CLOSING THE GENDER GAP IN STEM BY CLOSING THE GENDER GAP IN FTC

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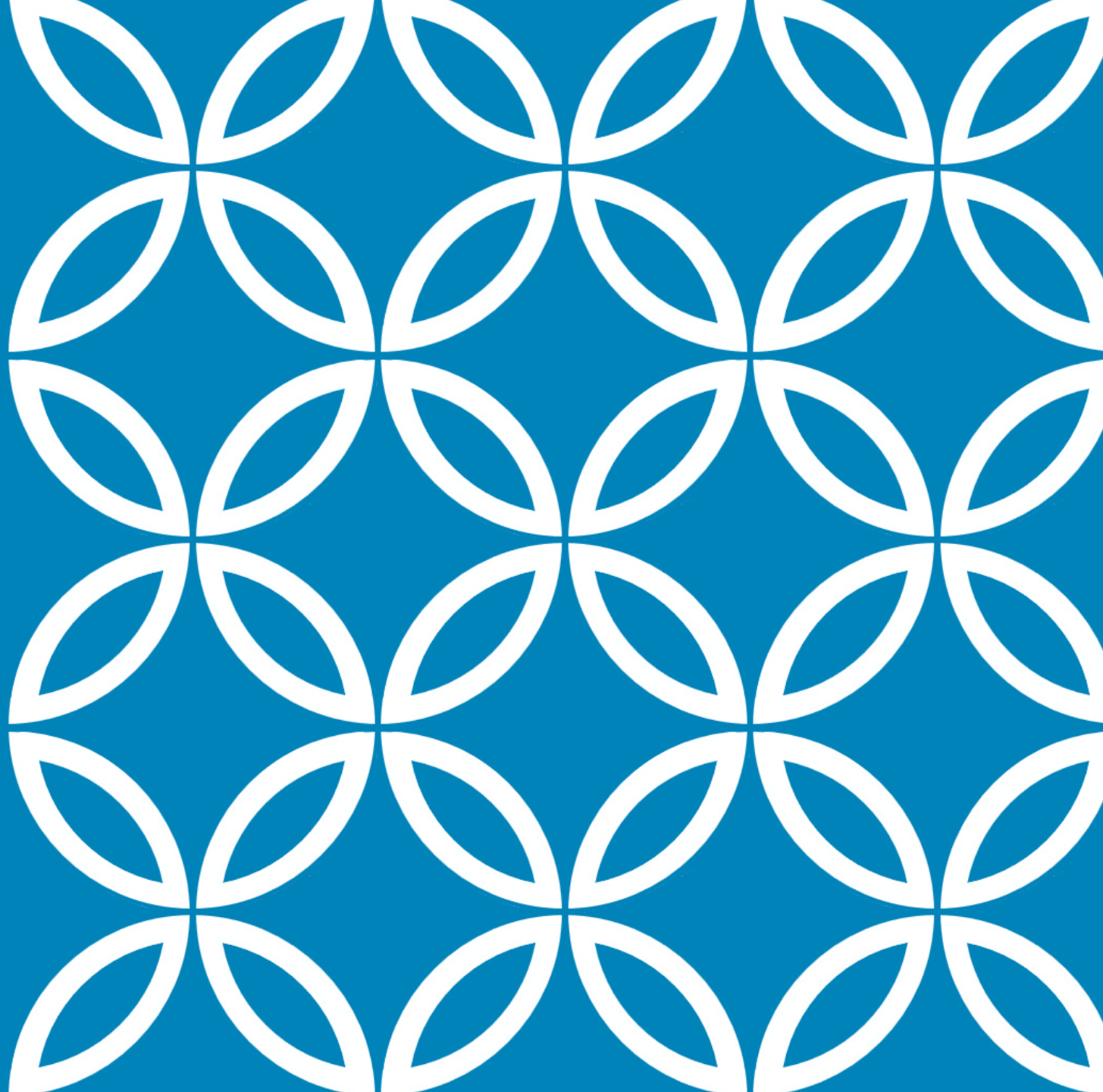
Teams of Innovative Problem Solvers, Inc. 2021

