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Persistence in STEM Fields at the U.S. Air Force Academy, 2019-2021: A Mixed-Methods Study

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Introduction

- Graduates from science, technology, engineering, and mathematics (STEM) majors are essential for a large number of professions and for a robust economy.¹
- In the last decade, although the demand for these professionals has climbed sharply, STEM shortages exist, in part because universities are not graduating enough people to meet the demand.²⁻⁴
- This shortage is more evident among female and minority groups.⁵⁻⁶

Introduction

- STEM graduates and a vigorous science and technology workforce have also been identified by the U.S. Department of Defense as essential for a strong military and for an evolving U.S. national security environment that demands greater scope and depth from science and technology.⁷⁻⁹
- Throughout its history, the U.S. Air Force has prioritized scientific discovery and has relied on a highly-skilled STEM workforce to manage the discovery, development, and integration of science and technology to advance its mission.¹⁰

Introduction

- STEM shortages are made worse by attrition, when college students who intended to graduate with a STEM degree decide to switch into nonSTEM majors. ¹¹⁻¹³
- The latest data reported that in 2011-12, 506,000 college students declared majors in STEM. Two years later, about 350,000 (69%) reported still pursuing STEM careers, an attrition rate of 31%. ¹⁴

Purpose and Research Questions

- This Phase III study analyzed data from the Registrar's Office and cadet surveys to identify factors associated with STEM attrition at USAFA. The research questions were:
- Was there a significant difference in the cadets' demographic and academic factors based on their major or major change?
- According to cadets, what recommendations could be implemented to prevent attrition from STEM majors, especially for cadets who have yet to declare a major?

Quantitative Methodology

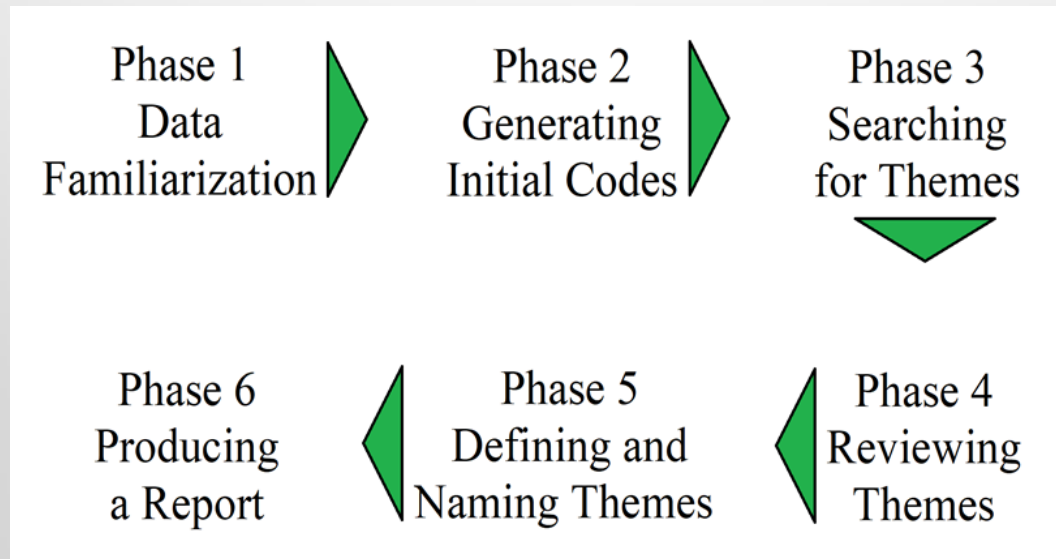
- Variables of interest included gender, race, class rank, primary and secondary major, attending Prep School, GPA, SAT Math, SAT Reading & Writing, and Scholar status. N = 3,651 cadets with a major.
- The dependent variable was the cadets' major status: STEM Persisters, nonSTEM Persisters, STEM Departers, and STEM Arrivers.
- Descriptive and inferential statistics (ANOVA, Chi-square) were calculated for quantitative data. Because this study was exploratory in nature, statistical significance was assigned at $p < 0.05$.

Qualitative Methodology

- The sample consisted of 44 freshmen and nonSTEM USAFA cadets, and who voluntarily completed an anonymous survey during a week of Dedicated Survey Assessment Time.
- Cadets answered the prompt: “In the near future, the Air Force may consider possible alternatives to increase the number of cadets who graduate with undergraduate degrees in Basic Sciences/Engineering. What three recommendations should the Academy implement to attract undecided cadets to declare a major in Basic Sciences/Engineering?”

