Practical Pre-field Collaborative Experience for Prospective Physics teachers

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The focus of this presentation is mainly on the design of this pre-field experience, and also the goals and outcomes, which are considered the takeaways.

Time is reserved somewhere in the middle and at the end for those who might be able to share other examples of pre-field collaborations or possibilities, and any recommendations that you might have for this one. As well, there is time for questions; however, questions can be asked anytime during the presentation.
In Montgomery County, Virginia, a yearlong robotics exists which incorporates a national robotics competition, For Inspiration and Recognition of Science and Technology (FIRST®). The program is a collaborative between Montgomery County Public Schools (all four high schools), Virginia Tech’s School of Education (Science Education), and the Department of Mechanical Engineering. High school students can participate in this program throughout their time in high school beginning at the sophomore level.

The program is in its 15th year.
Engineering Leadership in Practice: Managing the Technical Design Process

The course was co-developed with a faculty member in Mechanical Engineering.

It focuses on developing the students’ skills as a facilitator of learning and team processes. Beginning with setting goals and objectives, the university students facilitate the planning, designing and construction of the robot for the FIRST competition fostering the application of mathematics, and science content and theories, as well as the engineering design process.

They report on their progress regularly and maintain records. From these records, at the end of the semester, they prepare and present a final report to the high school faculty and make recommendations for advancing the program.
The comprehensive focus on mentoring and facilitating prepares the students for their real world practice as teachers and engineers. The university students learn to facilitate inquiries that support the high students discovery of the meanings of science and mathematics theories through the applications. These skills are also applicable to leading and participating in design teams in industry.

The knowledge gained from the experiences is applied in facilitating the work of their subteams.
University Mentor Expectations

Mentors are assigned to lead, or co-lead a subteam of high school students and they log a minimum of **15 hours each week** with their assigned groups during the build season. Mentors also **attend a minimum of one competition** with the FIRST team.

For twelve years, the course primarily consisted of engineering seniors from varied disciplines; however it was suggested in conversations during the planning meetings for the PhysTEC project that this program could also be valuable for physics students interested in teaching. Thus, PhysTEC slots were designated for the course. The first group of PhysTEC students were included in 2012.
VT PhysTEC’s Major Goal and Objective for this program

During the planning meetings, it was realized that this program aligned with the goals of providing a pre-field experience for physics students.

The goals are

• to provide future teachers with early and realistic teaching experiences that are tightly connected to science methods courses on inquiry-based and learner-centered pedagogy.

• To build on and expand existing programs, namely the Physics Outreach Team and the Robotics Program, to create two early field experiences for PhysTEC students.”
Additional Goals/Objectives

Experiences that counter social constructions around teaching as a profession.

• Not realizing the life in teaching based on past experiences
• Anyone can teach, or those who can do, and those who can’t teach.
• Teaching not a rewarding career

Students reported in interviews that they had conversations with parents and peers questioning their decisions to teach. Parents and peers made statements related to teaching not being a profession worthy of the hard work that they devoted to getting their degrees.
“I want us all to think about new and creative ways to engage young people in science and engineering ... encourage young people to create, build, and invent -- to be *makers* of things, not just *consumers* of things."

President Barack Obama

2009 National Academy of Sciences Annual Meeting
“In 2007, a Carnegie Foundation commission of distinguished researchers and public and private leaders concluded that "the nation’s capacity to innovate for economic growth and the ability of American workers to thrive in the modern workforce depend on a broad foundation of math and science learning, as do our hopes for preserving a vibrant democracy and the promise of social mobility that lie at the heart of the American dream".
This reduction of the United States’ competitive economic edge was cited as a major motivation for the crafting of the Next Generation Science Standards.

*Every* standard (K-12) incorporates “Science and Engineering Practices.”

At middle-school and high-school levels there are dedicated engineering standards.

While not all states will adopt NGSS, it will undoubtedly influence science and math education nationally.
NGSS has resulted in gained momentum on the emphasis on STEM education.

STEM was determined to be an “economic imperative,” and is now the word of the day. Federal policies, programs and initiatives communicated the significance of STEM education to address the growing number of occupations that will require a STEM background to meet the needs of an increasingly complex and demanding society.

Recently, in the focus on STEM education, more attention is being given to the “E” in this acronym. *Engineering is the application of science, technology and mathematics.*
How the practices of scientists and engineers are integrated into both inquiry and design

These activities are now being integrated with our science methods course.

One helpful way of understanding the practices of scientists and engineers is to frame them as work that is done in three spheres of activity,

• In one sphere, the dominant activity is investigation and empirical inquiry

• In the second, the essence of work is the construction of explanations or designs using reasoning, creative thinking, and models.

• And in the third sphere, the ideas, such as the fit of models and explanations to evidence or the appropriateness of product designs, are analyzed, debated, and evaluated [21-23].
Their Assignments

Mentors will

- **Co-develop with your subteam a timeline/gantt chart beginning with the goals and objectives** outlining the responsibilities for the final four weeks of build season for the subteam.

- **Keep a logbook of all of the subteam activities** related to the goals and objectives each week. This information will be used to inform the final evaluation report (#7).

- **Complete 4 memos**, one at the end of each week answering these questions: 1. What is the status of your sub-team? 2. What is your plan for the path forward for the sub-team and how will you facilitate it?

- **Submit a final evaluation report** due at the end of the semester to the university and public school faculty. The evaluation will include the goals and objectives, your activities related to the goals and objectives, your assessment of your effectiveness in achieving the goals and objectives, challenges and recommendations.

- Choose one of the recommendations and translate the strategy into a tool that is submitted to the FIRST high school administration.

- **Make a final oral presentation (15 min.)** of this evaluation for the high school faculty.
Thoughts?

What do you perceive as potential benefits?

What possibilities exist that you might have access to and/or modifications?
One of the first PhysTEC Student’s perspectives
Possible

- Application of physics theories and principles in an authentic project
- Exposure to alternative approach for teaching physics
- Jumpstart students’ thinking on making physics courses engaging and relevant
- Opportunity to be meaningfully engaged with students in an enjoyable activity
- Alternative view of the rewards of teaching
- Project applies the recommendations of the Next Generation Science Standards, which also aids in preparing students for majoring in STEM careers.
- Orienting them to the era in which they will be teaching.
MCPS/VT Robotics: Physics Connections

Drivetrain subteam
Practical physics applications: torque, geometry, force

Instructional opportunities: student-conducted research and synthesis

I worked with students on projectile motion equations for programming the basketball launcher and dealt a bit with torque and rpm reduction when designing our drivetrain. This year, center of mass is key while designing a bot that can lift recycling totes without tipping itself over.

I also remember last year walking students (who hadn't yet taken physics) through a physics problem to help them set up a pneumatic lift system. While we didn't end up using the pneumatics, they learned a bit about equilibrium, torque, and forces.
Questions or Comments