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# Measuring the Impact of the NSF GRFP in Engineering: A Bibliometric Analysis Amid Program Uncertainty

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## Abstract

The NSF Graduate Research Fellowship Program (GRFP) provides funding for aspiring STEM graduate students to pursue research based on their proposed projects and personal narratives. This competitive program has awarded around 2,000 fellows annually, providing financial support and flexibility for recipients to choose their graduate research labs and institutions. For students applying in their second year of graduate school, the fellowship enables them to continue existing projects in their established research groups.

In 2025, only 1,500 applicants were awarded fellowships, and for the 2026 application, the solicitation was posted two months later than in previous years, with submission deadlines delayed by one month. The new solicitation restricted eligibility to first-year graduate students, making second-year students ineligible. In engineering fields, second-year students often already have established positions in a lab, and may have produced preliminary publications or conference presentations. Given these recent changes and program uncertainty, characterizing and communicating the fellowship's impact through the scientific outputs of these fellows is increasingly important.

This work presents a preliminary bibliometric analysis of scientific literature authored by NSF GRFP awardees in engineering disciplines from 2000 to 2025. Using data from research.gov and the database Dimensions, scientific literature authored by NSF GRFP fellows was extracted and analyzed. Quantitative metrics are presented, including total scholarly output, median publications per fellow, and median citations received. Publications were also evaluated on open access status, journals with the most publications, and alignment with UN Sustainable Development Goals. Finally, publishing trends of fellows in the years preceding the fellowship were measured, clarifying the research experience students gain before applying. This analysis directly addresses how the elimination of second-year eligibility may affect applicant preparedness and the competitiveness of future cohorts in engineering fields.


## Introduction

Graduate engineering education offers enriching opportunities and promising career prospects, but increasing competition and funding pressures create significant costs for students. In most STEM graduate programs, students join a lab or research group to pursue a thesis or dissertation, gaining access to advisor expertise, technical facilities, and peer networks. Funding for these opportunities typically comes from grants led by a principal investigator (PI) who serves as the student's advisor and dissertation chair. Grants may originate from university programs or external sources like government agencies or foundations, with the PI securing, managing, and overseeing the funded research. Graduate students may also secure fellowships, pursued independently from internal or external sources. Unlike advisor-led grants, fellowships can be earned before enrollment or during graduate study, and students may gain more autonomy in their research pursuits.

Writing a graduate fellowship proposal is challenging, requiring students to craft compelling personal essays and research proposals while competing against applicants from diverse institutions and disciplines. Preparation demands developing skills in literature review, identifying research gaps, and aligning arguments with fellowship criteria. Academic librarians can support engineering students who are applying for fellowships by recommending literature search strategies and resources that facilitate scientific writing. Early connection with librarians during fellowship preparation also helps students establish best practices and awareness of ongoing support available throughout their graduate study. Preparing a fellowship application is itself educational for new students, and earning a fellowship reduces funding stress and enables focus on research quality.

The National Science Foundation (NSF) has offered engineering graduate students this transformative educational experience and financial security through the Graduate Research Fellowship Program (GRFP). Though highly competitive, this fellowship supports STEM graduate students who demonstrate intellectual merit and propose impactful research informed by their diverse backgrounds and lived experiences across the United States. However, the program's future has become uncertain with shifting federal budgets and priorities in 2025. This work provides an overview of the NSF GRFP, the changes making it harder for students to earn it, and the insight gained from historical program dynamics. The impact of the GRFP on graduate engineering education is then examined through publications authored by fellows from 2000-2025, revealing how publishing practices and research priorities have evolved across different federal administrations.

## Background

The NSF was incepted in 1950, and shortly after, the GRFP followed in 1952 [1]**.** This program was created to support future generations of talented scientists and researchers, pursuing research areas that aligned with national priorities. GRFP fellows are selected from a pool of applicants that may consist of US citizens, permanent residents, and nationals from the United States, as well as the Commonwealth of Puerto Rico and Guam [2], [3]. Currently, the GRFP award provides each recipient annual financial support for three consecutive years, which includes a living stipend of roughly $37,000 as well as $16,000 for tuition [1], [2], [4]. As of 2025, a cumulative total of 75,000 graduate students have been funded by the NSF GRFP since its creation, with roughly 16% of 13,000 applicants successfully awarded each year [4].

The NSF GRFP has consistently granted fellows much flexibility, not just in their graduate studies, but with the career prospects that follow. The fellowship is portable to any STEM graduate program in a US institution, and since the program supports individuals rather than specific research projects, each fellow has the flexibility and freedom to align their graduate work with their own interests and career prospects [3], [5]. This is in contrast to a typical graduate research experience, where a student conducts research under their faculty advisor's funded projects. When considering career prospects, fellows have experienced a higher likelihood of employment conducting research and/or teaching in higher education institutions compared to the national population of PhD recipients [3], [6].

The NSF GRFP also serves to support individuals from underrepresented groups, though the numbers have fluctuated throughout its existence. In 1966, just 12% of the 1,339 fellows were women, in contrast to 2015, where it grew to roughly half of the 2000 fellows being women, and one quarter overall being underrepresented minorities [5]. However, that growing trend was not consistent between those years. In 1999, the NSF GRFP saw a sharp decline in applications and awards to students in minority groups (roughly 100 less fellows than the previous year), when legislative and judicial ruling prohibited the use of race as a selection criterion in education [7]. And in 2025, the program's recent messaging has shifted with a new presidential administration. Previously, the NSF GRFP's website stated that its goal was to "ensure the quality, vitality, and diversity of the scientific and engineering workforce". However, the new version replaces "diversity" with "strength," [4] which may suggest a changing preference to only students with a more established academic merit, rather than students offering individualized ideas and perspectives that complement their academic merit and potential.

**Reduced awards and eligibility**

The GRFP underwent further changes in April of 2025, when the NSF initially made only 1,000 fellowship offers. A reduction that was likely an outcome from federal funding priorities shifting away from academic research. This was a historic and sharp decline from a record high in 2023 of 2,555 fellowship offers during a relatively stable era of the program, with 2008 marking the last time fewer than 1000 offers were made [4]. Conversely, the number of honorable mentions named in April 2025 reached a record 3,018 applicants. By comparison, the split between fellowship offers and honorable mentions was 50-50 from 2014 to 2024, with an average of 2,020 students awarded and 2,050 named honorable mentions per year [2]. For 2025, this proportion changed to 25% awards and 75% honorable mentions. There were also notable year-to-year drops in disciplines, with awards to chemistry students dropping 56% from 2025, and similar for physics, astronomy, geosciences, and life sciences. In comparison, awards in engineering fields dropped by 45%, and in materials research by 36%, which was the smallest drop [2].

The announcement in April did not represent a final decision, however. The NSF told students named honorable mentions that, subject to future fiscal plans, a subsequent announcement of additional awardees was possible [2], [4]. This was later confirmed in June 2025, as an additional 500 fellows from the pool of 3,018 honorable mentions were named. While the move provided some relief from such an impactful change to the GRFP, the disciplinary make-up of these additional fellows still reflected the agency's new focus. This second round of selection manifested a bias on the field of study, which was identified by former NSF GRFP Program Officers Brennan and Muller-Parker [8]. The second group of fellows showed zero awards for any of the 962 honorable mentions in life sciences, though 214 students in life sciences had been named fellows in April. Also, the group had only seven awardees in psychology and eight in social sciences, while 125 of the 203 honorable mentions in computer science, 101 of the 260 in physics and astronomy, and 123 of the 594 in engineering were named fellows [9]. In their study, Brennan and Muller-Parker further analyzed this evidence, validating the presence of bias in favor of students in computer science, materials science, engineering, and physics, and bias against life sciences, psychology, and geosciences [8].

For 2025, the new administration greatly impacted who received the NSF GRFP award, but all who had applied had followed the criteria in a solicitation posted in July 2024 [10]. This changed for the 2026 fellowship application period, as the NSF GRFP saw further changes upon the transition [11]. First, the posting of the official solicitation was delayed until late September, over two months later than the expected posting and less than a month before the typical submission deadlines (dates in mid October listed by fields of study). Fortunately, the solicitation outlined deadlines extended to mid November.

In a more consequential move, the new solicitation listed new eligibility criteria, marking second-year Ph.D. students as no longer eligible. Those that could still apply included undergraduates, students in joint bachelor's-master's programs, bachelor's degree holders, and first year Ph.D. students. An NSF spokesperson was reported noting that the elimination of second-year PhD students was meant to "restore the program's original emphasis on supporting students at the start of their research careers [12]."

In the decade preceding the change, students were able to apply up to two times; once as a senior in undergraduate, and once in graduate school, either in the first or second year [2]. Without warning, this decision cost second-year Ph.D students their final, and maybe only, chance to apply. While first-year students still had the opportunity, this final chance to apply suddenly arrived with a drastically shorter timeline to prepare or gain any meaningful experience to include in their application. With graduate students having only one chance to apply, many would normally follow the advice to wait until their second year, when their application would be stronger [12]. A fraction of these first-year graduate students may not have chosen a lab or had a defined project scope, as many programs do lab rotations in the first year.

**Characterizing impact from past fellows**

With a new era of the NSF GRFP for the foreseeable future, this raises a question about the demographics of the fellows that this program had supported in the past. Had a majority of fellows applied after completing a year of graduate study, where they potentially published research? While there are no publicly available data that states the proportion of applicants that are second-year Ph.D. students, a former GRFP director noted from their experience that a significant portion of applications came from students at this stage, and the students coming from lesser resourced universities took advantage of the extra year to get more experience or even produce publications [12]. If the trend did shift to a majority of fellows being more established researchers, how has this fellowship, sparking an increase in scholarly output, impacted the many fields of engineering research?

To characterize the impact of the NSF GRFP through scholarly publications, each fellow's name, field of study, and graduate affiliation is needed to thoroughly screen the scientific literature. Being a federal program funded by taxpayers, information for the NSF GRFP is publicly available online. Any individual award can be searched on the NSF awards search (https://www.nsf.gov/awardsearch/advanced-search) with element code 717200, or users can browse an interactive map of active awards online [13]. Most importantly, Research.gov has a searchable database of all awarded fellows [14], as well as applicants named as "honorable mention" that opted to have their name listed.

Data and other information related to NSF GRFP fellows have aided investigations in other fields. Cook et al. (2022) created an Awardees in Ocean Sciences (AOS) dataset based on NSF GRFP data, and they analyzed several demographics showing that women represented 69% of GRFP awards granted to students in ocean sciences from 1996 to 2021. Furthermore, they also proposed that a well-designed, longitudinal study of career trajectories could better assess the effect that the GRFP has had on career outcomes [3]. Roy and Edwards (2023) used the demographic data of NSF GRFP fellows from Civil and Environmental Engineering and Computer Science and Engineering to anonymously survey fellows to create a baseline snapshot of their own perceptions, behaviors and experiences. This survey revealed that scientific advancement was highly perceived as a top metric to evaluate academics, and academic freedom and mentorship as highly positive aspects of academia, while funding, publication, and tenure pressures were perceived as highly negative [15]. And also notable, Weiner and LeFevre (2022) used the NSF GRFP as a framework for an original scientific writing project, where first-year graduate students identified a technical research problem or question, articulated the problem through writing, designed a research strategy, and collaborated with groups of other students from diverse disciplinary backgrounds [16].