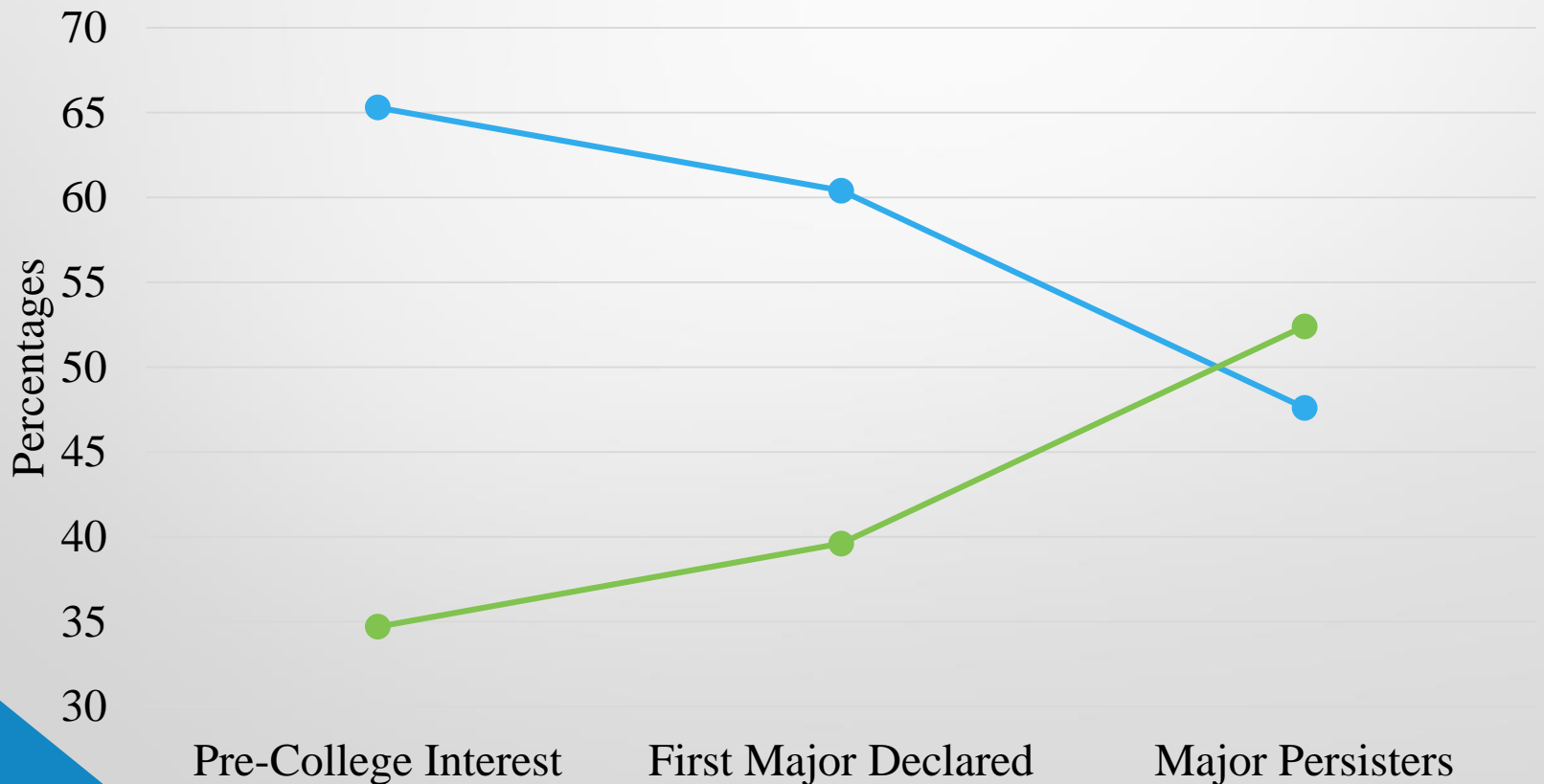
Qualitative Methodology

- The software Quirkos was used to organize the text by managing sources, tagging, and coding, and developing frameworks to understand thematic connections.
- Then, Thematic Analysis was implemented. This is a strategy for identifying, analyzing, organizing, describing and reporting themes within a data set. ¹⁵⁻¹⁷



