Grant Writing: Art, Science, Skill
Mastery through Application of Deliberative Approaches to Teaching and Learning

Rick McGee, PhD, Professor of Medical Education
Associate Dean for Professional Development

CCCR-CTRIS
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NORTHWESTERN UNIVERSITY
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Who am I? (for context of what follows…)

BS and PhD in Biochemistry – lipid biochemist

2 year postdoc at NIH in neurobiology

10 yrs at Georgetown (Pharmacology) – membrane biochemistry

4 yrs at Medical College of Ohio – Pharmacology and Associate Dean for Student Affairs – closed lab

12 yrs at Mayo Clinic – Graduate Student Affairs & Diversity

- Masters of Science in Clinical Research
- systematic scientific training vs. mentoring
- began evolution into social scientist

3.5 yrs at NIH – Graduate Partnerships Program – student affairs

12 yrs at Northwestern since 2007 – **Faculty coach**

- creating and testing group coaching to complement mentoring
- lead social science research team studying how scientists develop

Currently PI/Co-I on NIGMS R35 (MIRA), R25 IMSD, 2 National Research Mentoring Network (NRMN) U01s, IPERT R25

Overview of Today

Step back to consider grant writing as an incredibly complicated skill we typically leave up to mentors to informally ‘teach’

Introduce core principles of effective teaching and LEARNING

History of my approach – emphasis on getting feedback including oral feedback

Introduce some tools to assist writing, including concept of Rhetorical Patterns – how to use with flexibility

Introduce some other grant writing resources at Northwestern

But first, a short intro to the social context of writing in science

When you think about the environments that have ‘shaped you’, particularly as a clinician and/or scientist, which ones have been most important?

- Your undergraduate college/university
- Your graduate school
- Your MD or PhD program
- An individual lab
- A scientific organization/society

Were any of your environments particularly welcoming?

By contrast, were there any that were not inviting, or where you felt like you were being watched or judged and had to continually prove yourself?

How did you learn ‘how to act’ in research settings? (Clinical settings are more explicit about this…)

Communities of Practice

C of P (Lave & Wenger): groups who share a passion or goal for something they do, and learn how to do it better as they interact regularly

- Shared interest (domain)
- Competence – techniques, beliefs, talking and carrying oneself like a scientist
- Interaction and learning from each other
- Shared practices unique to each group – methods, tools, shared history, ways of doing things

Membership

- Legitimacy or marginalization of newcomers determined by perceived competence with practices
- Different rules may apply to different “types” of group members
- Practices draw on & reflect the power structures of group, as well as wider society, including those based in race, ethnicity, class, and gender

Examples & Implications of C of P for Scientists

Examples of C of P's in science

- Biomedical science as a whole or an individual discipline
- PhD programs and research groups

Challenges for newcomers

- Practices & rules often invisible (work habits, social expectations)
- Not consistent between labs or groups
- Seldom malicious or even conscious – but unconscious bias and untested assumptions can be played out
- If newcomers perceived as 'different', greater chance of marginalization
- Think about each research group you have joined…

Strategies to lessen marginalization

- Openness to what new members bring – match talent to project
- Provide key insider knowledge and guidance (mentoring/coaching)
- Important role of structured programs like this!

Writing and review of proposals is extreme C of P

Writing expectations – think about how structured they are…

- Writing styles very different between NSF and NIH
- Writing style totally different from writing papers

Behaviors of reviewers – incredibly socially constructed

- Review templates drive behaviors
- Strong force to ‘perform’ reviews colleagues will accept/value
- No time to do it so converge to least effort possible
- Even structures of summaries of discussion highly structured
- Codes of what people mean with words used in reviews

Why is grant writing so hard to learn?