Given that there is adequate and available information about all NSF GRFP fellows, it is possible to identify all fellows that pursued an engineering graduate program and attempt to extract the scholarly outputs produced at their graduate institution. This work outlines a preliminary bibliometric analysis of the scientific literature produced by NSF GRFP fellows in engineering awarded from 2000 to 2025. Fellow names and graduate institutions were used to obtain researcher IDs in Dimensions. Publications were extracted for all researchers identified in Dimensions using Google BigQuery, and these results were reduced to publications authored by fellows at their graduate institution both before and during the NSF GRFP award period. With these publication data, metrics are analyzed among each field of engineering including total scholarly output, the median number of publications produced by fellows, and median citation counts per publication. Other qualities of research impact were evaluated, including Open Access status and alignment with sustainability initiatives through the UN Sustainable Development Goals tagged in publications. Journals with the most publications authored by fellows were also determined and discussed. Last, the percentage of fellows that published before receiving the fellowship was measured between award years and engineering fields of study, and publications with first-authorship by fellows in this set were also determined, highlighting the degree of research experience some fellows gain before applying for the NSF GRFP.

**Methods**

Basic information for all NSF GRFP fellows was obtained online at Research.gov [14]. The database contains tabulated records, separated by year, from the beginning of the program in 1952 to the most recently announced cohort. Each record contains four fields with information originally entered by the applicant: Name, Baccalaureate Institution, Field of Study, and Current Institution. Under both the Baccalaureate and Current Institution fields, each tabulated name was manually entered by the applicant, however, Current Institution could be blank if an applicant was not yet decided or enrolled in a graduate institution at the time of submission. For Field of Study, applicants selected one option from a list created by the NSF [2].

Spreadsheets were downloaded directly from Research.gov for each cohort listed as "Award Offered" from 2000 to 2025. All files were combined into a single CSV file that included a column indicating the year of the award offered. A total of 41,835 NSF GRFP fellows in all fields were awarded in this timespan. The data were then filtered by Field of Study, extracting all fellows where the listed field contained the word "engineering". The resulting number of fellows in engineering was 11,773.

Fellows were verified with Dimensions researcher IDs found through Python API queries using name and graduate institution. From the initial NSG GRFP data, Python functions were first used to remove middle names and initials so that names were formatted as "Last, First" in each query, allowing for a broader search to ensure that results aren't missed due to using a highly specific name. To ensure higher accuracy when using institutions in the query, the organization ID (GRID ID) was found in Dimensions for both Baccalaureate Institution (BI), and Current Institution (CI) for each fellow. With the reformatted name and organization IDs, the following Dimensions query was used:

```
SEARCH RESEARCHERS
FOR "NAME"
WHERE RESEARCH_ORGS = "ORG_ID"
RETURN RESEARCHERS
```

In the query, "ORG_ID" was populated with the CI ID, however if the CI was not available due to any of the reasons mentioned above, the BI ID was used instead. In the Dimensions data schema, most researchers have multiple recorded IDs, typically differing between changing research affiliations [17]. With that knowledge, researchers were searched with a specific institution to ensure that the found researcher ID corresponded with publications produced by the fellow at their graduate institution, or at the very least, their baccalaureate institution. Of the 11,773 fellows in the set, Dimensions researcher IDs were found for 7,392 (62.8%).

The records extracted from Dimensions also included an ORCID ID, when available, for each researcher in the request. ORCID IDs for 4376 (37.2%) fellows were identified in this group. Separate from this data retrieval, Scopus IDs for a subset of awardees were also obtained using the Elsevier API, resulting in IDs found for 4391 (37.3%) fellows. Acquiring Scopus IDs helps expand the coverage of research IDs that exist within this pool of researchers, and extracting publication records from Scopus may help fill in the gaps of any records not found in Dimensions. However, acquiring publication data from both Dimensions and Scopus would require an additional step deduplicating publications found in both databases. This work only considered publication data from Dimensions, but future studies could benefit from a more expansive search using all available IDs and each respective database. To enable future work, the complete set of engineering NSF GRFP fellows with research IDs found in this work is available online (see Data Availability Statement). **Figure 1** shows a summary of extracted research IDs for each cohort year. With respect to the total fellows in each year, the plot illustrates how many fellows had any ID retrieved (Dimensions OR Scopus OR ORCID), had a Dimensions ID retrieved (regardless of other IDs found), and had all IDs retrieved (Dimensions AND Scopus AND ORCID). In the Appendix, **Figure A1** presents a Sankey diagram that further illustrates the breakdown of the number of fellows with which research identifiers were retrieved.

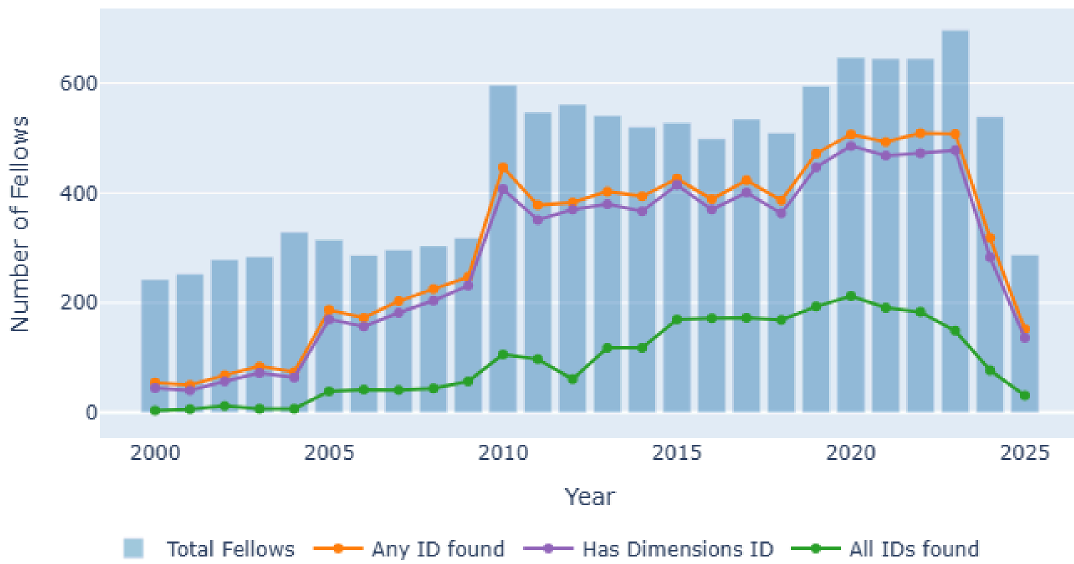


**Figure 1: Yearly summary of research IDs retrieved for NSF GRFP fellows**

Due to the large number of researcher IDs extracted, and anticipating multiple publication records for each, publication queries were made through the Dimensions implementation on Google BigQuery. This allowed for publication data for all identified researchers to be extracted with one request, which resulted in 130,876 records. The publication metadata included ID, publication date, type of publication, Open Access status, citation counts, field citation ratio, altmetric score and ID (if available), author metadata, fields of research, journal title, publication title, DOI, relative citation ratio, and UN Sustainable Development Goals (if available).

The demographic information for each fellow was joined with the respective publication records into a single dataset. For the scope of the study, the publication records were filtered to just those produced in the time before or within the fellowship award period. Fellows can elect to receive the funding for any three years in a five-year timeframe. Therefore, any publications produced in the five years following the award are likely the result of research conducted under GRFP funding. For a fellow awarded in 2015, for example, any publications produced during or before 2020 were kept. After this filtering, the total number of publications reached 70,594.

For most of the study, publication data is analyzed in groups, divided by the respective field of engineering for each fellow. While the NSF defines these classifications, some variation has occurred through the years, including the description or formatting of each field. Additionally, there are some fields that had lower representation among the selected fellows. Therefore, all unique fields of study were placed into one of 17 standardized categories, including an "Other" category for those that were more ambiguous, broad, or less represented. A list of the original unique field names, and the corresponding standardized name, is in **Table A1** of the Appendix. To analyze both the baccalaureate and graduate institutions of each fellow, each field of data was processed to normalize and standardize the various forms of institution names that were manually entered by each fellow. Using Open Refine, names in both fields were converted to uppercase, then clustering was used to identify groups of data sharing similar names, differing by formatting inconsistencies, and groups were merged based on user discretion.

**Results and discussion**

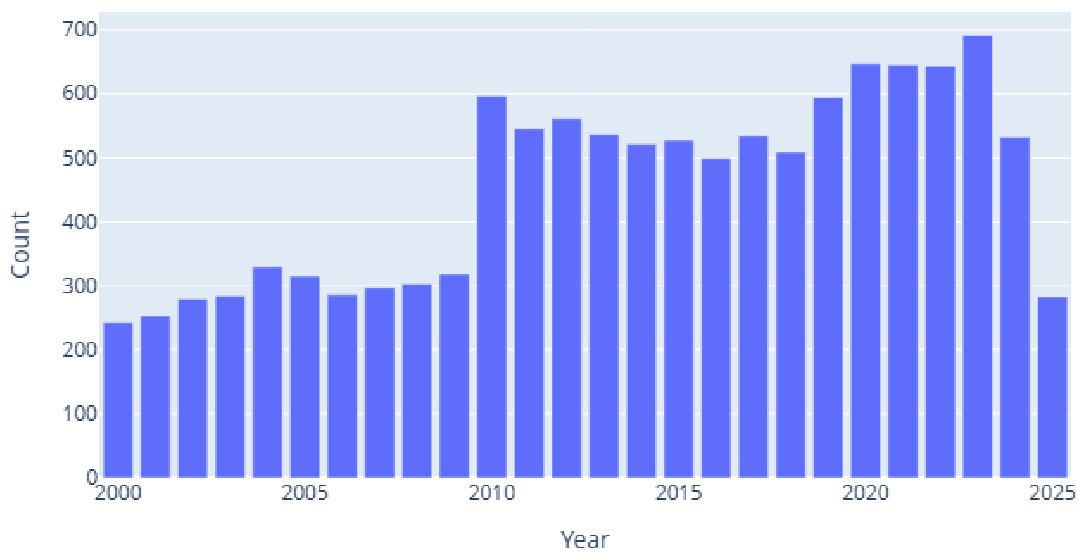


**Figure 2: Yearly number of NSF GRFP awards granted to students in engineering.**

<u>Demographic information</u>

This subsection presents basic demographic information: the yearly total of engineering fellows, the distribution of fellows across engineering fields, and the institutions that produced and received fellows in different fields. **Figure 2** shows the total number of engineering NSF GRFP fellows identified per award year. From 2000 to 2009, the number of engineering fellows wavered around 300. This then doubled in 2010 and gradually decreased to 500 fellows by 2018. From 2020 to 2023, fellows increased to above 600 each year, with the highest being 691 in 2023. Sharp decreases followed with only 532 in 2024 and then a drastic decrease to 283 in 2025, reflective of the new program changes.

