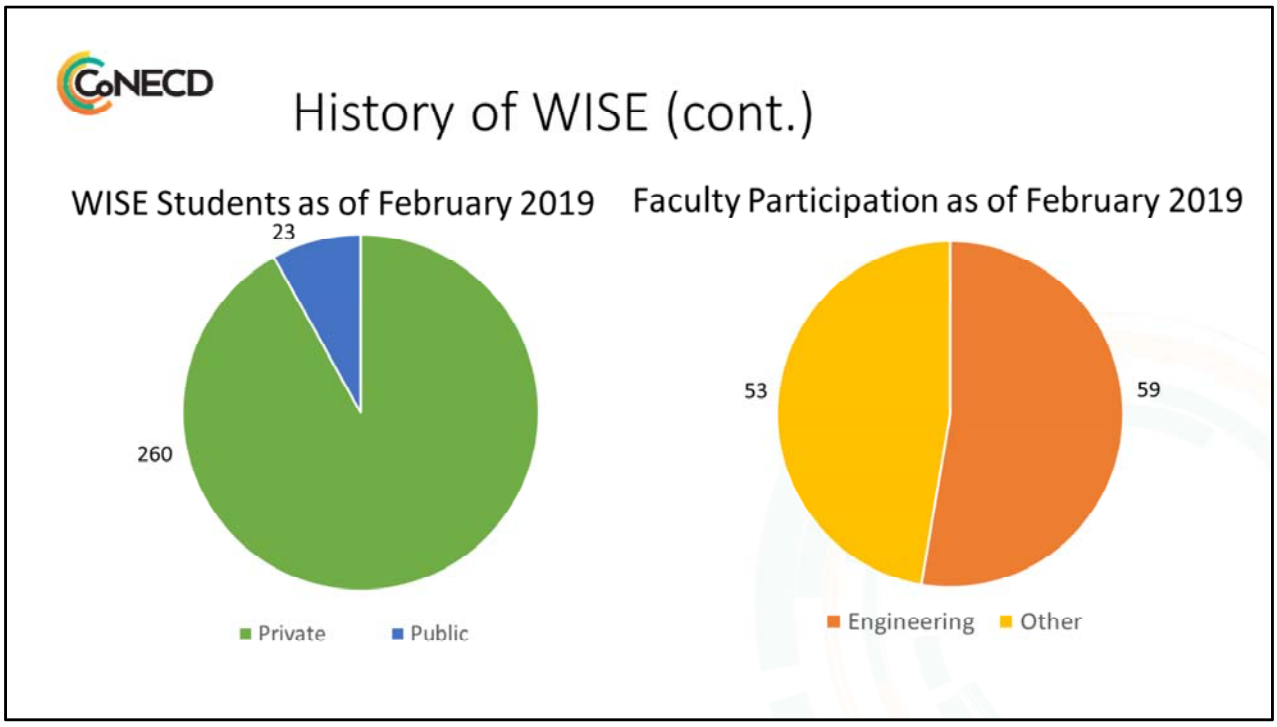
WISE was established in the fall of 2005 at Garrison Forest School, a private girls school, with funding from a local foundation. Although the funding ended, the program continues because the school can charge their families for the program. WISE attracts students to this school.

We added Western High School, an all-girls public school, in fall 2013. Started with 1 student per semester; now can have up to 5 students per semester.

In the beginning, the science department chair at Western was able to spend time to monitor the student and help them with their presentation because they were in her research, Anatomy, or AP Biology class. So she saw the students multiple times per week. The first students encouraged us to change to an online journal so they could type rather than write their reflections. Being in touch with them in person or by email made a big difference. One year there was a student taking a PLTW (Project Lead the Way) class, so the PLTW teacher monitored and helped the student with their presentation. Western enrollment went up requiring more sections of Biology so the research class went away (there were not enough teachers to keep the research class).

This is when the center staff got more involved reading and monitoring public school student journals and providing input on their presentations.