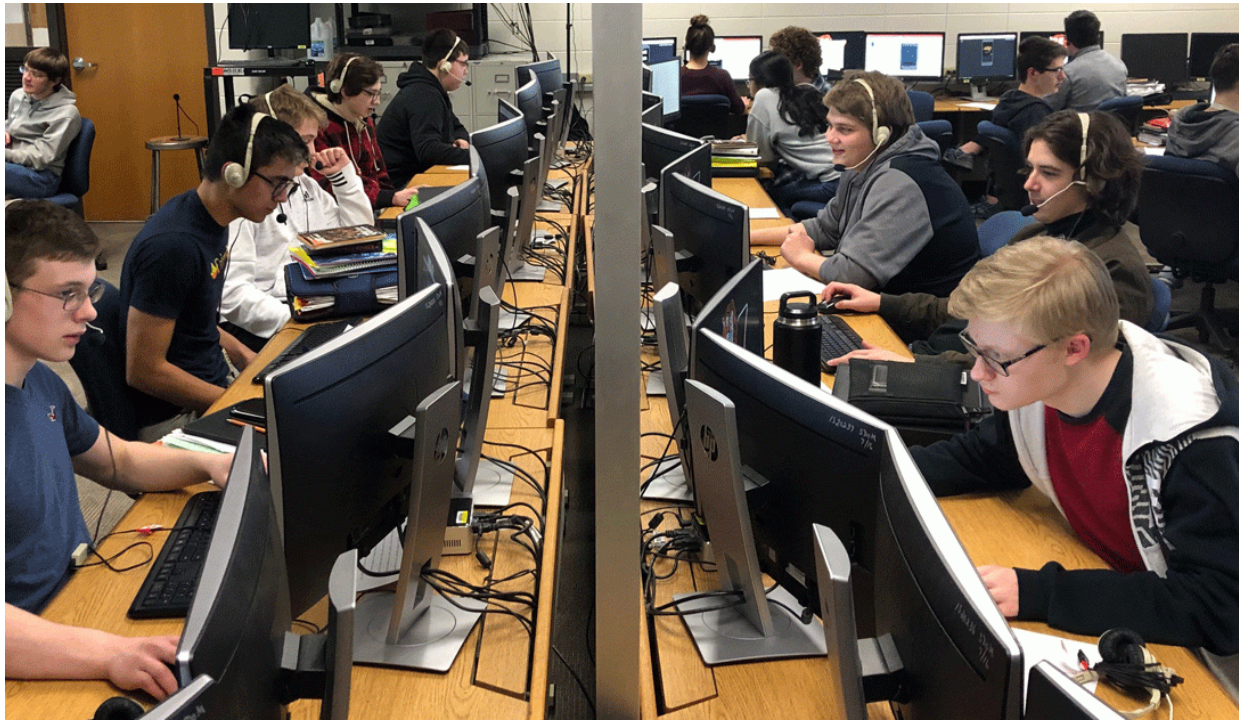


OUTLINE

- What is the gender gap, generally?
- What are the factors that lead to the gender gap?
- What are some solutions that reduce the gender gap?
- What is the gender gap in FTC?
- What is the plan to address the problem?
- What happened with the plan?
- What is the future work?

The video shows an FTC competition.
Among the (4) competing teams in the event, there are no girls among the drivers or operators.

GENDER GAP IN STEM(IN GENERAL)



This photo was taken from an online reference for AP Computer Science. Notice that most of the participants appear to be male.

The gender gap in stem refers to the observation that females are less likely than males to pursue careers in STEM fields.

- In 1980's, 40% of Computer Scientists were female compared to 20% in 2019. Women in Computer Science (2020)

The gender gap also refers to the observation that females are less likely to study STEM fields when compared to males.

- Females represent less than 20% of students studying computer science Vu(2017)

WHY IS THE GENDER GAP A PROBLEM?

STEM jobs pay more than non-stem jobs so when females move into STEM, their income is likely to increase. American Progress (2021)

This creates a meritorious cycle, because women are more likely to invest their income into their children, which improves their children's education and earning potential. This has a general impact of raising the standard of living within a society. JustActions.org (2021)

Teams make better decisions when females are included in the decision-making process, so having more females in STEM is likely to make better solutions withing STEM, which benefits us all. Larson(2017)

The is a shortage of STEM workers, so shifting women into STEM fields will help fill this shortage which will lead to more STEM projects being competed and completing existing projects faster. Radiya-Dixit(2016)

WHAT IS FTC?

https://youtu.be/XkJf4bXoa-0

- Teams of students build 20 pound aluminum robots with 4-8 motors/servos and sensors such as laser range finders and computer vision using Tensor Flow and Vuforia
- Teams compete in 5 rounds of qualifying games with a partner team as an alliance
- Each qualifying game has two phases: autonomous and teleOP
- During autonomous, robots operate without human direction.
- TeleOp allows humans to direct the robot with game controllers.
- Alliances win points when they score more points than their competing alliance
- The season generally runs from September through March
- 28 countries field a total of nearly twenty thousand FTC teams that compete through various rounds toward the World Championships
- FTC students apply their knowledge from AP Physcis, AP Statistics, AP Computer Science A, AP Calculus BC

WHY IS FTC IMPORTANT FOR KIDS?