**Table 1: Summary of NSF GRFP Fellows per Engineering Field**

| Engineering Field (Standardized Name) | Count |
|---|---|
| Biomedical Engineering | 3103 |
| Mechanical Engineering | 1951 |
| Chemical Engineering | 1680 |
| Electrical Engineering | 1252 |
| Environmental Engineering | 801 |
| Materials Science and Engineering | 794 |
| Aerospace Engineering | 693 |
| Civil Engineering | 455 |
| Other | 261 |
| Computer Science and Engineering | 255 |
| Industrial Engineering | 148 |
| Energy Engineering | 107 |
| Nuclear Engineering | 84 |
| Optical Engineering | 67 |
| Systems Engineering | 63 |
| Ocean Engineering | 37 |
| Agricultural Engineering | 22 |

In **Table 1,** fellows are grouped and counted by engineering field, using standardized titles that resulted from the methods mentioned earlier. Biomedical Engineering (BME), Mechanical Engineering (MechE), Chemical Engineering (ChE), and Electrical Engineering (EE) all had over 1,200 fellows, with BME having the most at 3,103, over twice as many as EE with 1,252. The fields with fewer than 100 fellows included Nuclear, Optical, Systems, Ocean, and Agricultural Engineering.

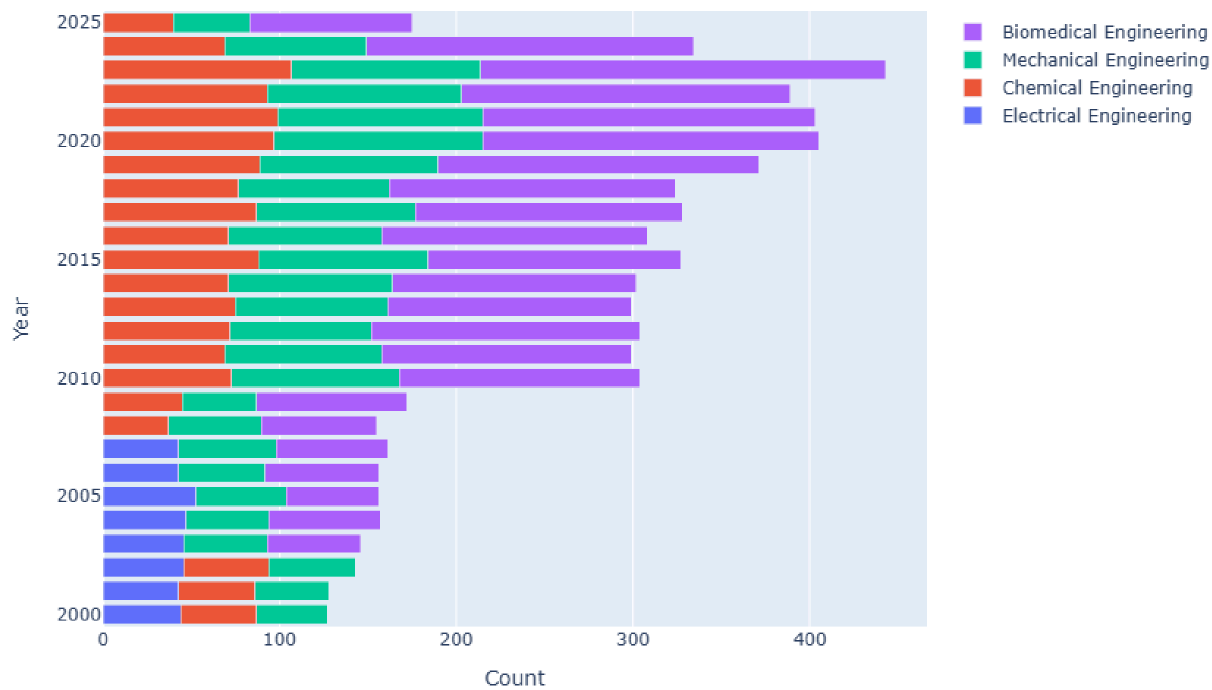


**Figure 3: Yearly summary of the top three fields of engineering with NSF GRFP fellows**

In **Figure 3,** engineering NSF GRFP fellows were analyzed again by award year, with the top three awarded fields of engineering highlighted. From 2000 to 2003, MechE, ChE, and EE were nearly equivalent in proportion to each as the top awarded fields. From 2004 to 2007, ChE was replaced with BME, which became the top awarded engineering field for all but one of those years. From 2008 to 2025, ChE, MechE, and BME consistently remained the top three fields. BME received the most awards annually, peaking at 229 fellows in 2023.

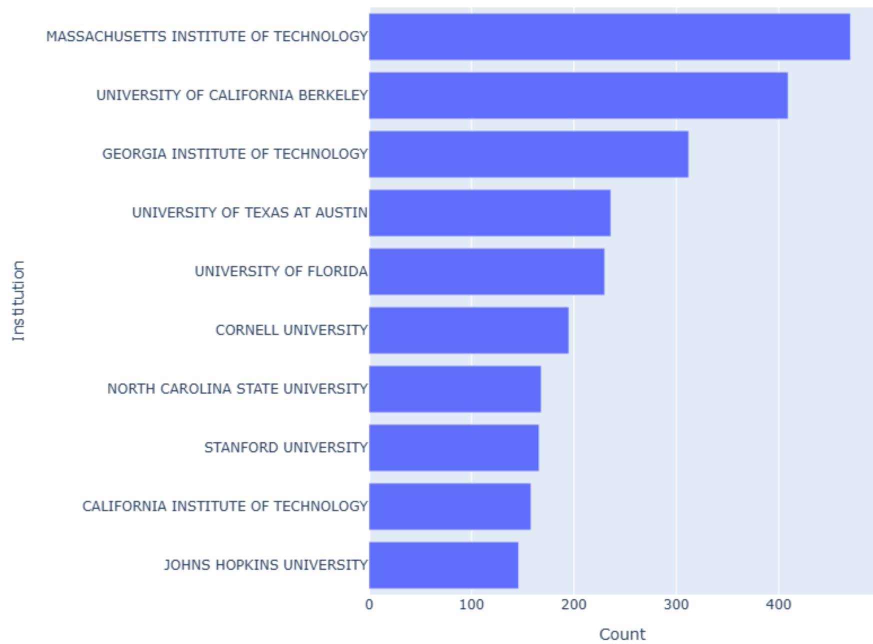


**Figure 4: Top ten baccalaureate institutions reported by NSF GRFP fellows**

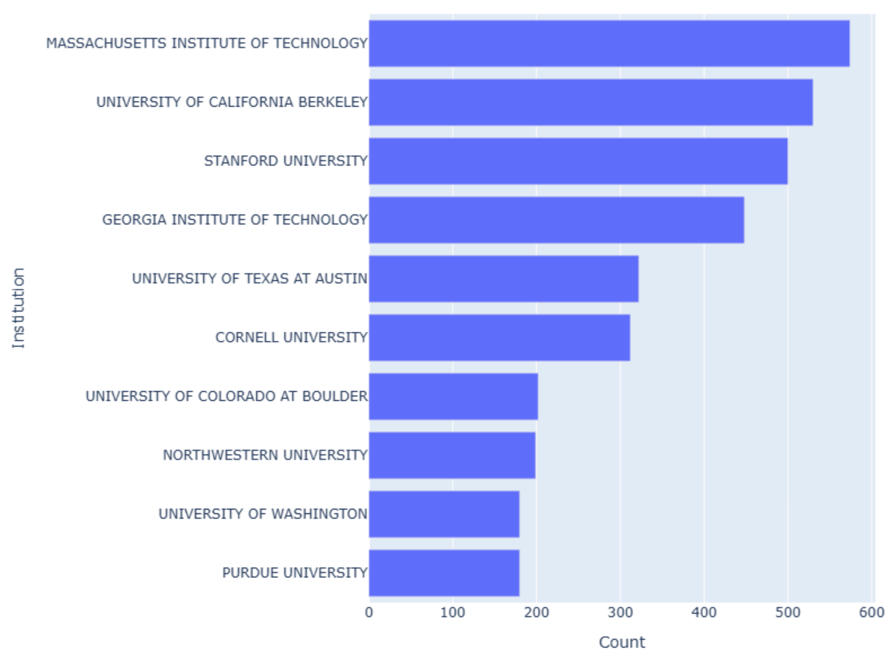


**Figure 5: Top ten graduate institutions reported by NSF GRFP fellows**

The institutions that produced and received the most NSF GRFP awards were analyzed, and the most awarded engineering fields at each institution were identified. Institutions were ranked by the total number of fellows they produced (baccalaureate, **Figure 4**) or hosted (graduate, **Figure 5**). The top five baccalaureate institutions included Massachusetts Institute of Technology (MIT), University of California Berkeley (UC Berkeley), Georgia Tech, University of Texas at Austin (UT Austin), and University of Florida (UF). **Figure 6** details the top-awarded fields of engineering per baccalaureate institution. BME, MechE, and ChE were among the top-awarded fields at all five institutions, while EE appeared in the top fields at all institutions except UF. Materials Science and Engineering (MSE) was highly awarded for MIT, UC Berkeley, and UF, while Aerospace Engineering was highly awarded for both Georgia Tech and UT Austin.

The five most reported graduate institutions included MIT, UC Berkeley, Stanford, Georgia Tech, and UT Austin. **Figure 7,** shows that BME, MechE, ChE, and EE were among the top-awarded fields at all five institutions. MSE was only found as a highly-awarded field for MIT and Stanford, while Environmental Engineering was found for UC Berkeley and UT Austin, and Aerospace Engineering for Georgia Tech.