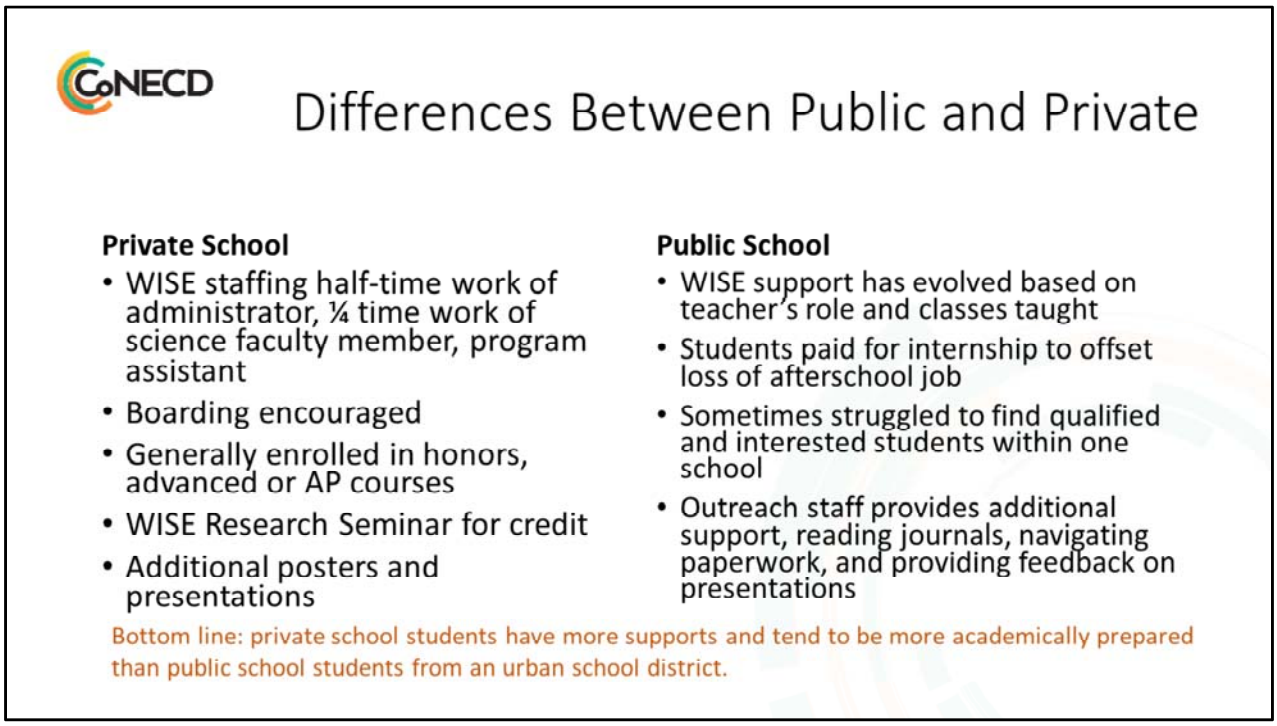
WISE expanded to all local Baltimore City public high schools in fall 2018, in part to consistently find qualified and interested students. We now have an interest and eligibility process which consists of an online form that the student fills out and then is followed with a teacher letter of recommendation and an official transcript.



As of February 2019 there have been 260 private and 23 public school student participants—total 283

Over 112 faculty have mentored over the past 14 years, including 59 engineering school faculty, representing 38% of the full time faculty, with almost half mentoring multiple times

WISE started with 7 students, now there are usually 30 a year.



College counseling:
Garrison Forest School (GFS) has 2 counselors for 60-70 students (senior class), who also advise juniors
Every week the counselors offer college workshops for juniors and seniors, outreach with parents. These students have generally been supported by parents and their school since early elementary. The expectation is that they'll go to college. The school has a 100% placement rate in 4-year colleges.
Western High School has 1 College Bound counselor in the school and 1 senior counselor for 300 students. Because this is a high poverty, majority minority school district, these students are likely to be first generation to college and not have as much home support as their GFS counterparts.

Teacher involvement in the program:
The teacher at GFS has more dedicated time for the program and visits labs while students are there. He meets with mentors which both supports them and lets them know that they are being held accountable. He also teaches a research class which prepares students for their experience and for which they get credit in combination with the program.

Administration involvement in the program:
The Dean of Special programs at the GFS has a conversation with every mentor, answers questions, and explains what we are looking for. Tries to match the students' interest to the research opportunity.

Transportation, boarding and peer interactions:
GFS busses the students from GFS to Hopkins and back, two days a week, so they have time to hear what each other are doing, debrief, and problem solve. Some students boarding for WISE will enjoy a living-learning community at the school that enhances their science experience and provides them with 24/7 faculty support.

