MITOCW | mitres16-9960-formulating_a_research_topic_captions

[Morse code beeps] [Whoosh]

[Helicopter rotor]

Hello.

Welcome to the Formulating a Research Topic workshop.

My name is Evan Kramer.

I'm an AeroAstro Communication Lab Fellow, and I will be your instructor today.

To get started let's take a moment to consider what quality research is.

We all strive to produce it, but definitions of quality vary from person to person.

However, there are some general characteristics that apply across the board which we will cover in this workshop.

Please pause the video and spend five minutes listing and providing rationale for a set of characteristics you believe research must possess to be considered quality.

[Alien spaceship beeps]

Now that we're primed to talk about research topics, here's a list of our lesson goals.

After this workshop, you will be able to understand common characteristics of quality graduate school research, implement a framework for formulating a well-defined research topic, and pursue next steps for formalizing your initial research topic formulation.

So quality research, what is it?

Generally, quality research in graduate school possesses three characteristics.

It is independent, meaning it can be conducted entirely by you without assistance from outside resources.

It is important, meaning it makes a contribution towards answering a specific question or gap in knowledge raised by several scholars within the research community.

And it is unique, meaning that it makes a first of its kind contribution by either addressing a previously unanswered question or introducing a novel solution approach within an existing body of work.

We've established some general criteria for what entails quality research, but how do we actually formulate a research topic that embodies those characteristics?

The first step is to acknowledge, that to perform quality research, you must have a well-defined research topic.

Formulating a well-defined research topic requires significant effort, but this effort is necessary to avoid running into unforeseen challenges during your Ph.D.

It is important to emphasize that this process takes time.

While it may be tempting to try to rush into a project, try to keep in mind that your chances of crafting a robust and cohesive research topic during graduate school is highly correlated with the amount of time and effort you spend during the formulation phase.

We present a five phase framework in this workshop that can be implemented during the formulation of your research topic.

We'll go into each phase on the following slides.

The first phase involves personal reflection.

Based on previous experiences and coursework, internships, and extracurricular activities, create a two column list.

The first column lists research fields you found interesting.

For example you might have had a summer internship where you were exposed to space propulsion work.

Or, you might have taken an undergraduate.

Course in aerospace controls that you particularly enjoyed.

Note that these topics are specific enough to carry out some exploratory reading, but general enough to avoid unnecessarily over constraining you at an early stage.

The second column lists ideas that align with your personal motivations to pursue a career in Stem research.

Your personal motivations might be extremely diverse.

For example, you may be passionate about increasing equitable access to space capabilities for low-resource nations and enabling efficient disaster response for remote communities.

There are no wrong entries for this column.

Anything that drives you to spend the next 2 to 5 years performing research in STEM belongs here.

Let's practice looking inwards in an activity.

In the Research Topic Formulation worksheet, fill out the left and middle columns.

Take ten minutes to get some ideas down, but feel free to revisit this table later, as this sort of personal reflection should not be rushed.

[Alien spaceship beeps]

Great job reflecting.

With the entries you've written in your table, start familiarizing yourself with the current state-of-the-art.

A good place to start would be popular science media outlets.

Try places like Space.com, The Verge, and Scientific American for high level, accessible articles.

As certain entries in your interest column pique your interest, start to perform deeper dives into your related academic literature using Google Scholar.

It is likely that several of the topics in the left column of your list get crossed off really quickly, as you realize they no longer interest you.

Try to narrow down your list of interests to about three before proceeding to the next step.

After you've reflected, and done some reading into your topics of interest, it is time to expand your table with a third column.

While personal interests and motivations are central to topic formulation, external factors must be considered too.

You'll need to consider the priorities of who your funding is coming from, and you'll need to consider areas of your lab's research thrusts.

The third column of your table will capture these external requirements.

An example for a funding requirement might include ensuring your work integrates elements of testbed development for satellite dynamics and control algorithm testing, if a grant that is funding your work was written focusing on this research area.

An example for a lab’s research thrust might be A.I.

applied to satellite operations, if that is where your advisor's expertise and active research interests lie.

If you're unsure about what belongs in this column, schedule a meeting with your advisor to discuss what external constraints you should consider during the topic formulation phase.