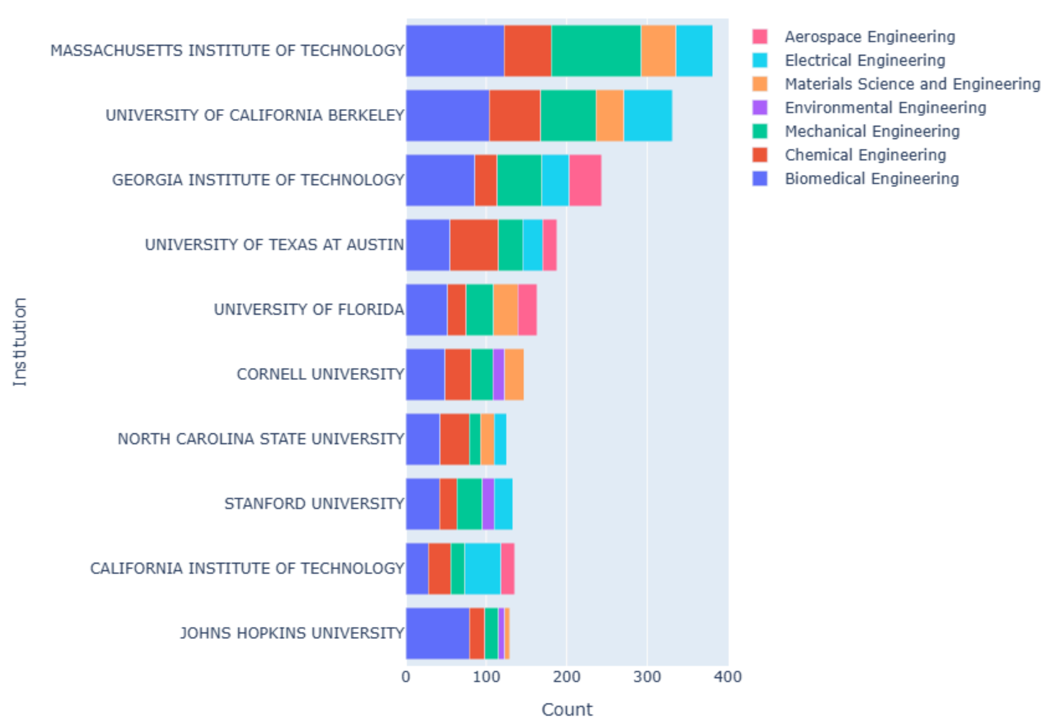


**Figure 6: Top five engineering field of study per baccalaureate institution reported by NSF GRFP fellows**

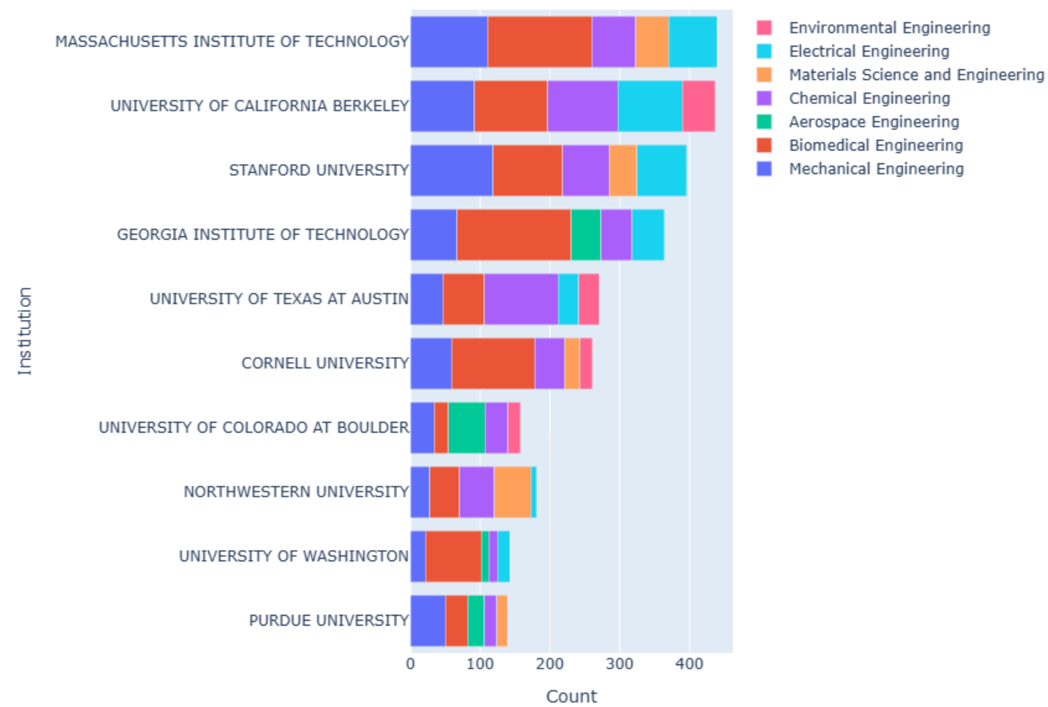


**Figure 7: Top five engineering field of study per graduate institution reported by NSF GRFP fellows**

Publication metrics

This subsection examines publication data from engineering NSF GRFP fellows during their respective award periods. Analyzed metrics include publication output per fellow, citation counts, Altmetric Attention scores, Open Access status, and UN Sustainable Development Goals. **Figure 8** shows the total number of publications authored by each cohort of fellows per award year. The years 2000 to 2004 show less than 500 publications in each, while the numbers rose to over 1,000 in 2005, steadily increasing until a maximum of 4,879 publications in 2020. From there, the annual scholarly output continuously drops for more recent years, which is due to there being a smaller timespan and a higher likelihood that fellows in these cohorts are still completing their graduate education. As a result, these fellows will have produced less publications relative to cohorts that can be fully analyzed over a five-year timespan. The lower publication counts prior to 2005 is likely a result of having fewer fellows awarded in each cohort and acquiring fewer Dimensions researcher IDs in these groups. The increase in publication counts over time may reflect both the growing number of fellows and increased publishing rates in engineering fields [18], [19].

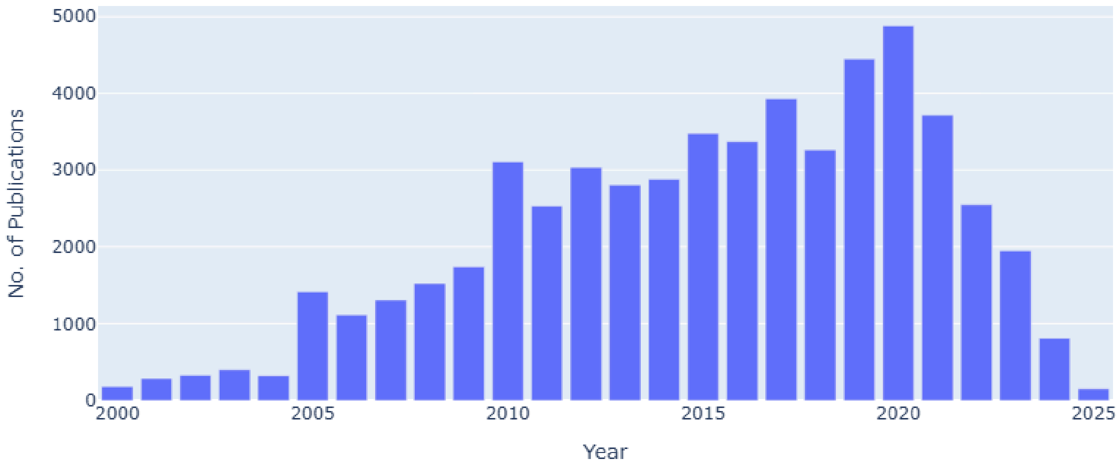


**Figure 8: Yearly scholarly output by NSF GRFP fellows during the respective award period**

**Figure 9** illustrates total publications authored by fellows across engineering fields. This analysis, and subsequent analyses, focus on the top ten publishing fields, with all other fields combined with the "Other" category. For this analysis, publications were categorized and presented by each type collected: article, preprint, and conference proceeding. Civil Engineering fellows were authored in 1,086 publications, the lowest number among the ten groups, with three quarters consisting of articles (761). In contrast, BME fellows were authored in 15,758 publications, roughly twice as much as the next groups with high publication counts: MechE (8772), ChE (8224), and EE (7261). The make up of BME publications included 12,000 articles, 1,925 preprints, and 1,398 conference proceedings. While MechE fellows authored more total publications than ChE fellows, ChE produced more articles (6,860) than MechE (5,457), which had considerably more conference proceedings (2,349). EE fellows authored the most conference proceedings (2,943), and BME fellows authored the most preprints (1,925).

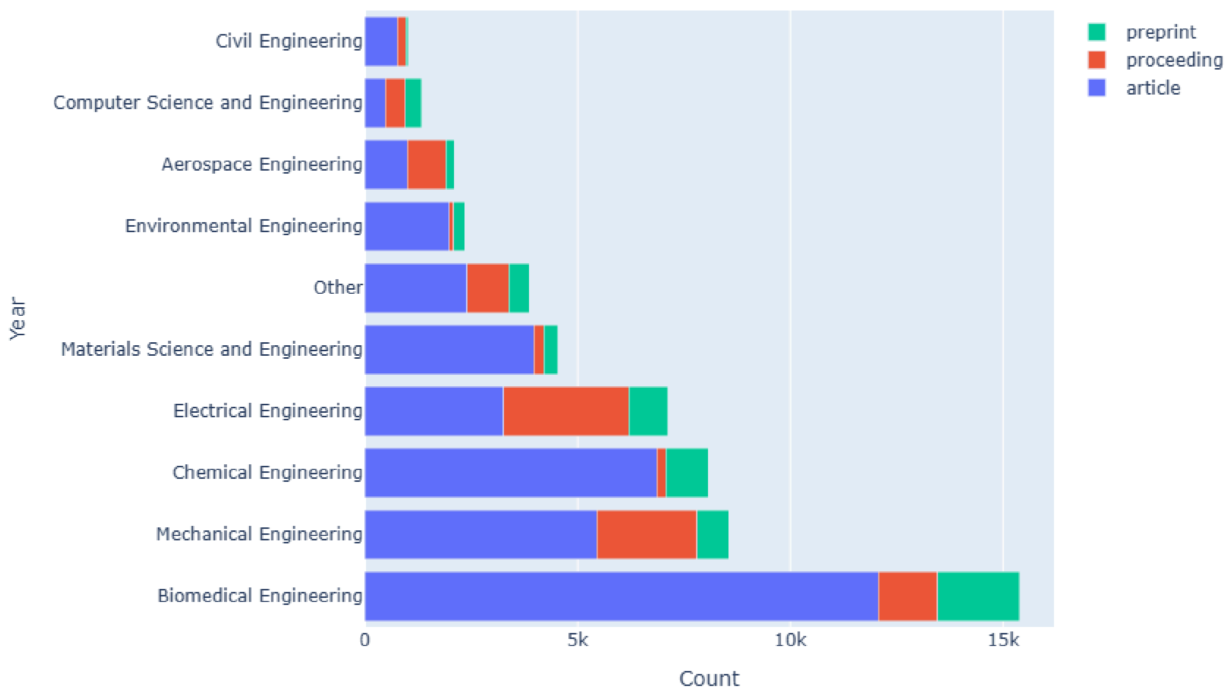


**Figure 9: Total scholarly output by NSF GRFP fellows per engineering field of study with indicated publication type (article, preprint, or conference proceeding)**

To further assess research impact, publication productivity and citation/attention metrics were analyzed. For this large set of diverse publications, these metrics exhibited asymmetrical distributions. This occurs when outliers are present, such as fellows with exceptionally high publication counts or publications with unusually high citation counts. Therefore, median values were analyzed rather than mean values, as means are heavily skewed by such distributions.