According to impact statement

According to FIRST (2020), nearly 60% of females that participate in FIRST choose STEM majors as opposed to 12% for females in general and these students are 3.7 and 5.3 times more likely to take courses in engineering and computer science

Three generations of robot teams.
The girls on the left are a rookie FTC team.
The boys in the middle founded their FTC team 5 years earlier.
The youngest girl, bottom left, is on an FLL team but will transition to FTC in two years, when the rookies will be the experts.

GENDER GAP IN ROBOTICS

Hendricks, Alemdar, & Olgletree (2012) documented my observations as a general trend in both VEX and FIRST where both female students and mentors participation dropped from roughly equal in elementary school to less than a third by high school. This decline leads to a gap that persists through college and into the work force in STEM fields such as computer science and engineering where women account for 13% and 26%, according to Society of Women Engineers (2019).

This photo is typical of many high achieving FTC teams. This team won the highest award at the regional competition. The photo appears to depict a team of 15 students with (2) females.

FACTORS IMPACTING GENDER GAP

Females are less successful at spatial reasoning when compared to males and spatial reasoning is considered vital to engineering and physics, Sorby(2016)

Females are more successful than males at reading and verbal skills, so females are choosing opportunities in humanities where they have a clear advantage over males. Breda and Knapp (2019)

Females have chosen fields that are not so "male dominant" because they do not identify with the male culture, the culture does not meet their needs and is not perceived as flexibile) Hill (ND)

https://www.youtube.com/watch?v=oVVDasLOKDk&t=2s

SOME SUCCESSFUL INTERVENTIONS FOR GENDER GAP

- Spatial Reasoning Courses Searby (2016)
- Mitigating "male" culture with visuals such as nature over sci-fi Wallace and Nino (2015)
- Mitigating use of language with test instructions (Pollack 2013)
- Female mentors Hill (ND), Galvin(2016), Dennehy and Sasgupta (2017)
- 79% of FIRST Female Alumni get into stem compared to 51% in the control group and 45% go into engineering compared to 15% in the control group. FIRST Faq (2020)
- Melchoir et al. (2019), Mantz(2019), Hendrix et al. (2012) robotics programs boost interest in STEM

This video is from Girl Powered, an imitative to form female robotics teams to close the gender gap

MY SPECIFIC PROBLEM. . . GIRLS ARE UNDER REPRESENTED IN VERMONT FTC CHAMPIONSHIPS

Girls are very uncommon among the driver, operator and captain on teams

Girls represent a small portion, if any, of most VT teams.

Retention of girls, from year to year, is low

The few girls that are on teams are often in roles such as note keeper, photographer

The over-whelming male bias drives girls away from FTC Male bias drives girls away González-Pérez et al. (2020), Chemaly (2015)

SOLUTION: SYSTEM OF CONNECTED FTC TEAMS

Taking inspiration from other tradition high school sports, TIPS will form rookie, JV and varsity teams. As with other sports, at least (1) group of teams will be all-female.

Each team will be mentored by another team with more experience.

Each team will build on their skills in design, fabrication, programming and operating the robot each year.

Practices will be organized into deliberate 4-hour “workshops” with targeted instruction that can be delivered remotely so teams can make training work for their schedule. Each season will contain 2-4 “workshops”.

Teams will be capped at 6 members to ensure that every participant is directly involved in decision making and operation of the robot.

WHY ALL FEMALE TEAMS?

- Creates more opportunities for girls to lead (boys are more aggressive in stem and tend to take charge when possible) Murphy (2020)
- Creates more opportunities for girls to actively participate in stem(boys are more aggressive than girls when it comes to grabbing and using materials) Murphy (2020)
- Opportunity to shift focus on team culture from competition to cooperation, which should help with retention (Kivikangas 2014)
- Opportunity to build girl-power or lasting supportive relationships between girls which helps with retention Deaner (2016)
- Opportunity to "brand" team to reflect the cultural images that best represent the team, which helps with retention

This video shows a first-half of the drivers and operators were female. By chance, the two all-female teams were placed together in an alliance.

WHY MAKE FLEXIBLE SCHEDULE?

Livingston (2019)

- Girls are busier than boys. They spend more time studying, helping at home and less time socializing and relaxing.

Hill (ND)

- females opt out of activities, like stem, because they do not believe they will get sufficient flexibility so they can not take on more responsibilities
- Jean et al. (2015)

WHY FEMALE MENTORS?