Another difference is high school credit versus a stipend. Western was initially chosen because they had a research class, but even so, the teacher explained the need for afterschool income to offset the loss of an afterschool job so we provided a stipend to those students. It may have been easier if a research class had been required. That would have helped with high school credit and time constraints of both the students and the teacher.

Critical Factors for Success

- Student readiness – academics and self-motivation
- Student support during the program
- Selection of interested mentor
- Mentor support before and during the program

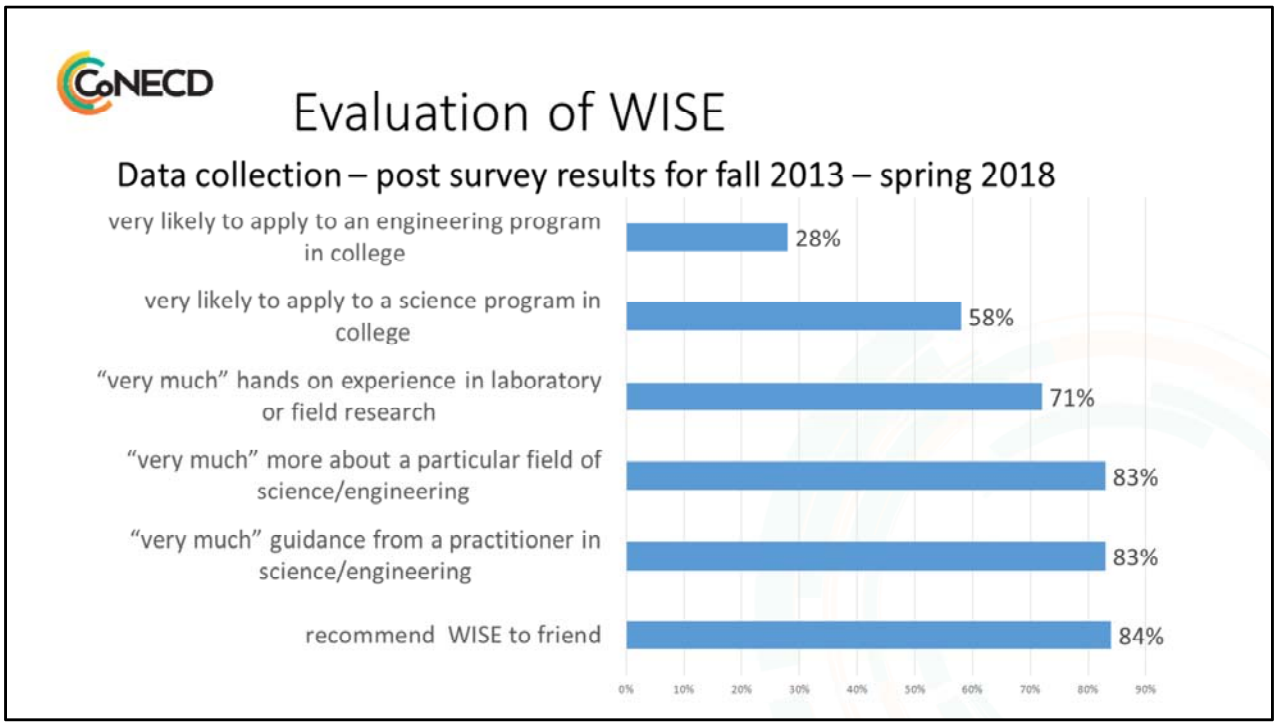
In both the public and private schools, student readiness is key to success. Both academically prepared and interested or self-motivated. Often the students will be learning entirely new things like how to program in Matlab, distill a solution, perform a lab technique, prepare a sample or analyze data. Their mentor will teach them how, but then will expect them to remember and be able to do again. Being self-motivated to learn and not being afraid of asking questions is key to success.

Student support during the program is also key, even if handled differently depending on which type of school:

Visiting students in labs
Reading students weekly journals and intervening if necessary
Providing opportunity for students to practice their presentation and receive feedback

Selection of an interested mentor is critical. We have had problems when the mentor was not motivated to be a mentor. Once a young woman was selected by her faculty advisor as a mentor because she was female. She told the mentee that she didn't like the field—that her parents made her do it. That faculty member offered that mentor again and we declined.