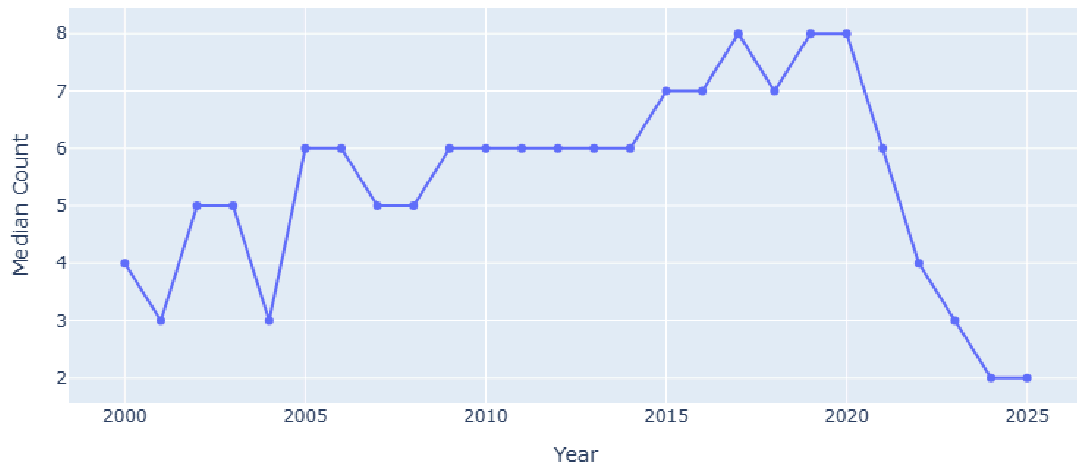


**Figure 10: Median number of publications authored by NSF GRFP fellows by year of award**

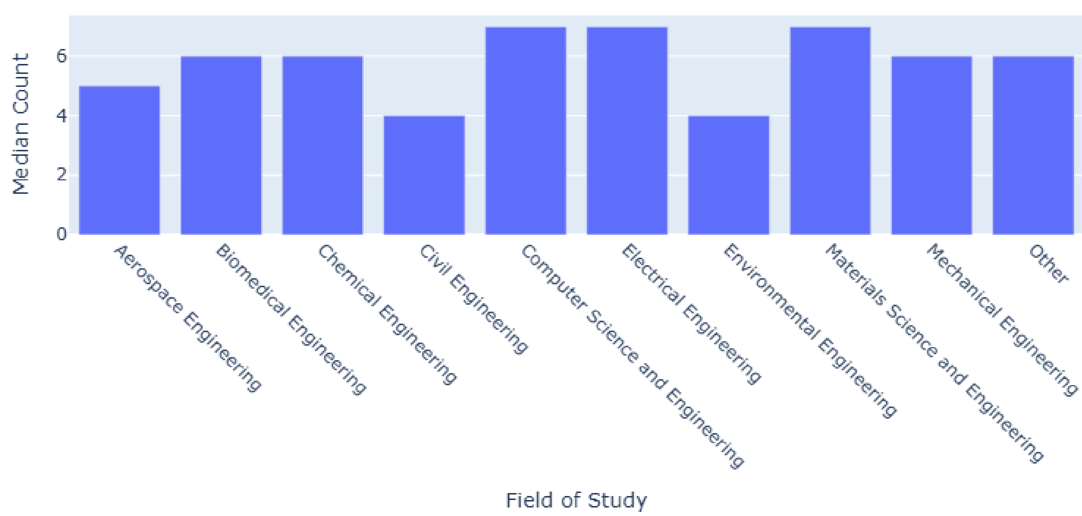


**Figure 11: Median number of publications authored by NSF GRFP fellows by reported engineering field of study**

The median number of publications authored by an NSF GRFP fellow was analyzed with respect to award year (**Figure 10**) and engineering field of study (**Figure 11**). The median publications per fellow fluctuated between three and six from 2000 to 2009. This may likely be due to the lower number of fellows awarded as well as the relatively low number of publications retrieved from 2000 to 2004. From 2009 to 2014, the median stayed consistent at six publications, then rose to eight by 2020, followed by a steep but continuous decline to two by 2025. These trends may likely be an outcome of the increases in fellowships awarded to engineering students over this period. With more fellows in engineering, there could be considerably more students with increased scholarly output. Contrarily, more factors should be considered, including that publication rates have generally increased across engineering disciplines, or that an increasing number of fellows are authoring publications in the time preceding the award period.

For the median publications analyzed by field of study, values ranged between four and seven publications. Computational Science and Engineering (CSE), MSE, and EE held the highest median publications authored per fellow. This is interesting when considering that these three fields showed different publication profiles in **Figure 9.** One possible explanation is that both CSE and EE fellows authored more publications through conference proceedings, while MSE had more articles authored per fellow, compared to fields with an overall high scholarly output. Civil and Environmental Engineering showed the lowest medians, likely due to smaller cohort sizes and lower publication output.

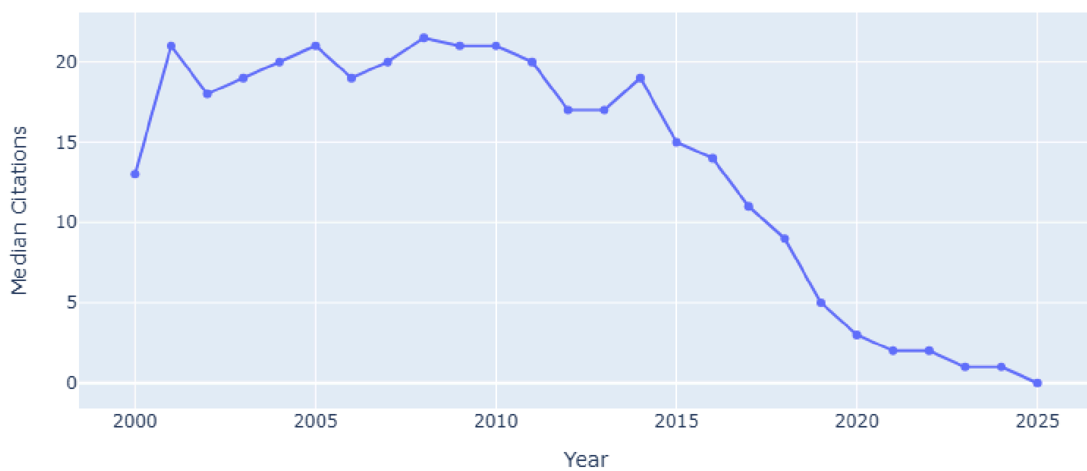


**Figure 12: Median citation count per publication authored by NSF GRFP fellows by year of award**

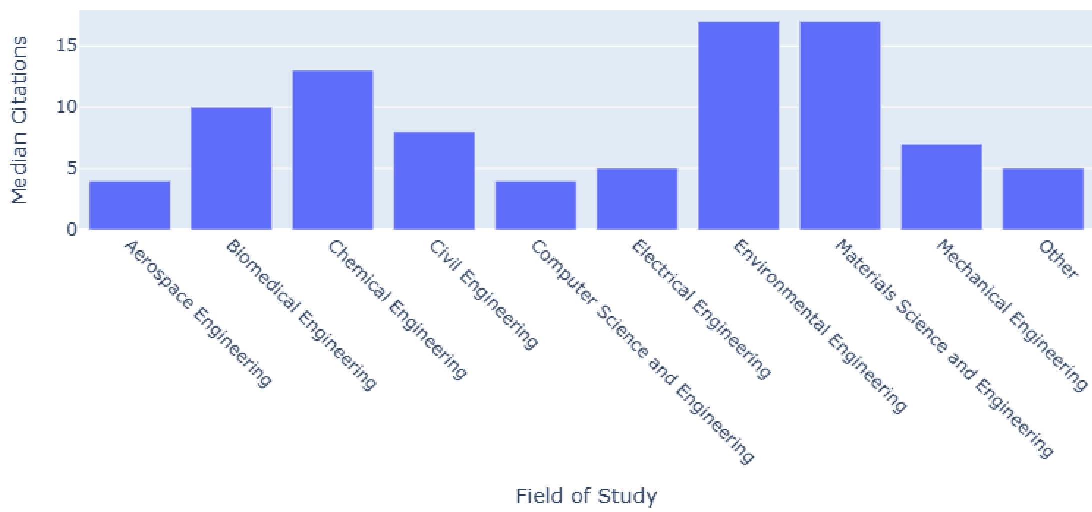


**Figure 13: Median citation count per publication authored by NSF GRFP fellows by reported engineering field of study**

Next, the median number of citations counts per publication were analyzed by award year (**Figure 12**) and field of study (**Figure 13**). The citation trend follows the expected pattern for aggregated metrics over a timespan of this size, as older publications accumulate more citations. Prior to 2010, the median citations consistently fluctuated around twenty, though 2000 through 2002 show deviation that may be due to the smaller sample size. Beyond 2010, the median citations naturally decreases as more recent publications see less citations relative to those in the preceding decade. The median citations are fifteen in 2015, three in 2020 and zero for 2025. Median citation counts across engineering fields ranged from four to seventeen, with Environmental Engineering and MSE being highest (17), followed by ChE (13).

Next, median Altmetric Attention Scores per publication were analyzed by award year and engineering field. The Altmetric Attention Score measures how much and what type of attention a publication receives from sources like social media, mainstream news sources, or other technical documents like policy reports, clinical guidelines, or patents. Mentions from these sources, which are unique and verified, are calculated in a weighted sum, where sources with a higher relative reach have a higher weight. Dimensions captures Altmetric scores for all publications and clinical trials that have been tracked for mentions by Altmetric. Therefore, scores were not available for all publications in this dataset. Additionally, Altmetric scores are most informative at the individual publication level, where Altmetric Explorer can provide qualitative context about attention sources. A detailed analysis of attention sources is warranted for a separate study. Since the available sample may be insufficient to identify trends or evaluate impact, results are mentioned briefly below, and corresponding figures are found in the Appendix.

The median Altmetric score varied between two and six across the study period. The median scores are notably consistent from 2009 to 2016, where the median remains at four. Across engineering fields, the median values ranged from three to five, with BME the highest. According to the Altmetric documentation [20], a score of five could indicate attention from a single blog, twenty social media shares (0.25 points per share on any platform), or include one mention in either a policy document, patent, or Wikipedia citation (three points) in combination with several social media shares.