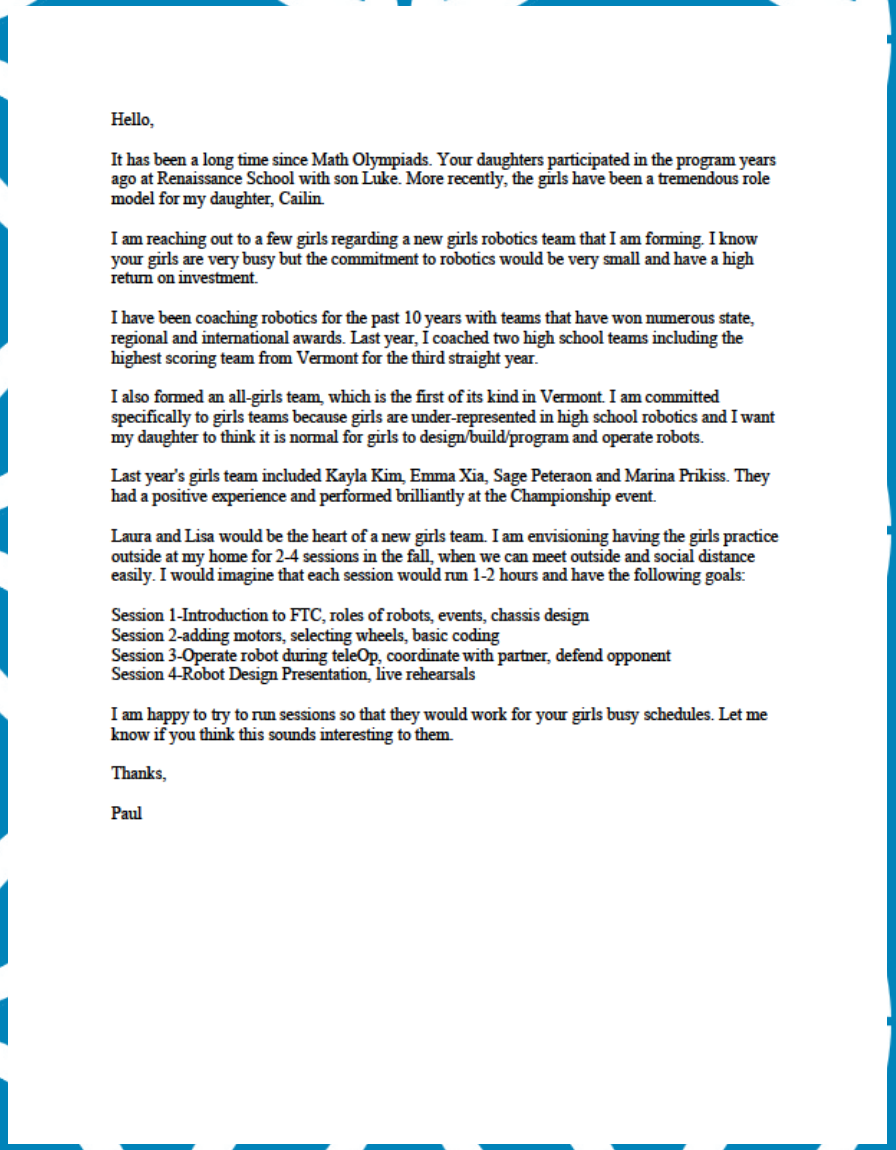
Galvin(2016)

- Female mentors change the culture of an organization because newer females relate to the culture as a female inclusive culture

WHY PERSONAL INVITATIONS?

More than half of girls in a YouGov-Abbott survey say they aren't encouraged to study STEM, but 89% of girls who are urged to study STEM say they plan to pursue it in their educations

Click on the pdf to see the letter I sent to prospective female team members.



Hello,

It has been a long time since Math Olympiads. Your daughters participated in the program years ago at Renaissance School with son Luke. More recently, the girls have been a tremendous role model for my daughter, Cailin.

I am reaching out to a few girls regarding a new girls robotics team that I am forming. I know your girls are very busy but the commitment to robotics would be very small and have a high return on investment.

I have been coaching robotics for the past 10 years with teams that have won numerous state, regional and international awards. Last year, I coached two high school teams including the highest scoring team from Vermont for the third straight year.

I also formed an all-girls team, which is the first of its kind in Vermont. I am committed specifically to girls teams because girls are under-represented in high school robotics and I want my daughter to think it is normal for girls to design/build/program and operate robots.

Last year's girls team included Kayla Kim, Emma Xia, Sage Peteraon and Marina Prikiss. They had a positive experience and performed brilliantly at the Championship event.

