

Growth Mindset and Agency in Learning Physics Innovation and Entrepreneurship

Daryl L. Moore, Anne E. Leak, and Benjamin M. Zwickl

HIGH POINT UNIVERSITY

Stout School of Education

One University Parkway, High Point, NC 27268



Abstract

What physics majors feel is possible to learn in physics has implications for what they can learn. This is especially critical for innovation and entrepreneurship (I&E) that students may not see as part of physics. We analyzed data from the PIPELINE national survey to describe student perceptions regarding innovation and entrepreneurship and how learnable students find each aspect.

Background

Growth Mindset: Carol Dweck posits that students with a growth mindset believe their skills can be developed [1].

Self-efficacy: Alfred Bandura suggests that internal and external social factors contribute to an individuals' perception of being able to overcome challenges [2]

Implicit Attribution: Yeager & Dweck relate an individuals' core assumptions of the malleability of personal qualities as influential in how one assesses situations and interactions [3].

Self-Determination: Ng holds that when students seek to attain some reward, such as grades, they are extrinsically motivated, yet students will achieve more academic growth when intrinsically motivated by individual choice or interest in their learning [4].

Purpose

Recent global career and job skills projection reports suggest that skills associated with innovation and entrepreneurship (I&E) consisting of Creativity, Communication, Leadership, Social Impact, Design, Business, and Technology will be essential for workplace success in the global workplace of the future.

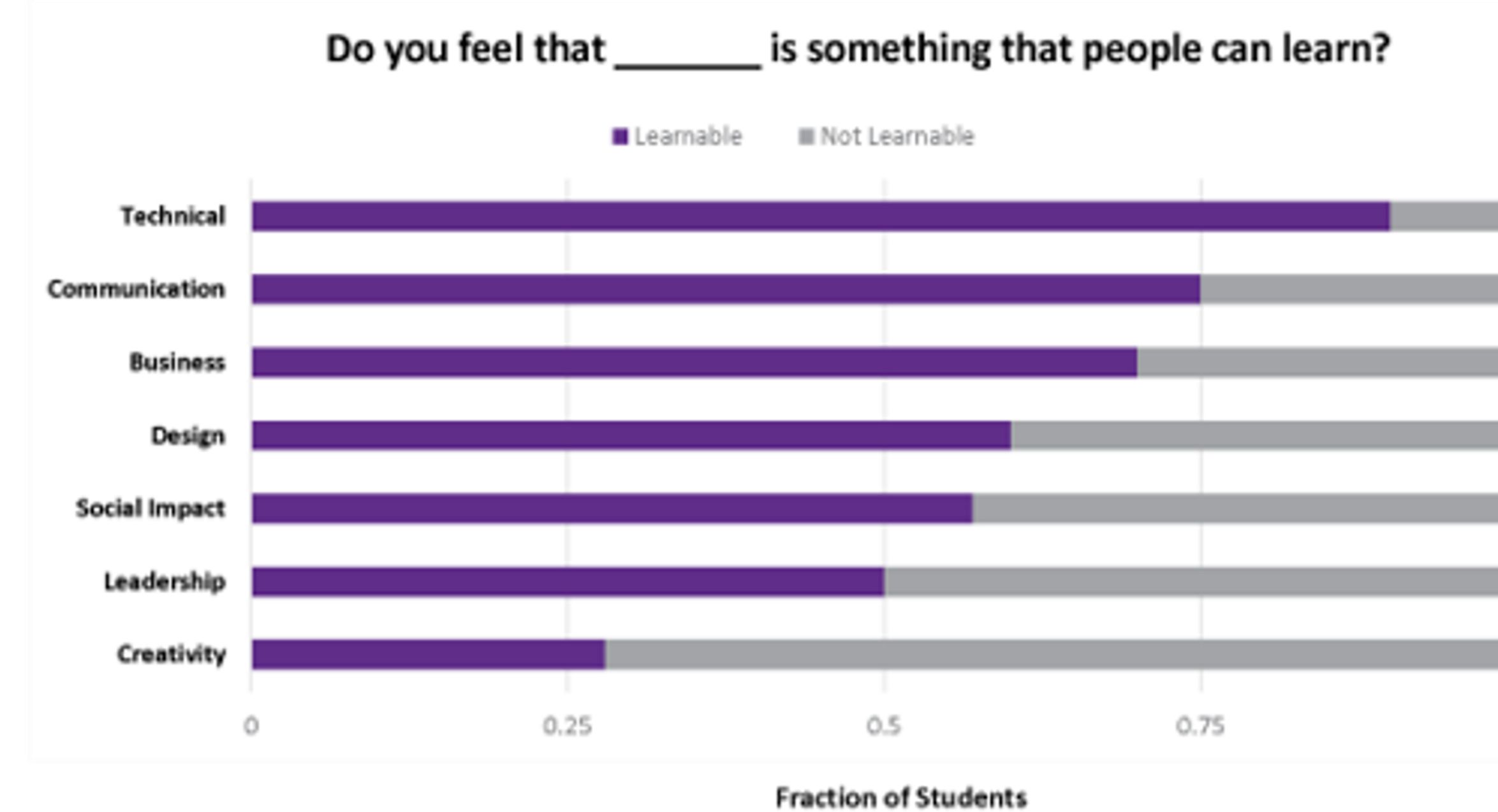
RQ1: Which aspects of I&E do students perceive as learnable?