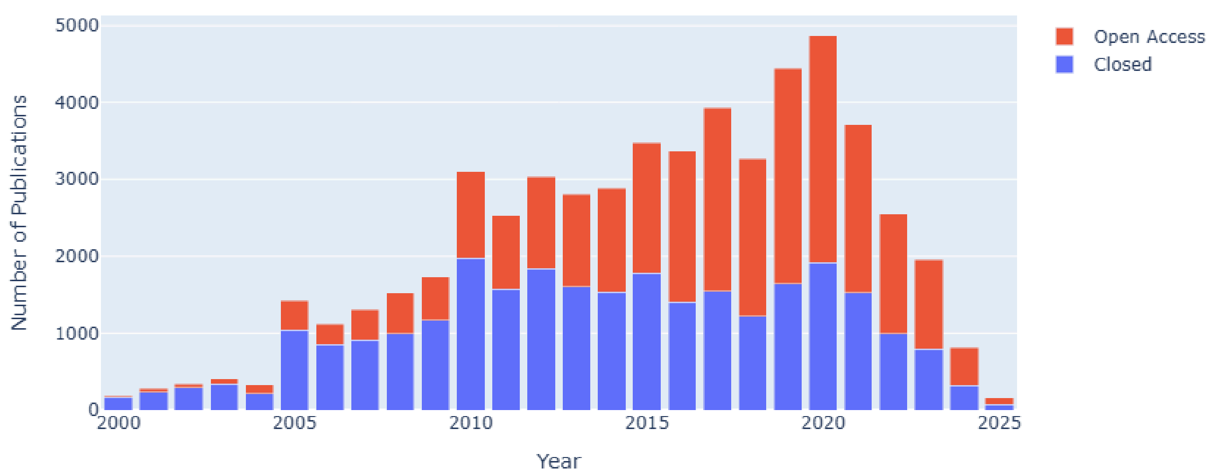


**Figure 14: Open access status for publications authored by NSF GRFP fellows by year of award**

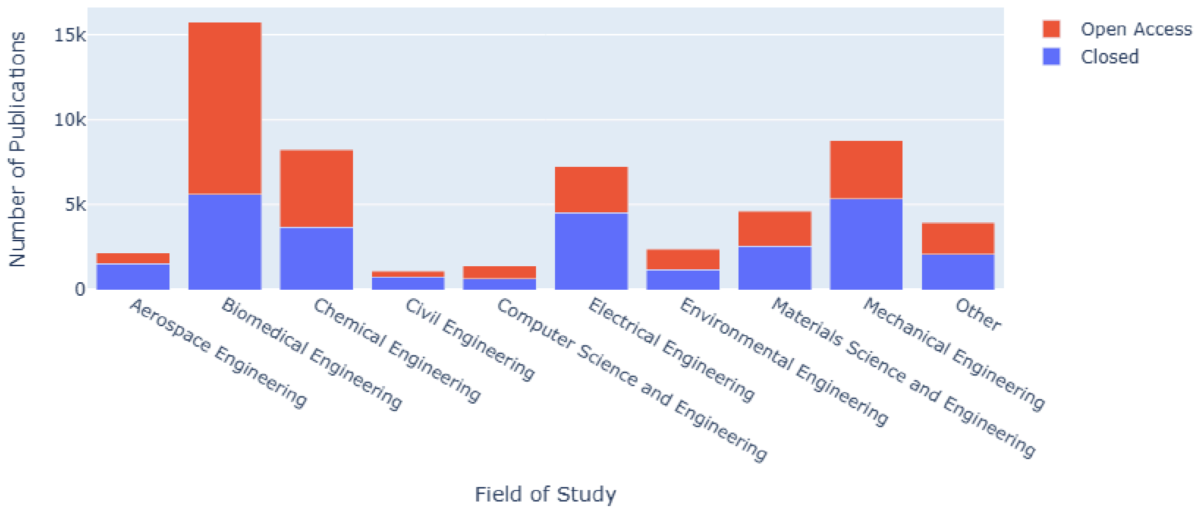


**Figure 15: Open access status for publications authored by NSF GRFP fellows by engineering field of study**

Turning to the accessibility of published research by NSF GRFP Fellows, Open Access (OA) publications were analyzed across award years (**Figure 14**) and engineering fields (**Figure 15**). Publications were classified as OA if they were green, bronze, gold, or hybrid. The percentage of OA publications, relative to the total for that year, has gradually increased over the study period. This may be a result of OA publishing practices becoming more common in engineering research, as well as increasing preprint publication. By field, ChE, EE, MSE, and MechE each had approximately 50% OA publications, while BME reached nearly two-thirds. BME's higher OA rate likely reflects its greater number of preprints.

To assess the societal relevance of publications, alignment with UN Sustainable Development Goals (SDGs) was examined. In 2015, the United Nations Member States adopted the 2030 Agenda for Sustainable Development, a call for a global partnership in reaching peace and prosperity for people and the planet [21]. This call for action is grounded by the seventeen agreed-upon SDGs and their associated targets. Dimensions tags publications with one or more of the SDGs, though not all publications have received tags. Publications with tags were organized by goal and are presented in **Table 2.** The three most-tagged SDGs were Affordable and Clean Energy (4,915 publications), Good Health and Well-Being (2,552), and Climate Action (1,052). These exceeded the remaining goals, with Clean Water and Sanitation ranking fourth (329).

**Table 2: Summary of UN Sustainable Development Goals Tagged in Publications**

| Sustainable Development Goal | Count |
|---|---|
| Affordable and Clean Energy | 4915 |
| Good Health and Well Being | 2552 |
| Climate Action | 1052 |
| Clean Water and Sanitation | 329 |
| Quality Education | 241 |
| Life on Land | 213 |
| Responsible Consumption and Production | 198 |
| Sustainable Cities and Communities | 178 |
| Life Below Water | 157 |
| Industry, Innovation and Infrastructure | 104 |
| Zero Hunger | 78 |
| Peace, Justice and Strong Institutions | 41 |
| Reduced Inequalities | 16 |
| Decent Work and Economic Growth | 16 |
| No Poverty | 14 |
| Gender Equality | 10 |
| Partnerships for the Goals | 4 |

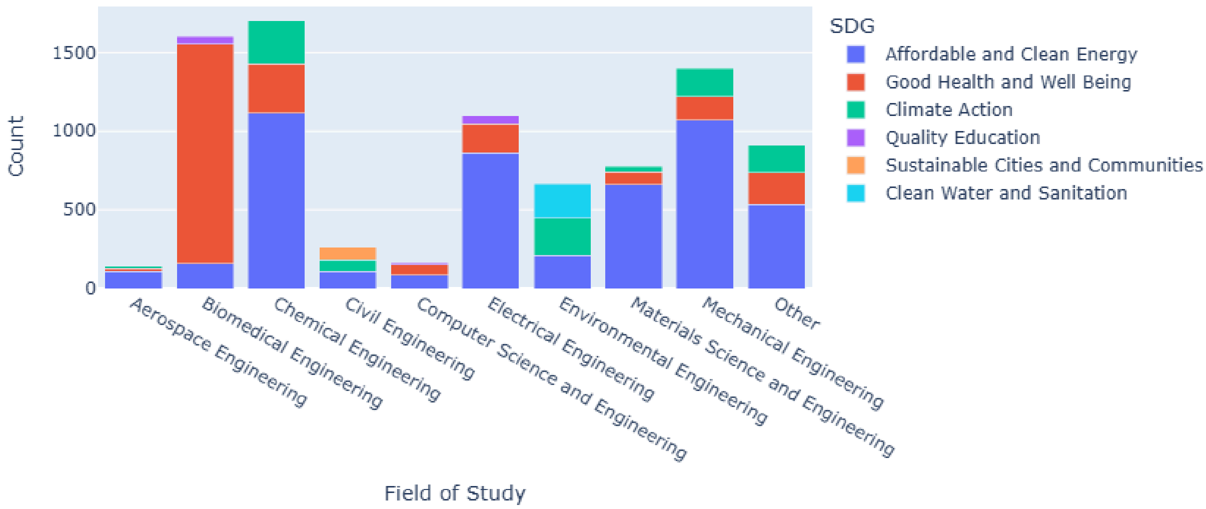


**Figure 16: Top three tagged UN Sustainable Development Goals in publications authored by NSF GRFP fellows by engineering field of study**

**Figure 16** shows the most frequently tagged SDGs for each engineering field. Affordable and Clean Energy appeared in publications for every field, with ChE (1,114), MechE (1,071), and EE (860) having the most tagged publications for that goal. Good Health and Well Being appeared in publications for all fields except Civil and Environmental Engineering. BME had the most publications tagged with this goal (1,391), followed by ChE (312) and Other (198). Climate Action appeared in all fields except BME and CSE, most commonly in ChE (275), Environmental Engineering (237), and MechE (184).

For the final analysis in this subsection, the ten journals with the most articles authored by NSF GRFP fellows were identified (**Table 3**). *Nature Communications* was the most common journal with publications authored by fellows (569 articles). The next two most common journals included *Nano Letters* (437) and *Advanced Materials* (426). This is quite notable, given the high impact factors between these three journals, which range from 9.1 to 26.8. Other journals with high impact factors are present on this list including *ACS Nano*, *Environmental Science and Technology*, and the *Proceedings of the National Academy of Sciences of the United States of America*. While some of these titles publish a broad range of subjects in science, engineering, and technology, it is worth noting the popularity of journals in materials science, particularly nanomaterials. This may address the fact that MSE had considerably high median citation counts while having comparatively lower numbers of produced publications. The subject of nanomaterials or other studied nano phenomena is not necessarily limited to MSE, as this has relevance in several engineering fields. These findings may coincide with the Materials Genome Initiative, started by the Obama administration in 2011 to create new policy, and infrastructure to discover and deploy advanced materials quicker and more efficiently [22].

**Table 3: Summary of Journals with Most NSF GRFP Fellow-Authored Publications**

| Journal Title | Impact Factor (2024) | Count |
|---|---|---|
| Nature Communications | 15.7 | 569 |
| Nano Letters | 9.1 | 437 |
| Advanced Materials | 26.8 | 426 |
| Proceedings of the National Academy of Sciences | 9.1 | 418 |
| Applied Physics Letters | 3.6 | 404 |
| Biophysical Journal | 3.1 | 393 |
| Scientific Reports | 3.9 | 384 |
| ACS Nano | 16.1 | 381 |
| ACS Applied Materials & Interfaces | 8.2 | 361 |
| Environmental Science and Technology | 11.3 | 360 |

First authorship and publications produced prior to award

To further characterize the scholarly output of NSF GRFP fellows, this subsection covers a brief summary of first-author publications and publications produced before fellowship receipt. First authorship typically indicates that the fellow led both the research and manuscript writing. These publications likely represent core thesis or dissertation work. Pre-award publications may reflect contributions to research at a fellows' graduate institutions during their first year or earlier work done prior to their program. Fellows with first-author publications before their award likely conducted research during their first graduate year, since achieving first authorship is difficult and rarely done outside of an established graduate program.

First, all first-author publications belonging to engineering fellows were analyzed from the original dataset. Publications were filtered to include only articles where the research ID of the first author matched the fellow's ID. In total, there were 17,176 first-author articles. Of the 11,773 engineering fellows, 5,314 published at least one first-author article. Median first-author publications per fellow showed little variation by award year or field of study. Among fellows who published as first author, the median was two articles, or three when including preprints and conference proceedings.