Laura and Lisa would be the heart of a new girls team. I am envisioning having the girls practice outside at my home for 2-4 sessions in the fall, when we can meet outside and social distance easily. I would imagine that each session would run 1-2 hours and have the following goals:

Session 1-Introduction to FTC, roles of robots, events, chassis design
Session 2-adding motors, selecting wheels, basic coding
Session 3-Operate robot during teleOp, coordinate with partner, defend opponent
Session 4-Robot Design Presentation, live rehearsals

I am happy to try to run sessions so that they would work for your girls busy schedules. Let me know if you think this sounds interesting to them.

Thanks,

Paul

WHY SEQUENTIAL CURRICULUM?

- Keeps social contract of optimizing time (20-40 hours per year)
- Pushes content delivery to “work-shops” that are stand-alone, allowing for teams flexibility with training.
- Established measurable, achievable goals
- Demonstrates how skills progress over time
- Builds an expectation of personal growth
- Creates opportunities for stages of mentors
- Creates opportunities for re-use of equipment

DANIELSON FRAMEWORK

Learning Environment

Component 2A-

Students understand the importance of the content

The video will highlight sharing important information about robotics as it is a viable career path and many college engineering programs offer scholarships to FIRST participants because those colleges recognize the benefits of robotics. We will share the impacts state from the FIRST website during first the zoom meeting.

Component 2B-

Students show pride in their work

This will be demonstrated when the older girls discuss their experiences at the 2020 Vermont State Championship and show videos about them at the competition. The older girls will say positive things and show positive feelings though tone of voice and body language.