Think about how much has to be mastered first…then…

Proposals require complex integration of existing knowledge, research questions and design, and unique form of writing

In the past has seldom been approached as a concrete skill to be purposefully taught – aside from workshops

Largely left to mentors and self-learning

Informal mentoring as a process is very idiosyncratic with high degree of variability in skills taught

Often tacit (or explicit) belief among some scientists that being able to figure it out by yourself is one of the determinants of whether or not you ‘belong’ in the Community – no evidence this belief leads to the best scientists or science

Starting Tenets

1. Writing research and fellowship proposals is not time away from science, it is integral to doing good science
2. Grant writing is a complex skill that is best learned through conscious application of high level leaching and learning principles
3. With few exceptions, high quality writing will not cover up weak or inadequately developed science
4. Proposal writing as not a linear process, think of it as a cyclic series of steps in research conception and writing
5. Getting effective feedback is often the weakest link in the cycle

How do we learn and master a skill?

Can start by either a guided process or self-actuated

Some combination of cognitive analysis of foundations and principles, and attempts at reproduction

Some kind of feedback loop to gauge ‘success’

Repeat as many times as needed or until feedback exhausted

How does this apply to grant writing?

How does this fit with how any of you have learned or taught writing research proposals?

Some core elements of learning and teaching

Starts from gauging how much a person does or should be expected to know what they are trying to replicate

Accurate models of what is being replicated

Clear display of underlying principles and patterns to be replicated – making the invisible visible

Deliberative practice with **effective feedback** that replicates, in this case, peer review

Modeling how cognition of readers can be both similar and different in every brain that reads something

Trial and error can work ok but it is a very expensive design – what costs come to mind?

Evolution of approach – MSCI at Mayo Clinic

Mid-1990s leading day-long grant writing workshop – rave reviews but little impact unless already well-prepared

NIH K30 curriculum awards for clinical researchers – teaching vs mentoring model became more prominent

1 credit course on grantsmanship – introduced peer feedback on early pieces of writing

Gradually added more interactive feedback – first version of current group process introduced with postbac researchers – BIG impact – added to graduate student curriculum

Left for NIH and replicated with students otherwise not getting any exposure to writing grants

Big change with move to Northwestern with focus on faculty development – implemented first faculty group in 2008

Principles upon which it is based…

Research mentoring is so idiosyncratic and variable impossible to get big impact relying on improving it

Core principles of teaching and learning – conscious thought into what needs to be learned, design of teaching to achieve it, practice with feedback, led by expert with dedicated time

Social science principles also integral to design!

Cultural Capital – knowledge and behaviors passed on by those in 'power' and high social status which is much less available to those who are not – but it CAN be taught – norms of behavior (e.g. style of writing) critical

Communities of Practice – groups acquire tacit knowledge of what an insider (someone who belongs) knows but often invisible or unstated – but judgements based on it

Display of thinking and behavior of experts vs. novices

Facilitated Group Process, display multiple cognitive views

Consider the 2-3 big elements of a proposal

The Science – Is the science worth spending money on vs. all of the other proposals that are being reviewed?

- New research ideas take a long time to refine
- Refinement cannot occur in a vacuum – cycles of thinking, reading, doodling, and feedback from more brains essential
- Must develop clear research questions and/or hypotheses

The Writing – Again a series of iterative cycles

- Writing is central to clarifying thinking, questions, hypotheses approach
- Writing is a window into thinking, feeding back into the science
- Always start with small, focused pieces of writing for feedback
- Ultimately, writing is about 'telling the story'

The Candidate and Environment – For K or other training proposals

Faculty Grant Writers Groups – began in 2008

Every 4 months – “Whose writing a proposal?”

Session 1 deconstructs the elements of NIH style proposals – or accomplished by *“Navigating the Research Enterprise”* series

Session 2 – everyone comes with paper copy of research questions, hypotheses or Specific Aims (if they are that far)

In real time, read and discuss each one – I model talking through what my brain is hearing from what I read – others do as well once they see the method

Each week refine and revise questions, hypotheses, aims, aims page

Move on to Significance, Innovation, other sections of F and K

Especially effective done early during writing – discourage trying to come with polished writing

Added recording of oral interchange – game-changer!

Grant Writers Groups - continued

May go on to Approach but most often these are beyond the expertise of the group, but not always

Still requires input of scientific mentors, and other mentors for K, but focuses that time on the science while we develop writing skills and give fresh eyes to improve writing

Audio recording of discussion BIG improvement - captures thinking and discussion which otherwise often lost

What is happening during writers groups?