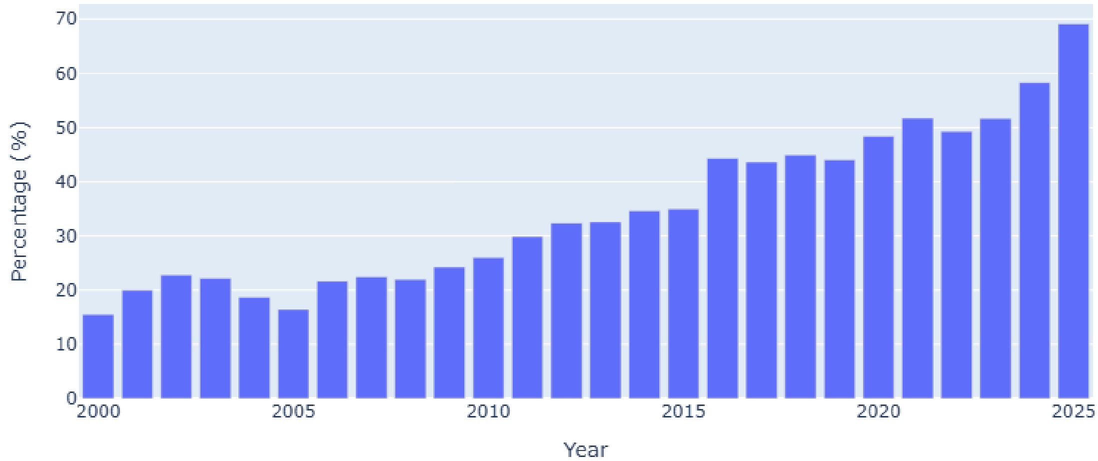


**Figure 17: Yearly percentage of NSF GRFP fellows authored in publications before award**

Next, pre-award publications were identified and summarized. Publications were filtered to include only articles published before the year in which the fellow received the NSF GRFP. The resulting number of articles was 11,529, and the number of fellows with these publications was 2,882. The percentage of NSF GRFP fellows with a prior published article is illustrated by award year in **Figure 17**. Pre-award publication rates increased considerably over the study period, from 15.5% in 2000 to 69.1% in 2025. The percentage of fellows with a prior published article is also illustrated by field of study in **Figure 18**. Half of fellows in BME and ChE had pre-award publications, compared to 40% in MSE and 20% in Aerospace and Civil Engineering. These observations are consistent with graduate publishing shifting earlier in careers, where the median year of first publication has continued shifting to several years before PhD completion [23], [24]. The final analysis examines pre-award first-author publications. A total of 2,505 articles met these criteria. The percentage of fellows with pre-award first-author publications was measured for each award year (**Figure 19**). This rate increased gradually from 6.7% in 2000 to a peak of 23% in 2024, then declined to 19.9% in 2025. These findings may strongly suggest that engineering graduate students are conducting focused research in their first year, or earlier, and they may be doing this to strengthen their applications.

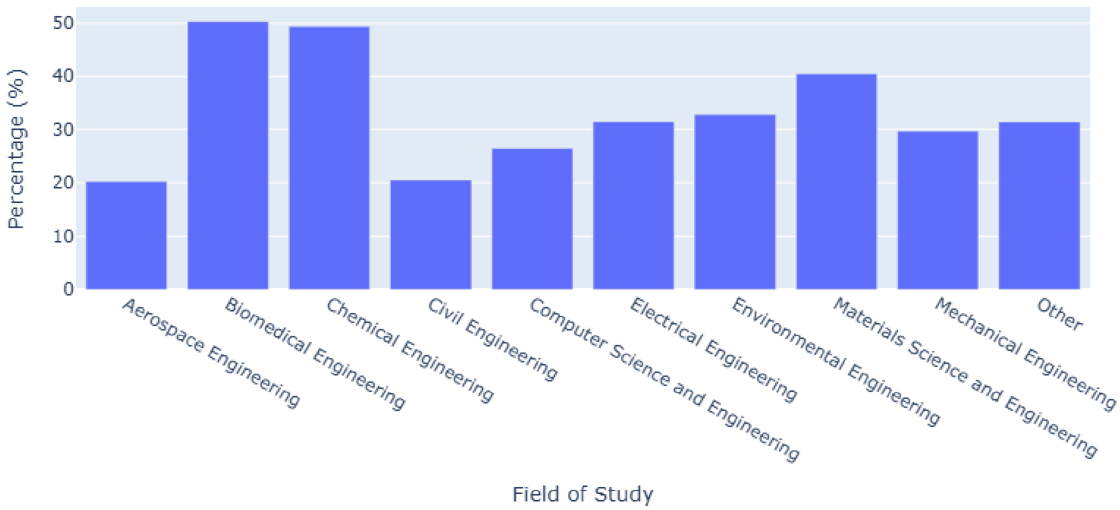


**Figure 18: Percentage by engineering field of study of NSF GRFP fellows authored in publications before award**

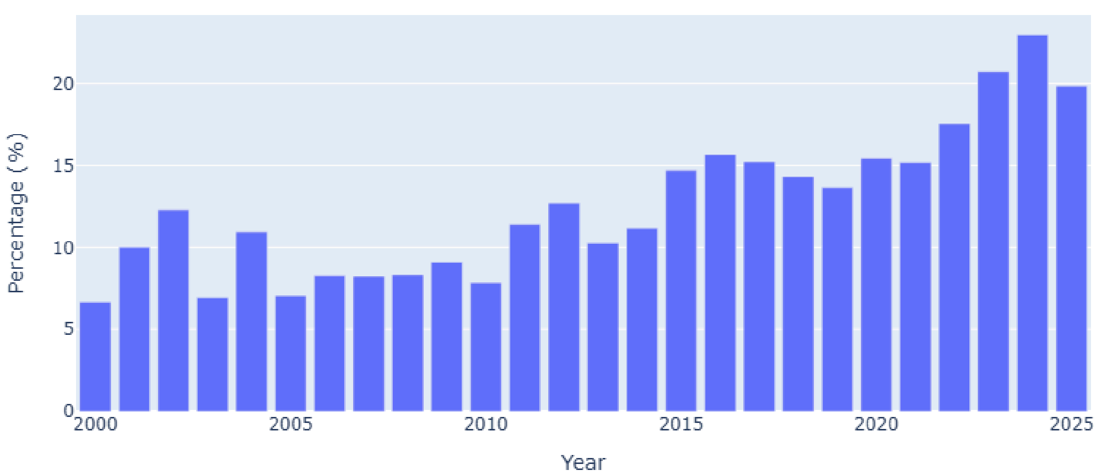


**Figure 19: Yearly percentage of NSF GRFP fellows with articles published first-author before award**

### Limitations

Given the number of NSF GRFP fellows awarded over several decades and across STEM disciplines, fully understanding the fellowship's impact is challenging due to numerous confounding variables. This study focused on just one subset of this fellowship, limiting the scope to engineering fellows from the past twenty-five years. These analyses describe the fellowship's impact on graduate engineering education only through recent academic literature. Significant insight remains from other fields, such as life sciences, geosciences, or social and behavioral sciences. While this study explores only engineering fields, valuable insight was gained through comparisons between engineering subfields and between different eras of the United States federal administrations in the 21st century.

Future studies with a narrower focus on specific engineering fields, institution types, or student demographics would reveal clearer, localized impact. Such studies would especially produce stronger evidence using control samples, standardized data, and qualitative metrics. Collecting a control sample could be increasingly difficult based on the sample size of GRFP fellows studied. For a study on engineering students at a single institution, a control group could include all engineering graduate students from that institution, but the chosen timespan would have a significant effect on the feasibility of obtaining a complete list. To properly compare samples, factors may need to be normalized. GRFP fellows represent a minority of total graduate scholarly output, so a control group would need proportional representation in sampling. Qualitative metrics would further strengthen arguments about the impact of the NSF GRFP. While scholarly output and citation counts measure a fellow's presence in academic literature, detailed Altmetrics like media mentions, patent citations, and political influence would reveal how a fellow's research translates to technological or social impact.

**Conclusion**

This work presented a demographic summary and an exploratory bibliometric analysis of engineering graduate research from NSF GRFP fellows awarded from 2000 to 2025. Using publication data from fellows identified in Dimensions, total scholarly output, median authored publications, and median citation counts were evaluated with respect to award cohort year and subfield of engineering. Open access status and Sustainable Development Goals were summarized within these groups of publications, and the most common journals were identified. In addition to publication impact metrics of NSF GRFP fellows, publishing practices of fellows prior to earning the award was quantified.

The NSF GRFP has significantly expanded its support for engineering graduate students since 2010, with fellowship numbers growing up until 2023. This growth has been particularly evident in Biomedical Engineering (BME), which emerged as a highly awarded field starting in 2013, alongside Chemical Engineering (ChE) and Mechanical Engineering (MechE) which have been supported consistently. High-ranking institutions with strong engineering reputations produce and receive the majority of fellows, demonstrating that this is a highly competitive award.

Publication output for fellows has increased significantly, rising from over 1,000 publications in 2005 to nearly 5,000 in 2023. This growth reflects both larger cohort sizes and potentially increased publishing rates in engineering disciplines. Fellows in BME produced considerably more publications than other fields in total, while Computer Science and Engineering (CSE), Electrical Engineering (EE), and Materials Science and Engineering (MSE) showed higher median publications per fellow. Overall, publications from the previous decade have accumulated median citation counts around twenty, with MSE achieving the highest counts.

Research contributions from engineering NSF GRFP fellows have become more accessible, as Open Access publishing has become increasingly common among fellows' work. This research has also aligned with societal challenges in sustainability. Publications most frequently aligned with the UN Sustainable Development Goals of Affordable and Clean Energy, Good Health and Well-Being, and Climate Action. Affordable and Clean Energy appeared across multiple engineering fields, while publications from fellows in BME were unsurprisingly most aligned with Good Health and Well-Being. High-impact journals published much of the work authored by fellows, particularly journals in materials science and nanomaterials such as *ACS Nano*, *Advanced Materials*, and *Nature Communications*. This trend of high-impact publishing in materials science may coincide with the Materials Genome Initiative launched in 2011.

Publishing practices among NSF GRFP fellows have grown considerably and become more prominent in the early years of graduate education. Fellows produced a median of two first-author publications, or three when including conference proceedings and preprints. And in a most notable finding, pre-award publication rates ascended from 15.5% in 2000 to 69.1% in 2025, with a significant portion having the fellow as first-author. This pattern was most prominent in BME and ChE (50% of fellows) and MSE (40%), suggesting that graduate students may conduct research during their first year before applying to the fellowship.

The NSF GRFP has developed a strong reputation for supporting engineering graduate students that contribute publications addressing challenges in energy, climate, and health, and many applicants are becoming established authors prior to applying. However, it is uncertain if these trends will continue with recent changes to the program. Funding levels of the NSF GRFP were already reduced, and new eligibility criteria will limit the future applicant pool. With proposed cuts to federal funding for STEM research across agencies, the NSF GRFP is an additional opportunity that is more limited and competitive for new engineering graduate students entering an uncertain era in higher education and institutional research. The composition of future cohorts and the focus of their research may greatly shift as a result.

The combination of fewer fellowship chances and shorter windows of eligibility for the NSF GRFP create a new environment with heightened competition and urgency in research productivity. As more engineering students navigate this new environment, the need for institutional support significantly grows. Engineering libraries can greatly offer this support by providing quiet spaces for students to work on proposals, workshops on writing graduate research proposals, and librarians to guide them through the process of designing research projects and communicating their potential impact. Additionally, engineering researchers will need more support from librarians overall, including guidance with funding databases, identifying research gaps, and continuing to comply with Open Access and data management mandates from funding agencies.

This analysis of NSF GRFP fellows in engineering demonstrates the fellowship's substantial contribution to graduate research, especially with publishing practices becoming more common in the earlier years of graduate study. Changes to federal programs will give fewer students the opportunity to make these contributions, and they will intensify the competitive landscape of academic research, which may have led to the accelerated publishing rates found here. In this new landscape, university libraries will serve a dire role to support the talented students that will demonstrate impactful research, but face systematic barriers.

**Acknowledgements**

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**Data Availability**

Data and code that support this work are available in the KiltHub Repository at Carnegie Mellon University Libraries at https://doi.org/10.1184/R1/32060559. A complete list of NSF GRFP fellows from 2000-2025 is available from the research.gov source, and a modified version of this list with only engineering fellows is also available including any researcher IDs that were located. In compliance with the Terms of Use for Dimensions, the full set of publication data will not be made publicly available, but limited subsets of the data are available upon request.