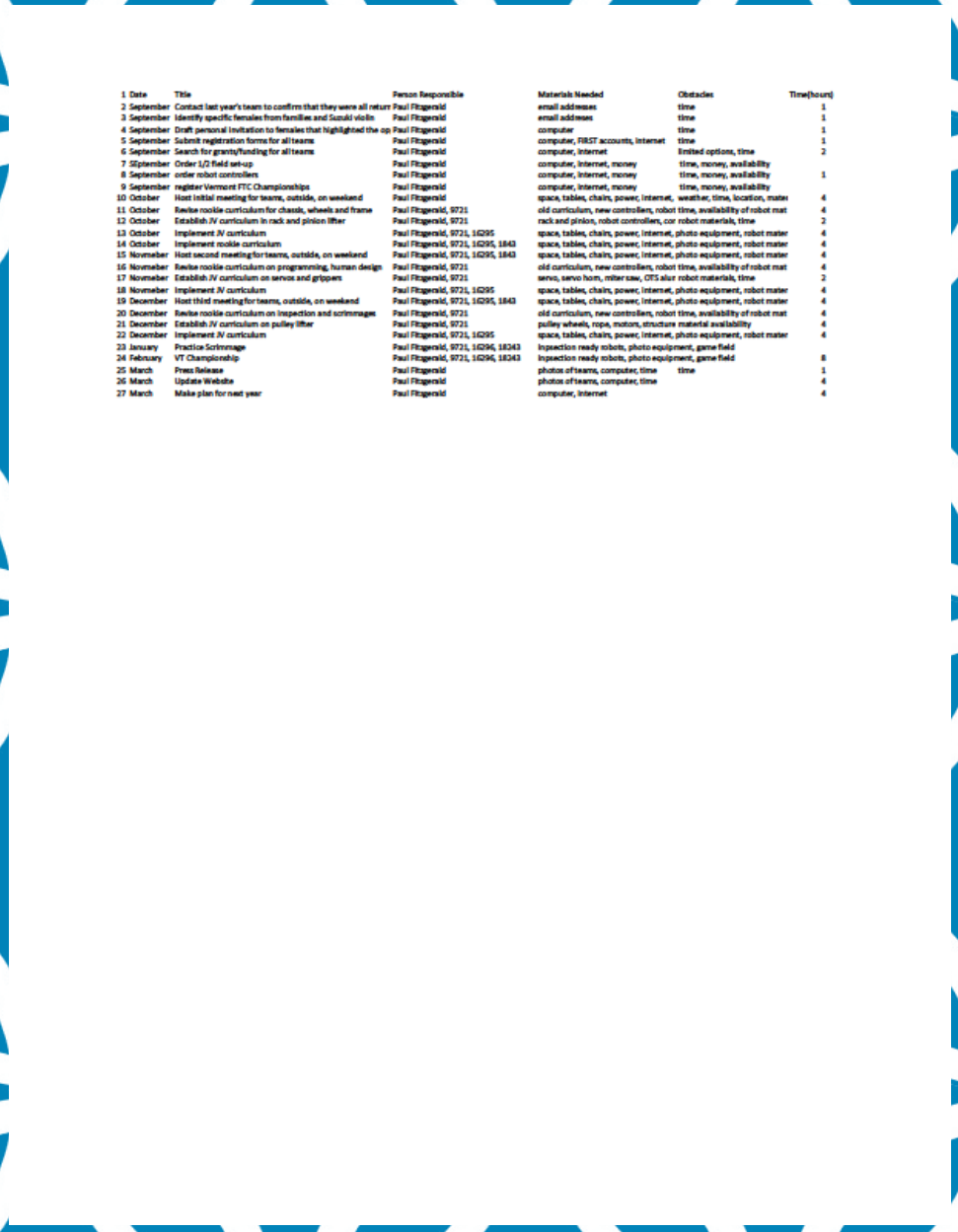
Professional Responsibilities

Component 4B-

a. Maintaining Non-instruction records
    i. I will record a video of the online mentoring using Zoom that will document the older girls mentoring the younger girls.
    ii. I will share the video on the non-profit website to encourage other girls to try robotics.

PLAN AND CURRICULUM OUTLINE

Click on pdf for details, including timeline, responsible persons, potential obstacles, necessary resources



	Date	Title	Person Responsible	Materials Needed	Obstacles	Time(hours)
2	September	Contact last year's team to confirm that they were all return	Paul Fitzgerald	email addresses	time	1
3	September	Identify specific females from families and Suzuki violin	Paul Fitzgerald	email addresses	time	1
4	September	Draft personal invitation to females that highlighted the op	Paul Fitzgerald	computer	time	1
5	September	Submit registration forms for all teams	Paul Fitzgerald	computer, FIRST accounts, internet	time	1
6	September	Search for grants/funding for all teams	Paul Fitzgerald	computer, internet	limited options, time	2
7	SEptember	Order 1/2 field set-up	Paul Fitzgerald	computer, internet, money	time, money, availability	
8	September	order robot controllers	Paul Fitzgerald	computer, internet, money	time, money, availability	1
9	September	register Vermont FTC Championships	Paul Fitzgerald	computer, internet, money	time, money, availability	
10	October	Host initial meeting for teams, outside, on weekend	Paul Fitzgerald	space, tables, chairs, power, internet,	weather, time, location, mater	4
11	October	Revise rookie curriculum for chassis, wheels and frame	Paul Fitzgerald, 9721	old curriculum, new controllers, robot time, availability of robot mat		4
12	October	Establish JV curriculum in rack and pinion lifter	Paul Fitzgerald, 9721	rack and pinion, robot controllers, cor robot materials, time		2
13	October	Implement JV curriculum	Paul Fitzgerald, 9721, 16295	space, tables, chairs, power, internet, photo equipment, robot mater		4
14	October	Implement rookie curriculum	Paul Fitzgerald, 9721, 16295, 1843	space, tables, chairs, power, internet, photo equipment, robot mater		4
15	Novmeber	Host second meeting for teams, outside, on weekend	Paul Fitzgerald, 9721, 16295, 1843	space, tables, chairs, power, internet, photo equipment, robot mater		4
16	Novmeber	Revise rookie curriculum on programming, human design	Paul Fitzgerald, 9721	old curriculum, new controllers, robot time, availability of robot mat		4
17	Novmeber	Establish JV curriculum on servos and grippers	Paul Fitzgerald, 9721	servo, servo horn, miter saw, OTS alur robot materials, time		2
18	Novmeber	Implement JV curriculum	Paul Fitzgerald, 9721, 16295	space, tables, chairs, power, internet, photo equipment, robot mater		4
19	December	Host third meeting for teams, outside, on weekend	Paul Fitzgerald, 9721, 16295, 1843	space, tables, chairs, power, internet, photo equipment, robot mater		4
20	December	Revise rookie curriculum on inspection and scrimmages	Paul Fitzgerald, 9721	old curriculum, new controllers, robot time, availability of robot mat		4
21	December	Establish JV curriculum on pulley lifter	Paul Fitzgerald, 9721	pulley wheels, rope, motors, structure material availability		4
22	December	Implement JV curriculum	Paul Fitzgerald, 9721, 16295	space, tables, chairs, power, internet, photo equipment, robot mater		4
23	January	Practice Scrimmage	Paul Fitzgerald, 9721, 16296, 18343	Inspection ready robots, photo equipment, game field		
24	February	VT Championship	Paul Fitzgerald, 9721, 16296, 18343	Inspection ready robots, photo equipment, game field		8
25	March	Press Release	Paul Fitzgerald	photos of teams, computer, time	time	1
26	March	Update Website	Paul Fitzgerald	photos of teams, computer, time		4
27	March	Make plan for next year	Paul Fitzgerald	computer, internet		4

