On Being a Physics Major: Student Perceptions of Physics Difficulties, Rewards, and Applicability of Innovation and Entrepreneurship

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Abstract

Undergraduate majors' attitudes and perceptions about physics can strongly influence their identity as physicists, persistence, and pursuit of physics-related careers. Career pursuit especially, is impacted by students' perception of physics and its relationship to aspects of innovation and entrepreneurship (IE), which are essential skills for physics-intensive careers.

To explore students' attitudes and perceptions, we surveyed 178 physics majors nationally. To analyze this data, we used descriptive statistics and emergent methods of qualitative analysis. While data collection is ongoing, preliminary results show themes of physics majors' value for hard work, broadly applicable problem-solving skills, and the rewarding quest for a meaningful application of their knowledge.

Research Questions

1) What do physics majors emphasize when asked to describe physics to a high school student considering majoring in physics?
2) How do students position physics with respect to aspects of innovation and entrepreneurship and other disciplines?

Introduction

Physics Students' Retention and Career Paths

- There are difficulties retaining students in physics yet departments with a strong career focus have better retention. [1]
- Physics students go on to pursue multiple different career paths including a sizable number in the private sector. [2]
- Physics bachelors recipients who worked in the private sector reflected that learning more innovation and entrepreneurship skills (creativity, communication, technology, leadership, design, business, and social impact) in physics would benefit future students to enter and succeed in these careers. [3,4]

Perceived and Socialized Physics Identities

- How students see themselves with respect to physics, their identity, has implications for whether they will persist in physics and see physics as a viable career path. [5]
- Wang and Hazari (2018) identified the role of synergy between implicit (e.g., assigning the student a challenging task) and explicit (e.g., telling the student they should consider a physics-related career) teacher recognizing strategies in influencing students' identity. [6]
- Physics departments can broaden disciplinary boundaries and recognize majors as physicists, or not, based on social interactions related to a [perceived and socialized] ability of the student with respect to a [perceived and socialized] nature of physics. [7]

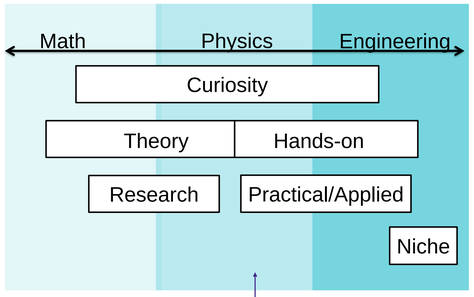
Study Design and Analysis

- Physics I&E (PIE) Perspectives survey of 178 student participants from 12 colleges and universities in the Northeast, Midwest, South, and Southeast regions of the U.S.
- Open-ended free response question: "If you were to describe being a physics major to a senior in high school who was considering majoring in physics, what would you tell them about being a physics major to help them with their decision?"
- Phenomenological coding methods to examine students' perceptions about physics as a discipline
- NVIVO matrix coding, cluster analysis, and semantic analysis methods were used to compare between codes and identify themes

Perception of Physics as Positioned with Other Disciplines

Physics versus Math:

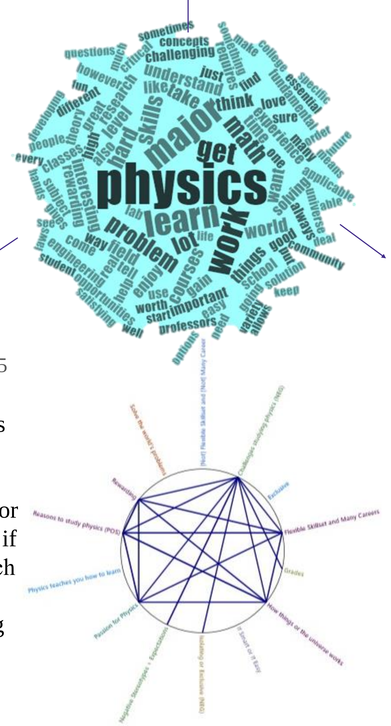
- "The "If you love mathematics and you love the application of mathematics to real world phenomenon, physics is a great choice to major in."
- "Keep up with the higher level math courses, because having a good handle on the theory is essential."
- "Physics is hard because it's mostly math hiding behind a mask."



Physics versus Engineering:

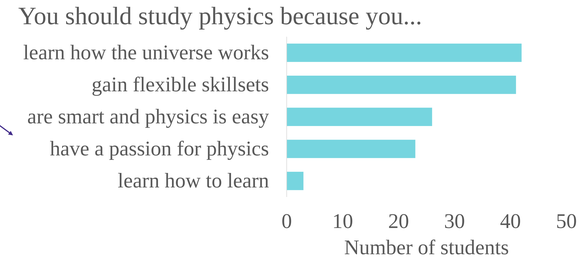
- "The main attraction [of physics] to this point for me has been a lot of very interesting research opportunities that I don't think a lot of engineering majors get."
- "A fairly common saying is engineers do one problem a thousand times, but physicists solve a thousand problems once."

How to Succeed



- Attitudes: Physics majors highlighted four key attitudes and mindsets needed for success; curiosity, innovation, perseverance, and comfort with failure.
- Community: "The longer you stay in the physics major the more you'll start to sound like the professors... if you just like imitating [the way they talk], it'll be much easier for you to stick through the 4 years."
- "Balance your life outside of physics. It is a demanding major and sometimes you can get a little lost in all the work, but it is important to maintain friendships."

Rewards and Challenges



- Challenging, but rewarding: "challenging and time consuming, but the stuff you get to learn and do makes it worth it. Especially if you are truly passionate and engaged in learning physics."
- Rewards: Over 150 students mentioned a reward of physics in some form, though there were a diverse range of reasons why they felt it was rewarding.
- Challenges: most students talked about physics as hard, though some identified specific categories including negative stereotypes and expectations, harsh grading policies, and an isolating culture.

Discussion

When describing physics, students position physics between disciplines and emphasize rewards like understanding how the universe works: Students position physics with respect to other disciplines (especially math or engineering) or their own high school experience, provide advice on how to succeed as a physics major, or discuss the rewards and challenges of learning physics. Rewards are typically described as either learning how the universe works or gaining flexible skill sets, the latter being more career focused.

Physics I&E (PIE) Perspectives Survey can be a valuable tool for planning and implementing inclusive and career-focused department change: Students' perceived physics identities can be at odds with department goals for retention, inclusion, and successful career placements. Understanding their students' identities can help departments broaden disciplinary boundaries and provide more inclusive social interactions that recognize students as [future] physicists and support them across a range of careers.

Selected References

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