**AI Disclosure**

The author used Claude Sonnet 4.5 (Anthropic) to assist in preparing this work, specifically for brainstorming, adjusting phrasing for clarity, constructing parts of code, and creating comments in code.

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## Appendix

**Table A1: Unique Fields of Study Entered by NSF GRFP Applicants and Corresponding Standardized Name**

| **Field Name Entered by Applicant** | **Standardized Field Name** |
|---|---|
| Aeronautical and Aerospace | Aerospace Engineering |
| Aeronautical and Aerospace Engineering | Aerospace Engineering |
| AERONAUT | Aerospace Engineering |
| Agricultural | Agricultural Engineering |
| Agricultural Engineering | Agricultural Engineering |
| AGRICULT | Agricultural Engineering |
| Artificial Intelligence | Computer Science and Engineering |
| Bioengineering | Biomedical Engineering |
| Bioengineering and Biomedical | Biomedical Engineering |
| Biomedical | Biomedical Engineering |
| Biomedical Engineering | Biomedical Engineering |
| Chemical Engineering | Chemical Engineering |
| Civil Engineering | Civil Engineering |
| Civil Engineering (including Transport, Water, Construction) | Civil Engineering |
| CompUTER | Computer Science and Engineering |
| Computer Engineering | Computer Science and Engineering |
| Computer Engineering (including Networking) | Computer Science and Engineering |
| Computational Science and Engineering | Computer Science and Engineering |
| Computationally Intensive Research | Computer Science and Engineering |
| Electrical and Electronic | Electrical Engineering |

| Field Name Entered by Applicant | Standardized Field Name |
| --- | --- |
| Electrical and Electronic Engineering | Electrical Engineering |
| Electrical Engineering | Electrical Engineering |
| Energy | Energy Engineering |
| Energy and Power Engineering | Energy Engineering |
| Energy Engineering | Energy Engineering |
| ENERGY | Energy Engineering |
| Engineering Mechanics | Other |
| Engineering Science | Other |
| Environmental and/or Ecological Engineering | Environmental Engineering |
| Environmental Engineering | Environmental Engineering |
| Industrial | Industrial Engineering |
| Industrial Engineering and Operations Research | Industrial Engineering |
| Machine Learning | Computer Science and Engineering |
| Manufacturing Engineering | Other |
| Materials Engineering | Materials Science and Engineering |
| Materials Science and Engineering (including Polymers, Ceramics, S | Materials Science and Engineering |
| Materials Science and Engineering (including Polymers Ceramics S | Materials Science and Engineering |
| METALLRG | Materials Science and Engineering |
| Metallurgical | Materials Science and Engineering |
| Mechanical Engineering | Mechanical Engineering |
| MECHANCS | Mechanical Engineering |
| Nuclear | Nuclear Engineering |
| Nuclear Engineering | Nuclear Engineering |
| NUCLEAR | Nuclear Engineering |

| **Field Name Entered by Applicant** | **Standardized Field Name** |
|---|---|
| Ocean | Ocean Engineering |
| Ocean Engineering | Ocean Engineering |
| OCEAN | Ocean Engineering |
| Optical Engineering | Optical Engineering |
| other | Other |
| other (specify) | Other |
| other (specify) | Other |
| Other (specify) | Other |
| Other (specify) | Other |
| OTHER | Other |
| POLYMER | Materials Science and Engineering |
| Polymer | Materials Science and Engineering |
| Polymer Engineering | Materials Science and Engineering |
| Quantum Engineering | Other |
| Quantum Information Science | Other |
| Robotics, Control, Automation | Systems Engineering |
| SCIENCE | Other |
| Systems Engineering | Systems Engineering |
| SYSTEMS | Systems Engineering |

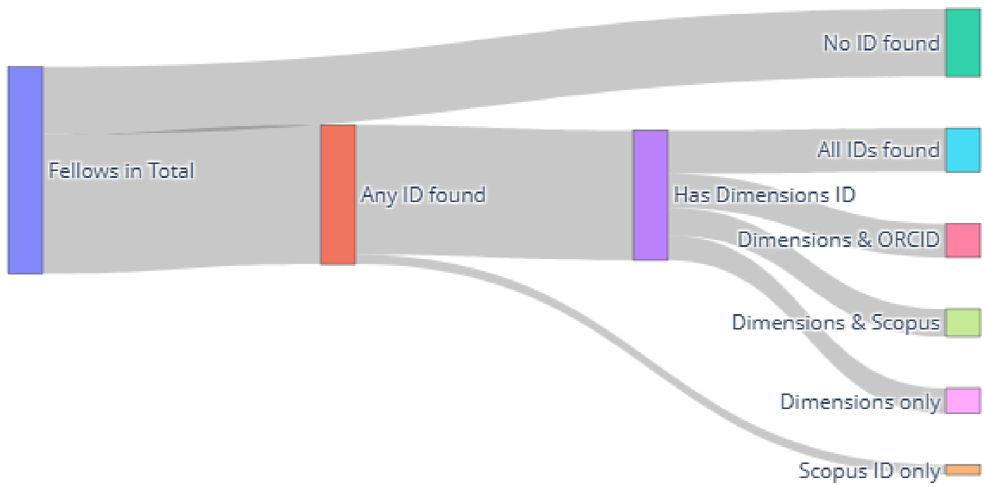


**Figure A1: Distribution of NSF GRFP fellows with various research identifiers found in this study**

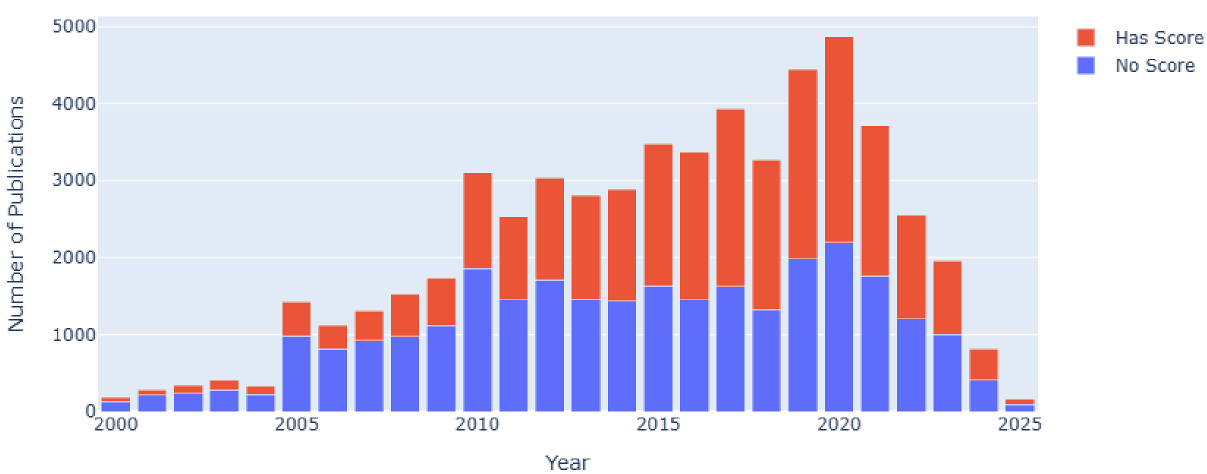


**Figure A2: Availability of Altmetric Attention Score among publications authored by NSF GRFP fellows by year of award**

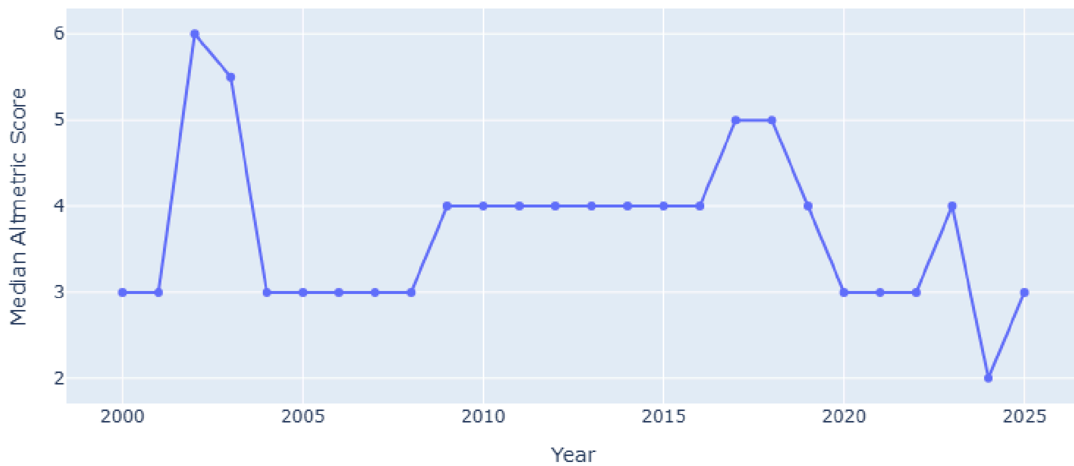


**Figure A3: Median Altmetric Attention Score among publications authored by NSF GRFP fellows by year of award**

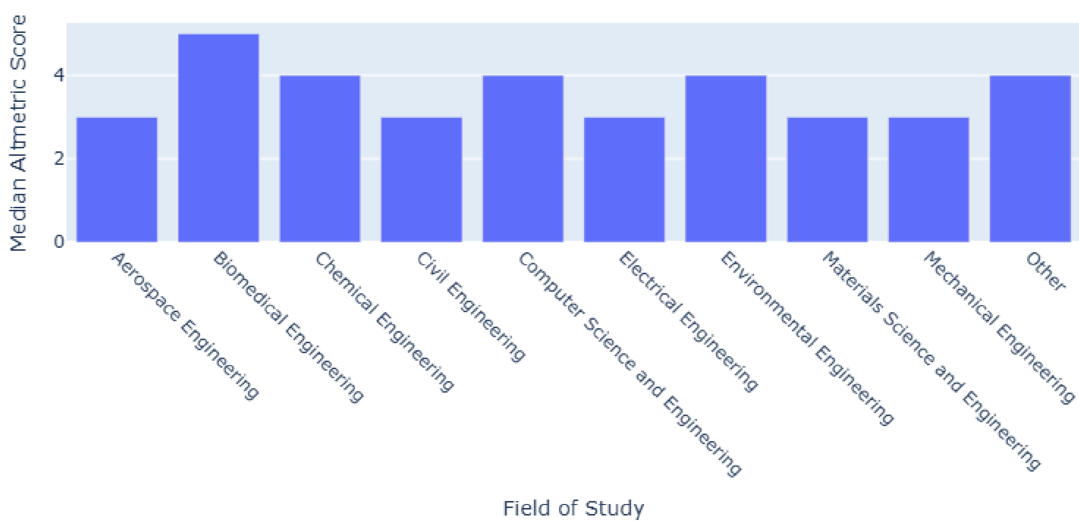


**Figure A4: Median Altmetric Attention Score among publications authored by NSF GRFP fellows by engineering field of study**