CURRICULUM PROGRESSION OVERVIEW

ROOKIE BOT (5 PTS)

Symmetrical frame

Two motor drive system

OnBot Java Programming

Battery, controller, switch for electronics

Inspection ready with numbers, bumpers

Assists JV, Varsity in competition by pushing and defense

JV BOT (15 PTS)

- Re-use rookie chassis
- Single active system for collection
- Spur gears, rack gears, chains, sprockets, servos
- Active scores points, assists Varsity and defense

VARSITY 1 60+ PTS

- Re-use JV chassis
- Autonomous navigation using 2m distance sensors, motor encoders and gyro
- active lifter system using pulleys, linear slides
- Android studio for programming

ELITE 100+ PTS

- Autonomous behaviors with TensorFlow and Object Recognition
- Autonomous navigation with Vuforia and Image Detection
- Holonomic Drive Systems using mecanum wheels and 4 motors
- Web Cam for computer vision

IMPLEMENTATION (OVERVIEW)

2020

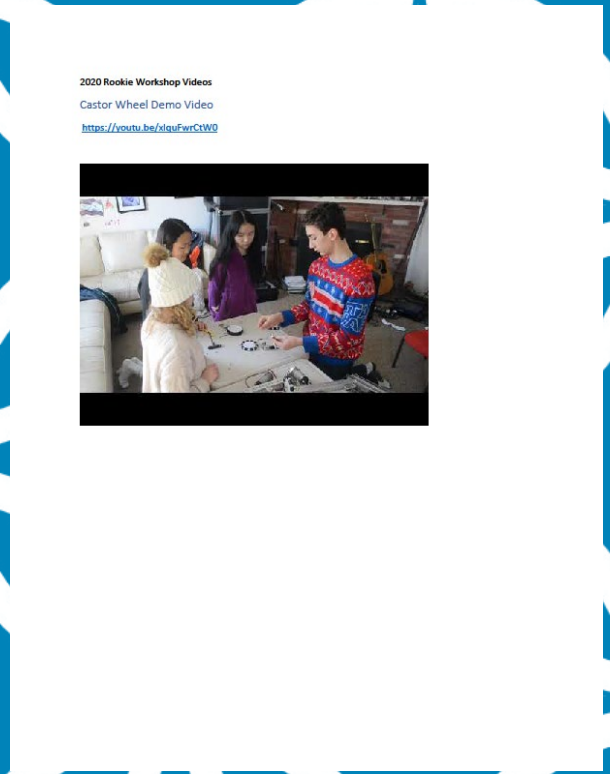
launched first girls team by inviting the sisters of current team members and a few other girls I knew personally through math or violin

held (3) training sessions where older team mentored their siblings, including cooperative scrimmages

Rookie team participated in 2020 Vermont FTC Championships as first all-female team from VT

- 2021
  - Alumni successfully mentored varsity team for Dean's List Award and for robot fabrication using Zoom
  - Varsity team mentored JV team both in-person and remotely
  - 2020 Rookie team transitioned to 2021 JV team.
    - Added a single active collecting system, based on spur gears and servos
    - Re-used chassis from 2020
    - Two in-person sessions, outside
  - Formed a new rookie team
    - Personal invitation to two sisters I knew from math and violin
    - They modified a prototype chassis
    - Remote trainings because of COVID
    - Remote mentoring from Varsity and JV Teams
  - Both teams competed in 2021 VT FTC Championships

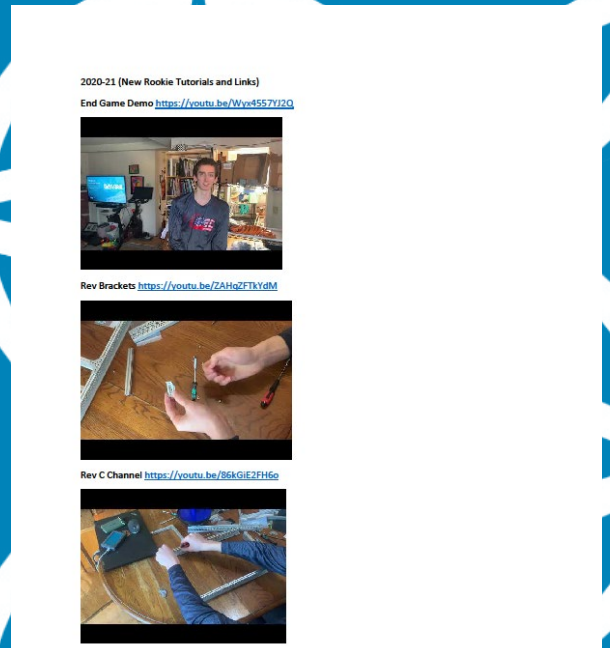
IMPLEMENTATION-DOCUMENTATION-ROOKIE TRAINING (2020) AND UPDATED FOR (2021) PDF'S WITH LINKS (VARSITY MENTORING ROOKIE)



