

This is a guide to writing research proposals. It might be overwhelming at first but don't worry! My [first research proposal](#) was just a page long, and it was more of a problem description as only three sentences of it were original ideas. What I didn't know at the time was that in those three sentences was the key idea to inventing the first [algorithm](#) to assign experimental microwave spectra given nothing but the spectrum.

The second time I wrote a research proposal was as a homework assignment for a scholarship. We had to write in the [NSF GRFP](#) application research proposal format as it's a likely reason a US undergraduate majoring in STEM would write a research proposal. I remember feeling nervous about writing about a field (quantum computing) I hadn't done any research in at the time, and I felt like I had no idea what I was writing about (using the [ZX-calculus](#) for quantum compilation). But I ended up actually implementing that proposal's main idea a year later while interning at IBM Q, for presenting it became 1 of 12 undergrads internationally accepted to the final round of the [2020 ACM Student Research Competition](#), and am starting a PhD learning about and possibly researching on that topic this fall. Only in hindsight do I realize I should have more confidence in my ideas.

In any case, if you are a US undergrad applying to grad school in the US in STEM, I recommend applying to the NSF GRFP (you can apply once as a 4th year undergrad and again in your first 2 years of grad school) because they give feedback from reviewers that's helpful, it's helpful to write about your goals and research ideas, and if you get it you get a cool >\$30k a year for 3 years of grad school (if the grad program is fully funded as many are, it would cover the remaining years) that gives you more independence in your research directions. There might be workshops held by various departments and other entities at your university on applying to fellowships and stuff. Fellowships like these are thought of as crapshoots, but just applying could help your grad app chances --- it's not uncommon for grad apps to ask you to list all the fellowships you applied to as you earning it would save your grad program money. I just found out about this site with graduate funding and fellowship tips, <https://www.profellow.com/>, with a free database listing over 1,300 funding opportunities; their list of fellowships for US engineering students

The NSF GRFP application requires both a personal statement (max 3 pages) and a research proposal (max 2 pages including references); the prompts (also online [here](#)) for both are listed together at the end of this doc. The full program solicitation aka application details is this long pdf document online [here](#). Unofficial insight into the review process is [here](#). I've linked my successful [NSF GRFP research proposal](#), [personal statement](#), and [reviewer feedback](#).

Remember that a research proposal is about the problem statement, your research ideas that you haven't done (yet), and why you're well-suited to carry out that research. Emphasis on it's research you haven't done yet - if you knew it will work, it ain't research :)

I didn't follow a guide when writing my NSF GRFP research proposal. I looked online and think that [this guide is quite good](#), and this site has [many examples](#). The only commentary I have to add:

- The Broader Impacts part of the application is specific to NSF apps, to have you reflect on how your research and/or your efforts (ex. outreach, education) have and/or will benefit society - this varies a lot between applications, and it's unknown if in the NSF GRFP it's equally weighted with Intellectual Merit, but it's certainly important.
- For some research areas and projects, methodology is a crucial section of the research proposal (ex. growing plants, developing chemical assays, etc.). For others, it is close to nonexistent (ex. my research on inventing microwave spectroscopy algorithms, the methodology is that I try things, make note of the problems and what did/didn't work, and try more things). Ultimately, what makes your research proposal effective at communicating what you want is highly personalized to you, read by experts in your field who will likely not be familiar with the intricacies of your research topic. Getting feedback from people both in and not in your field will go a long way towards fine-tuning how well your audience will understand your writing given their background knowledge, while still communicating your main points.
- A change I was relieved I made in the final minutes before I turned in my NSF GRFP application was bolding, italicizing, and underlining words to emphasize in my research proposal. Had I not been a horrible procrastinator, I would have been a lot more thoughtful on organizing it, and I only got away with less organization because the research topic was quantum computer architecture which is such a new topic that there's ridiculously many open problems and lack of structure. The NSF GRFP research proposal requires organizing into sections; the names of these sections are of your choice, other than that it's required you have sections on Intellectual Merit and Broader Impacts (see next page). On top of that, I highly recommend emphasizing (with formatting) anything that you want to stand out to people reading hundreds of these proposals: such as your thesis statement, important statistics, a 1-5 word summary of each section, or assigning bold numbers to separate ideas in the proposal as I did.
- You can have figures in your NSF GRFP research proposal. I didn't because the 2 page including references limit is already tight and it wasn't necessary for the proposed research, but in two other proposals linked in this doc I found it very helpful.
- In retrospect, my NSF GRFP proposal could have been much better with more coherent organization and consultation of the literature. I consider my [later research proposal](#) for my University of Oxford CS DPhil application much more mature in terms of how much I actually knew and was prepared for about quantum computing research. However, the audiences for these two proposals were different: my NSF GRFP reviewers were computer science researchers who were not necessarily quantum computer scientists, while the Oxford CS proposal also targeted readers of general computer science background but among them included reader(s?) whose research focus was the topic, the ZX-calculus.

Please evaluate against these two criteria:

- I. **Intellectual Merit:** the potential to advance knowledge.
- II. **Broader Impacts:** the potential to benefit society and contribute to the achievement of specific, desired societal outcomes.

Important questions to ask yourself before writing the statement:

1. What issues in the scientific community are you most passionate about?
2. Do you possess the technical knowledge and skills necessary for conducting this work, or will you have sufficient mentoring and training to complete the study?
3. Is this plan feasible for the allotted time and institutional resources?
4. How will your research contribute to the "big picture" outside the academic context?
5. How can you draft a plan using the guidelines presented in the essay instructions?
6. How does your proposed research address the Intellectual Merit and Broader Impacts criteria?

Research statement:

Present an original research topic that you would like to pursue in graduate school. Describe the research idea, your general approach, as well as any unique resources that may be needed for accomplishing the research goal (i.e., access to national facilities or collections, collaborations, overseas work, etc.) You may choose to include important literature citations. Address the potential of the research to advance knowledge and understanding within science as well as the potential for broader impacts on society. The research discussed must be in a field listed in the Solicitation (Section X, Fields of Study).

Personal statement:

Describe your personal, educational and/or professional experiences that motivate your decision to pursue advanced study in science, technology, engineering or mathematics (STEM). Include specific examples of any research and/or professional activities in which you have participated. Present a concise description of the activities, highlight the results and discuss how these activities have prepared you to seek a graduate degree. Specify your role in the activity including the extent to which you worked independently and/or as part of a team. Describe the contributions of your activity to advancing knowledge in STEM fields as well as the potential for broader societal impacts (See Solicitation, Section VI, for more information about Broader Impacts).

NSF Fellows are expected to become globally engaged knowledge experts and leaders who can contribute significantly to research, education, and innovations in science and engineering. The purpose of this statement is to demonstrate your potential to satisfy this requirement. Your ideas and examples do not have to be confined necessarily to the discipline that you have chosen to pursue.