Development or refinement of scientific thinking, ability to define research questions, hypotheses,

Scientific writing skills – down to level of sentence construction

Viewing proposal writing as a highly refined stylistic pattern – including rhetorical patterns

Detailed knowledge of what goes into each section and why

Developing ability to ‘think like a reviewer’

Demystification – grant writing is a very learnable skill

Simulation of grant review process and realities

Positive peer group – all in it together

Career development guidance – sometimes harsh reality check

Some realize it is not for them – often a positive outcome!

But can’t salvage weak science!

What is happening during writers groups?

Often times big changes in the science – Aims Page is pivotal display of the science for dialogue and feedback

For R grants, the science is absolutely make or break – groups can often identify weaknesses if not fix them

For K and F, it is all about the full package

Highly effective writing cannot salvage weak science!

Participants so far…

350+ different people since 2008 – also many repeats

Roughly 30-50% stay the course in each group

- Some realize they need more time, preliminary data, pubs
- Always positive environment – many return to new groups

Excellent connections among those who persist

Many referrals from colleague to colleague

Faculty mentors referring Fellows and junior faculty to the group

NO instances of mentors reacting negatively

As could be expected, difference of style and content between group and mentors pop up – good teaching tool, careful not to be dogmatic or proscriptive about only one way to write

More on participants and what happens

~30-50% success of those who submit – sometimes with resubmission of course

High number of responses indicate perception of substantial value

Many anecdotal successes…currently analyzing extensive data

Over 300 grants funded – primarily NIH K and R

~150 different people (out of ~350)

At least 89 R01s – either worked on in group or subsequently – some people with several

~50 Ks, 39 R21s, wide array of other R, P, and U grants

Group model also expanded via collaborations with AAMC and National Research Mentoring Network – NRMN

Central to all proposals are the review criteria

All writing starts from knowing the review criteria whether for NIH or any other type of award

Critical to provide EXACTLY what reviewers and those who make funding decision expect and want to see

No margin for error when it comes to following directions

As a novice, impossible to decode the review criteria or know what people are expecting to read!!!!

Know the review criteria – R series grants

Overall Impact – the score that matters

Core Review Criteria for Research Proposals

- Significance – may be global or within a field
- Investigator(s)
- Innovation
- Approach
- Environment

You are actually writing to review criteria

Review criteria very different for F and K awards

Review criteria for K-Series

Overall Impact/Merit – the score that matters

- Candidate
- Career Development Plan/Career Goals and Objectives
- Research Plan
- Mentor(s), Co-Mentor(s), Consultant(s), Collaborators
- Environment & Institutional Commitment to the Candidate

ALL sections of the application must be strong – any one that is weak is very likely to drag down the rest

K99/R00 similar but slightly different ‘story line’

Online Tools to Assist Grant Writing

Developed by communications expert who worked with us for 18 months – Karl Keller

Animated PowerPoint presentations with audio – each 15 minutes or less

Vivid display of the patterns that reviewers see and expect to see in grant judged as high quality and fundable

Classic cultural capital which funded PIs have acquired but often can't articulate what they are doing or why

http://www.northwestern.edu/climb/resources/written-communication/index.html

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WRITTEN COMMUNICATION

Being a scientist means more than just doing exceptional research. A good scientist is also a good writer. In fact, you won't truly be successful as a scientist until you learn to write well. You have to publish papers and apply for grants to fund your work. In fact, your career depends on the ability to write well.

The resources below are designed to help you improve your writing skills. The advice provided here is not only actionable and practical, it's science-based. The advice is designed to "de-mystify" the writing process. These resources focus on skills you can quickly master, no matter how you view yourself as a writer, and no matter how complex and subtle the science is.

The links below lead to PowerPoint or video files used for our workshops for second year CLIMB students when we focus on written communication skills.