RQ2: Based on growth mindset and related theories, why might each aspect be more or less learnable for students?

Findings

Findings using descriptive statistics and thematic coding from 133 undergraduate physics majors illustrate the aspects of physics that most commonly demonstrate a growth mindset across I&E aspects.

I&E Aspects



Technical: Students feel that technical skills are relevant, accessible, and report that they have learned these skills from a variety of experiences, especially labs and research.

Communication: Students found that communication skills were learnable, but required substantial autonomy, because of a lack of access to explicit instruction.

Business: Business skills were learnable by students, but not generally relevant to doing physics.

Design: Design was considered either learnable or somewhat learnable, and less so than technical, communication, and business aspects of I&E.

Social Impact: Social impact was considered by students as either learnable or somewhat learnable, but most felt that it was not messaged as important in their department.

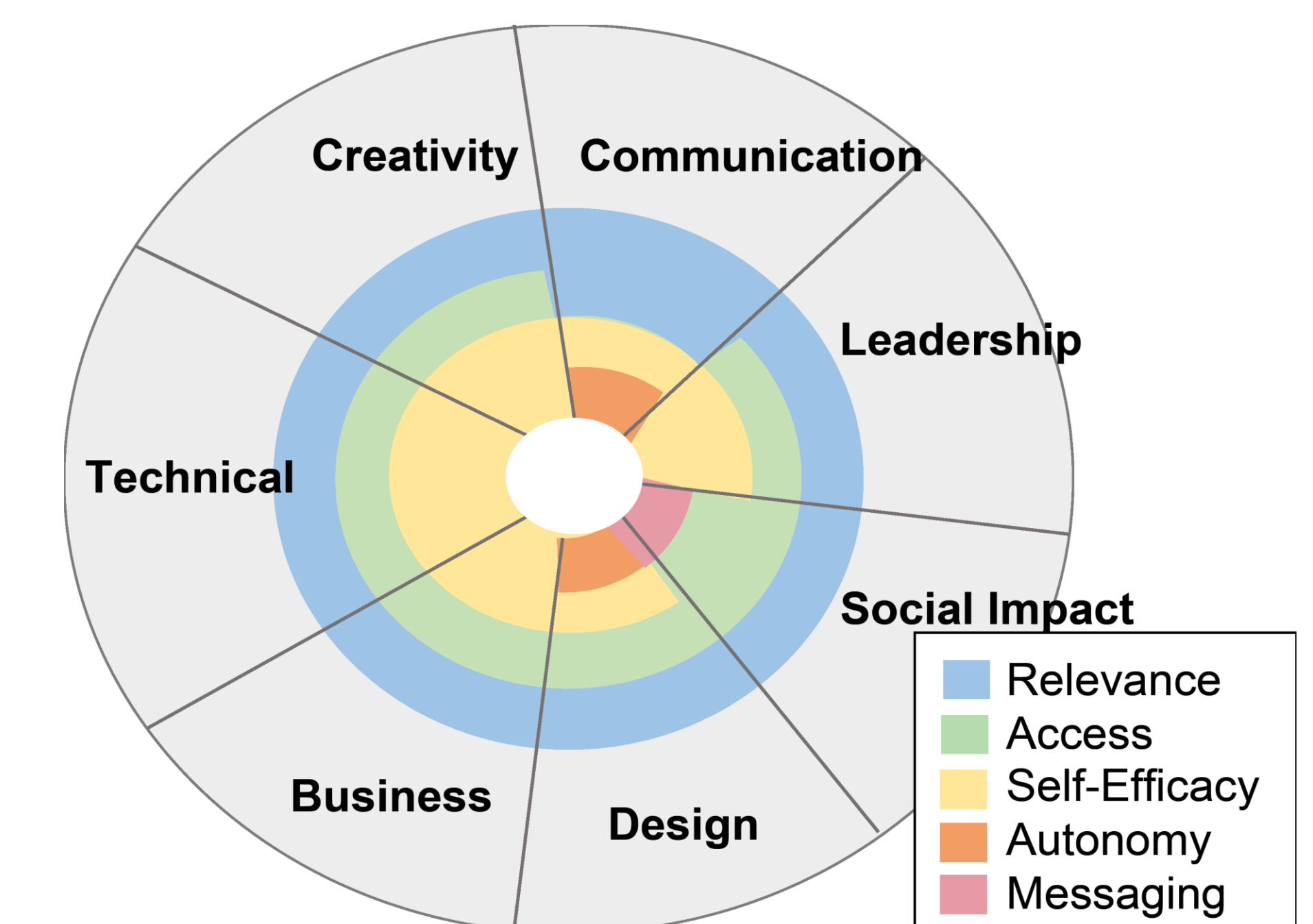
Leadership: Leadership was considered either learnable or somewhat learnable by students. Students discussed leadership in terms of relevance, access, and self-efficacy with many students feeling it was not relevant to physics.

Creativity: Creativity was perceived as the least learnable of the I&E

Aspects due to a lack of perceived connection to physics. A few students discussed relevance to labs and research, as well as access in these settings.

Growth Mindset Themes Across Aspects

For each of the I&E aspects, five themes related to growth mindset emerged: Relevance, Access, Self-efficacy, Autonomy, and Messaging.



Discussion

RQ1: Which aspects of I&E do students perceive as learnable?