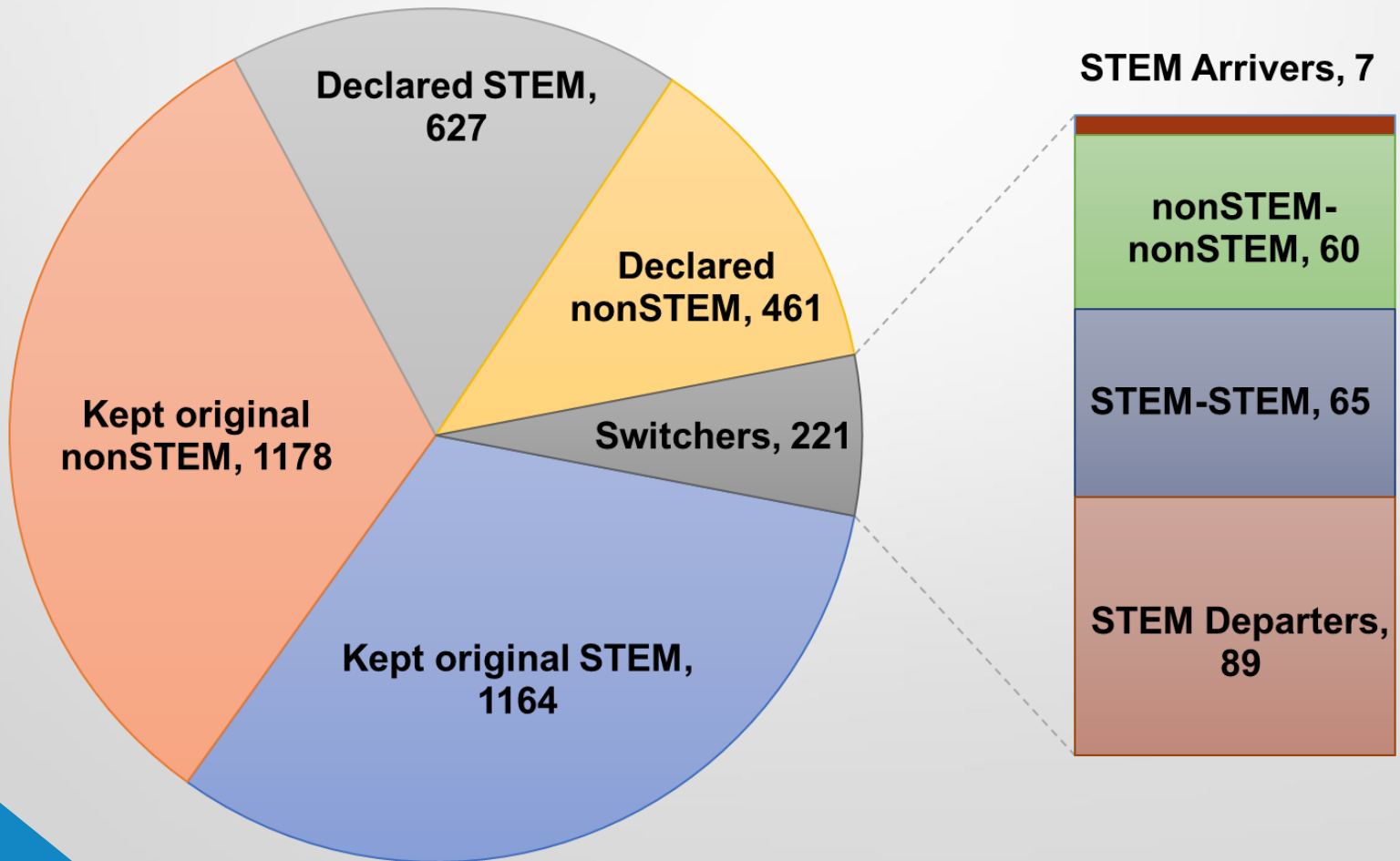
Quantitative Results

- Percentage of cadets and their progression within STEM and nonSTEM majors (STEM = blue)



Quantitative Results

- Number of cadets per major status



Quantitative Results

- Gender, race, declaring a secondary major, or declaring minors were not associated with STEM departures.
- Compared with STEM Persisters, becoming a STEM Departure was associated with:
 - Being a sophomore, $X^2 = 50.8$, $p < 0.001$.
 - Attending Prep School, $X^2 = 8.0$, $p = 0.005$.
 - Not having Scholar status, $X^2 = 5.1$, $p = 0.023$.
 - Lower SAT Math and R&W scores, $t = 3.5$, $p < 0.001$.
 - Lower GPA, $t = 9.9$, $p < 0.001$.

Qualitative Results

- *Occupation and Job Markets*
- 15 cadets reported that the Academy should divulge or suggest occupational pathways after graduation. USAFA should “show how STEM applies outside USAFA” and “brief on the positives of those majors”.
- *Class Difficulty and Minor Availability*
- 14 cadets perceived STEM coursework as “difficult” or “challenging”. USAFA can “make the classes not as hard” and add more non-STEM minors so that cadets can pursue a STEM major while also satisfying their desire to pursue non-STEM interests.

Qualitative Results

- *Heavy Workload and Burnout*
- 14 cadets perceived the amount of work in STEM courses as “excessive”, resulting in “burnout”, “decrease in quality of life”, and “exhaustion”. USAFA should “decrease the workload on those who choose STEM majors, so they don't get burnt out”.
- *Instructor Characteristics*
- 9 cadets reported low satisfaction with course instructors' interactions, that “STEM major [instructors] need to act like they care more about cadets”, and that “better [instructors] should teach core classes instead of the worst ones in the department”. Instructor quality, mentorship, and cadet engagement should improve.

Qualitative Results

- *Other Recommendations*
- Full disclosures on the necessary work, time, and effort commitments. “Before students come, that's the time to tell them that USAFA is a STEM school”.
- More opportunities to engage in informal STEM learning experiences, like clubs, teams, and off-base STEM activities.
- Additional STEM academic support (tutoring, labs).

Conclusion

- The proportion of STEM to nonSTEM cadets goes from ~2:1 to ~1:1 by their junior year. Most of the STEM attrition occurred before cadets declared a major or shortly thereafter. To avoid attrition, cadets recommended that USAFA:
 - Fully disclose the rigor of STEM majors to incoming cadets
 - Provide pedagogical training to instructors in the “Core”
 - Emphasize the relevance and rewards of STEM majors after graduation and/or military service
- Future research will identify majors with the most attrition.

Acknowledgments

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