The next step in our framework is to formulate a research statement.

This is exciting because we're now starting to bring together all of the pieces that you've been working on separately.

Research statements should be in “To...By...While” format.

This format explicitly identifies what you are trying to accomplish, how you will accomplish it, and which constraints you will consider.

Your table of entries contains the information needed to write your first draft of a research statement.

A possible research statement could be defined with one entry from each column, or you may be able to create a topic with multiple entries from each column.

An example research statement from the previously shown table entries is, “To enable efficient natural disaster response for remote communities by developing an A.I.- powered rapid response scheduling algorithm for a remote sensing satellite while accounting for limitations to satellite operations imposed by the space environment.” Implementing this research statement format by referencing your table entries not only describes what you'll do, how you'll do it, and within what constraints, but it also ensures that your own personal interests, motivations, and relevant external factors are captured in your formulation.

We'll now practice writing a research statement.

The first step will be to write some entries in the third column of your table for external requirements.

After that, and regardless of how mature you feel your entries in your table are, go ahead and draft a research statement in “To...By...While” format, that communicates what you're proposing to do, how you'll do it, and which constraints or assumptions you'll be working under.

Please take ten minutes for this activity before returning to the workshop.

[Alien spaceship beeps]

Congratulations on drafting your first research statement.

The last phase in the formulation framework is to iterate and track your work.

You'll end up creating several iterations of research statements as you continue to read literature.

Your readings will inform how you iterate on your research statements language to pinpoint exact gaps in knowledge.

As you continue to read, formulate a focus area Venn diagram where your topic is at the center and related literature gets organized into regions surrounding it.

This diagram will help you stay organized and track all of the papers that you read.

It is also a really useful way to visually describe the research that you perform.

You might even find it useful to include in presentations you give, including your Ph.D.

proposal defense down the road, since it effectively contextualizes your research topic.

You've now completed all the steps in the research topic formulation framework.

So what exactly comes next?

After initial formulation comes official formalization of your research topic.

Formalization involves the addition of more structure to what you are working on by clearly articulating why and how you're going to perform it.

Central to articulating why and how you're performing your research is a gap analysis that frames your work within the context of the current state-of-the-art.

The concept is similar to the reading you did during formulation, but now it is extremely focused in the sense that you need to amass a set of papers that describe the current state-of-the-art for the topic you're focusing on and what they're clearly demonstrated limitations are.

An example gap analysis is shown in the table at right, where the focus area of the topic is radiometric terrain correction for synthetic aperture radar satellite imagery.

The current state-of-the-art is summarized in the middle cell and the limitations of the current approach are listed in the bottom cell, with citations to the literature references that point out these gaps.

After you've completed your gap analysis, you'll have an extremely robust and documented case for why the research you are pursuing is worthwhile.

With a gap analysis in hand, you can progress to write the following.

Focused questions serve as a stepwise set of milestones, posed as questions, that must be answered to address a focus area.

A Ph.D.

research topic might have 3 to 5 focus questions, some of which are contingent upon answers to others.

Objective statements directly respond to focus questions and detail what you will do, how you will do it, and within which constraints.

These share the structure of research statements, but are narrower in scope.

Contribution statements clearly defined the novel insights, advancements, and solutions your research offers to the field.

These are the statements you will claim you fulfilled when you defend your Ph.D.

dissertation down the road.

There is understandable uncertainty early on in the research formalization process.

You might not know how to write all of your questions, objectives, and contributions.

Your gap analysis ahould offer a starting point, however, and as you progress during your graduate school journey, you can revisit language in your statements.

Once you've completed the formalization steps, you have a solid course charted for your graduate school research.

That concludes this workshop on formulating a research topic.

You should now be able to understand common characteristics of quality graduate school research, implement a framework for formulating a well-defined research topic, and pursue next steps for formalizing your initial research topic formulation.

I hope you find the presented resources useful in your graduate school research journey.

This workshop was created and presented by Fellows of the MIT AeroAstro Communication Lab.

You can find other workshops related to technical communication in our MIT OpenCourseWare repository.

Thank you.

[Morse code beeps]