2020 Rookie Workshop Videos

Castor Wheel Demo Video

https://youtu.be/xlquFwrCtW0



2020-21 (New Rookie Tutorials and Links)

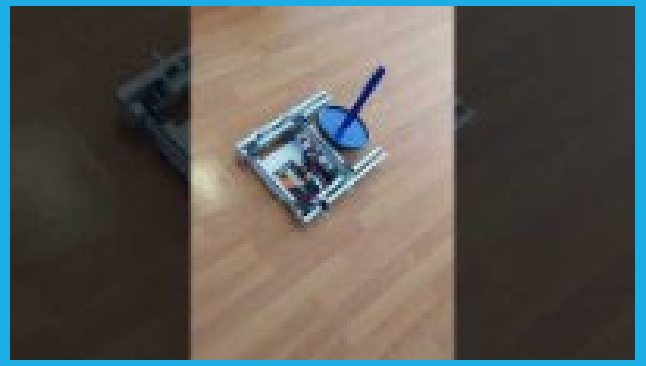
End Game Demo https://youtu.be/Wyx4557YJ2Q

Rev Brackets https://youtu.be/ZAHqZFTkYdM

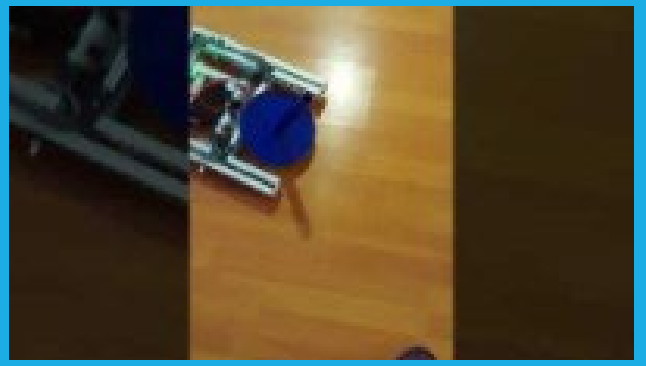
Rev C Channel https://youtu.be/86kGiE2FH6o

IMPLEMENTATION DOCUMENTATION- ROOKIE TEAM

https://youtu.be/aeldt1LCSIY Driver 1 Robot Demonstration



https://youtu.be/UEn9gdFLC68 Driver 2



https://youtu.be/le6a0hn8jGE Rookie Presentation

https://youtu.be/7uv7QtN80g0 JV Mentoring Rookie

IMPLEMENTATION DOCUMENTATION - JV TEAM

https://youtu.be/JwnOjksk8wQ Judges Presentation

https://youtu.be/4YTtWYo9QrU Robot Operation Demonstration

IMPLEMENTATION DOCUMENTATION -VARSITY TEAM

https://youtu.be/S67bkHhxRIg Robot Design Presentation

https://youtu.be/C6Tm2Nvetro Robot Demonstration Video

Notice-younger sister, FLL team 3958-helping due to COVID restrictions

REFLECTIONS

Varsity team was recognized with second place for Innovation (for rookie-JV-varsity progression) and second place for Connections (for mentoring three teams) which validated their efforts. Robot scored 100+ points.

JV Team successfully mentored rookie team to be ready for judging events and their robot scored 15 points. JV team plans to return next year.

Rookie team successfully participated in competition and earned 5 pts. They are also planning to return next year.

NEXT STEPS

I hope all of the participants return as alumni mentors or active team members next year so that they can progress to the next level.

I need to find a space to fit all of these teams so there can be monthly community practices.

I would like to find a female adult mentor that can attend each monthly community practice.

I would like to present my proposal to high school coaches at SBHS, CVU and Essex along with starting new teams at Winooksi and Burlington High Schools.

I need to make some JV tutorials on lifters, sweepers and servos.

I need to make some varsity videos on pulleys and computer vision.

I would like to work on a curriculum reference that connects FTC directly to AP Physics and AP Computer Science A

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CLICK TO VIEW PDF

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