Mentor support before and during the program is important to gauge their interest, to help them think through how they are going to teach a high school student with much less specific knowledge than them—learn how to do what they are planning for students to do and also to see if they need any cultural competency guidance. During the program it is helpful to bring mentors together for an informal pizza lunch, for example, so that they can share their experiences with each other and learn successful strategies from each other.



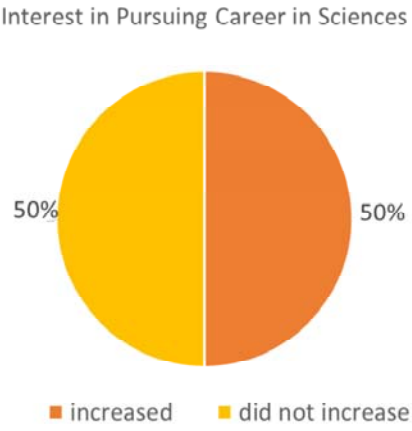
Based on evaluation data, WISE has been fairly successful

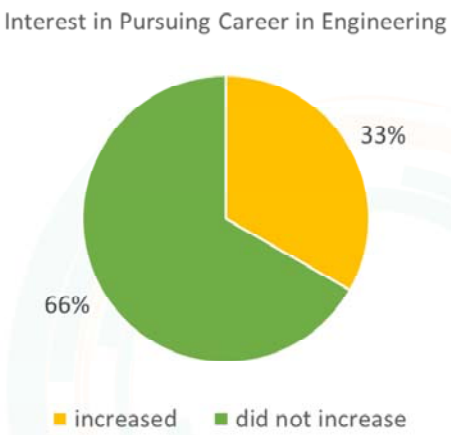
Data collection of post survey results for fall 2013 – spring 2018 were analyzed:
84% of respondents would recommend the WISE program to a friend
83% agreed they received "very much" guidance from a practitioner in science/engineering
83% agreed they learned "very much" more about a particular field of science/engineering
71% agreed that they got "very much" hands on experience in laboratory or field research

58% said they were very likely to apply to a science program in college
28% said they were very likely to apply to an engineering program in college

Evaluation of WISE (cont.)

Data collection – post survey results for fall 2013 – spring 2018





Furthermore:

50% increased their interest in pursuing a career in the sciences
33% increased their interest in pursuing a career in engineering

These results support our goal of increasing women in science and engineering fields

Note: There were 73 respondents, but not all respondents answered all questions

Results

Tracking of post-high school colleges and degrees and other measures of success

	Major in STEM fields	Publish	Continue	Science Fair
Private School	67%	2	16	1
Public School	50%	1	2	

GFS has an alumni office so more easily can track students' colleges and degrees after high school graduation than a public school can

As of Summer 2018:
GFS had 67% of graduates major in STEM fields
Western had 50% of graduates major in STEM fields

We'd like to point to other measures of success which we don't actively track but have learned about as faculty, students, mentors or schools have shared:

- 3 Students have been included on publications, 1 from a public school and 2 from the private school
- 18 students have continued research with their mentors beyond the initial semester, 2 from the public school, 16 from the private school
- And 1 student from the private school participated in Intel Science Fair and was named a 2014 Intel Science Talent semifinalist—one of 300

Student Quotes

- "This program has broadened my horizons. I've always been interested in the medical side of science, and thought going to medical school was pretty much the only option. Now I know that there are great things being done in chemical and biomolecular engineering, too. Going forward, I now have another option that I didn't even know about before this."
  - M. Hunt, 17, All Girls Public High School

Student Quotes (cont.)

- "Being part of WISE has been extremely worthwhile for a lot of reasons, including the fact that it gave me experience juggling a lot of things at once and handling challenges that were completely new to me. I think it has also made me more confident in general."
  - D. Anderson, 16, All Girls Public High School

Case Study

Fall 2013 student from Western HS worked in a Chemical and Biomolecular Engineering lab with a female professor and a male graduate student mentor

- Graduated from Trinity Washington University with biochemistry major in 2018
- Had research internship at Georgetown Lombardi Comprehensive Cancer Center during college
- Inducted into Phi Beta Kappa Honor Society
- Working in neuroimaging research study at the Maryland Psychiatric Research Center

In the fall of 2013 a student from Western High School participated in WISE in a chemical and biomolecular engineering lab with a female professor and a male graduate student mentor

She since graduated from Trinity Washington University with a biochemistry major in 2018 (4 years!)