Students with a growth mindset described multiple elements that contributed to their learnability of I&E including access to learning opportunities in physics classes or autonomy for learning outside of physics, attitudes toward learning I&E, messaging from professors and peers that demonstrated value, relevance to students' interests or career goals, and self-efficacy. Across the I&E aspects, growth mindset and the related theory base aligns with participants narratives. According to the data, Relevance, Access, and Self-efficacy codes indicate the highest perceptions of learnability in a positive or negative context.

RQ2: Based on growth mindset and related theories, why might each aspect be more or less learnable for students?

For aspects in course learnings that may not seem as connected to physics, like business and design, students may have additional challenges learning them based on a perceived lack of relevance, access, autonomy, or messaging in the physics department culture.

Acknowledgements

We would like to thank the PIPELINE Network and the physics students who volunteered to participate in this study. This work is supported by the National Science Foundation's Improving Undergraduate STEM Education (IUSE) program under Award No. 1624882.

Selected References

- [1] Dweck, C. (2000). Self-theories : Their role in motivation, personality, and development (Essays in social psychology). Philadelphia, PA: Psychology Press.
- [2] Bandura, A. (1993). Perceived self-efficacy in cognitive development and functioning. Educational Psychologist, 28(2), 117-117.
- [3] Yeager, D., & Dweck, C. (2012). Mindsets that promote resilience: When students believe that personal characteristics can be developed. Educational Psychologist, 47(4), 302-314.
- [4] Betsy, Ng. (2018). The neuroscience of growth mindset and intrinsic motivation. Brain Sciences, 8(2). doi:10.3390/brainsci8020020