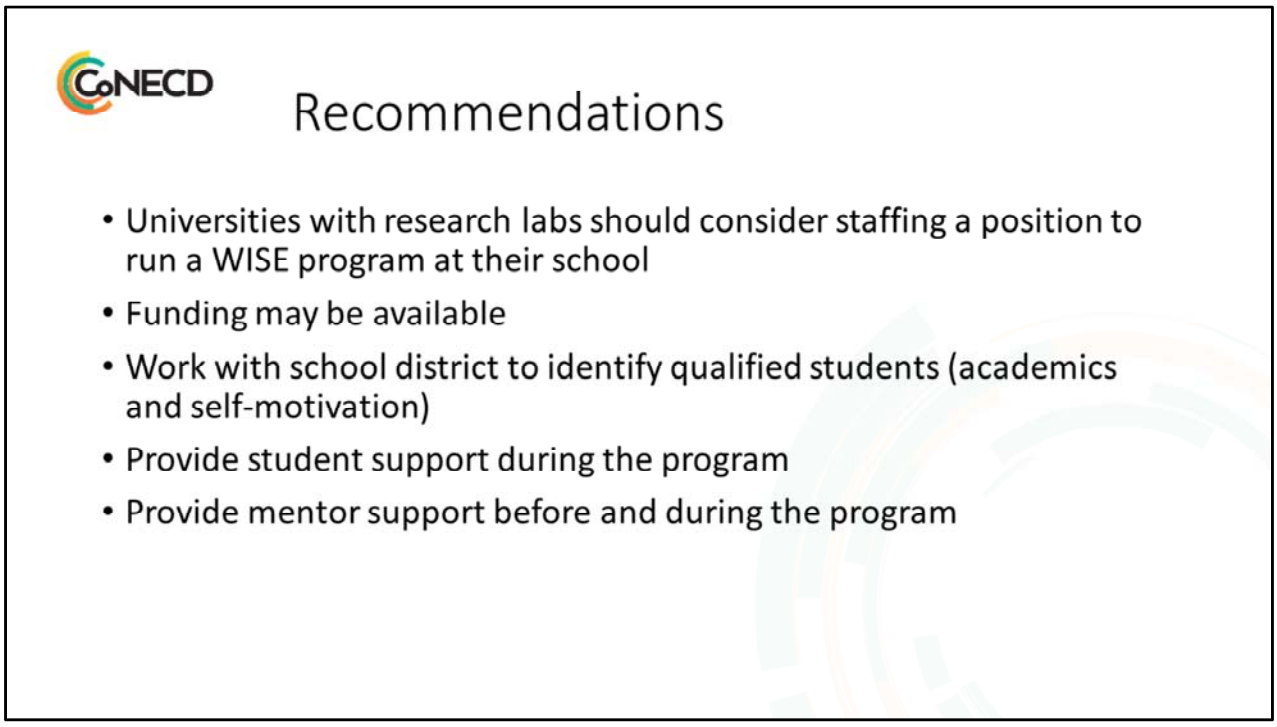
She had a research internship at Georgetown Lombardi Comprehensive Cancer Center during college as well as 2 other internships

She was inducted into the Phi Beta Kappa Honor Society

She is now working in neuroimaging research study at a Maryland Psychiatric Research Center

In her own words, “My work at Johns Hopkins University […] helped open many doors for me when it came to applying for summer internships. This summer I'm interning at a medical center assisting in breast cancer research. [WISE] also helped me to do well in my science lab courses as I (already) knew many of the basic techniques and equipment. I'm still very grateful for the WISE opportunity.”

L. Garcia, biochemistry major, mathematics minor, and first WISE student from Western High School



We would like to encourage Universities with research labs to consider staffing a position to run a WISE program at their school

Funding may be available through:

- NSF AISL which may provide initial staff position
- Faculty NSF CAREER grants which may provide several years of stipends for high school students
- Local foundations or Corporate foundations focused on STEM
- University Diversity Office, School of Engineering, School of Science, School of Medicine, Provost's office
- Mayor's office of workforce development—look for summer youth employment

Work with school district to identify and recruit qualified students (academics and self-motivation). Expect to do both top down and bottom up communications.

Provide Student support during the program

- If first-gen, consider extra support with required paperwork
- Visit students in labs
- Read students' weekly journals and intervening if necessary
- Provide opportunity to practice presentation and receive feedback

Provide guidance to faculty in selecting interested mentors

Provide mentor support before and during the program