View a PowerPoint or video file:

- Key Science Writing Skills
  - 5 Principles for Writing Readable Sentences
  - Creating Coherent Paragraphs: Topic Sentences, Echo Words, Transitions
- NIH Grant and Dissertation Proposals
  - Aims Pages, Part 1: Rhetorical Patterns
  - Aims Pages, Part 2: Specific Aims
  - Understanding NIH Review Criteria
  - NIH Grants: Analyzing the "Big Structure" of a Funded Proposal
  - NIH Grants: Exlporing the "Significance" and "Innovation" Sections
  - NiH Grants: Analyzing the "Approach" Section
- NSF Grant Proposals

QUICK LINKS

- Contact Us

NORTHWESTERN BIOSCIENCE PROGRAMS

- Biomedical Engineering (BME)
- Chemical and Biological Engineering (ChBE)
- Driskill Graduate Program in the Life Sciences (DGP)
- Interdepartmental Biological Sciences (IBiS)
- Northwestern University Interdepartmental Neuroscience (NUIN)

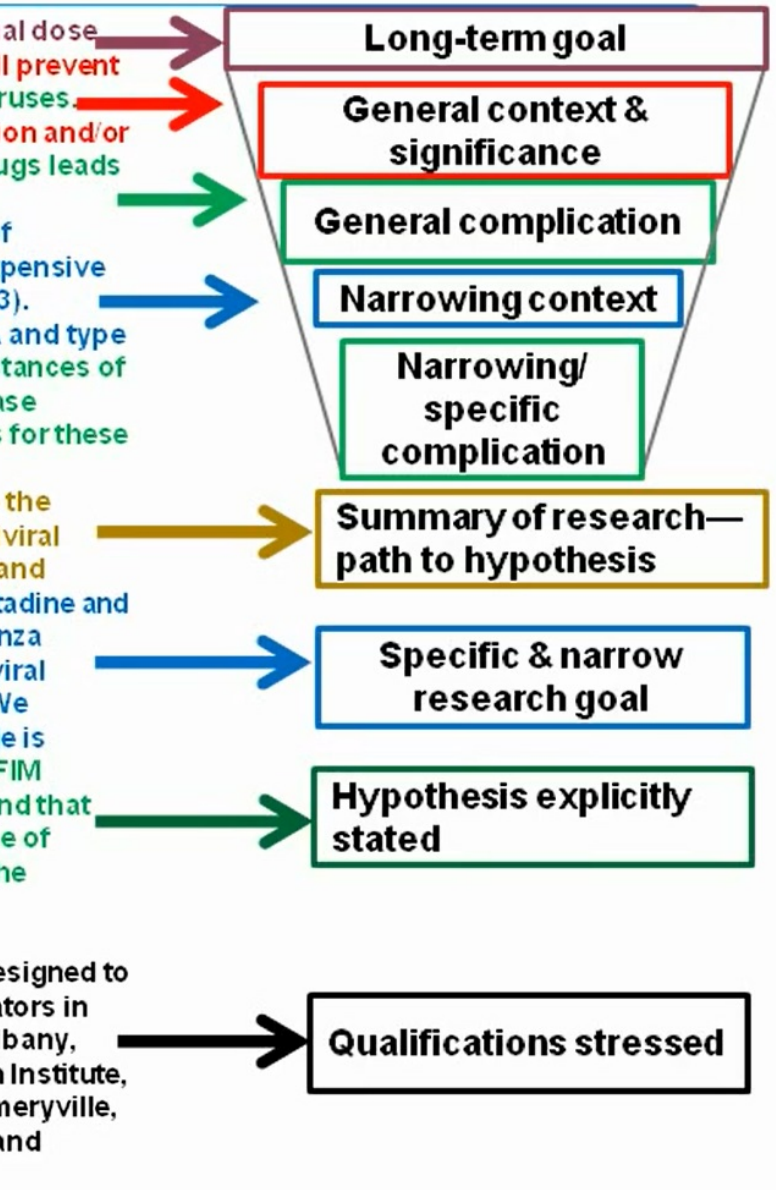
The next paragraph takes up other components, with qualifications addressed after aims

Specific Aims The long term goal of this research project is to identify the optimal dose and schedule of administration of drugs active against influenza viruses that will prevent and/or cure people with influenza without causing the emergence of resistant viruses. The adamantanes and neuraminidase inhibitors have been used for the prevention and/or treatment of influenza. However, they often fail because treatment with these drugs leads to the emergence of resistant viruses in the treated population.

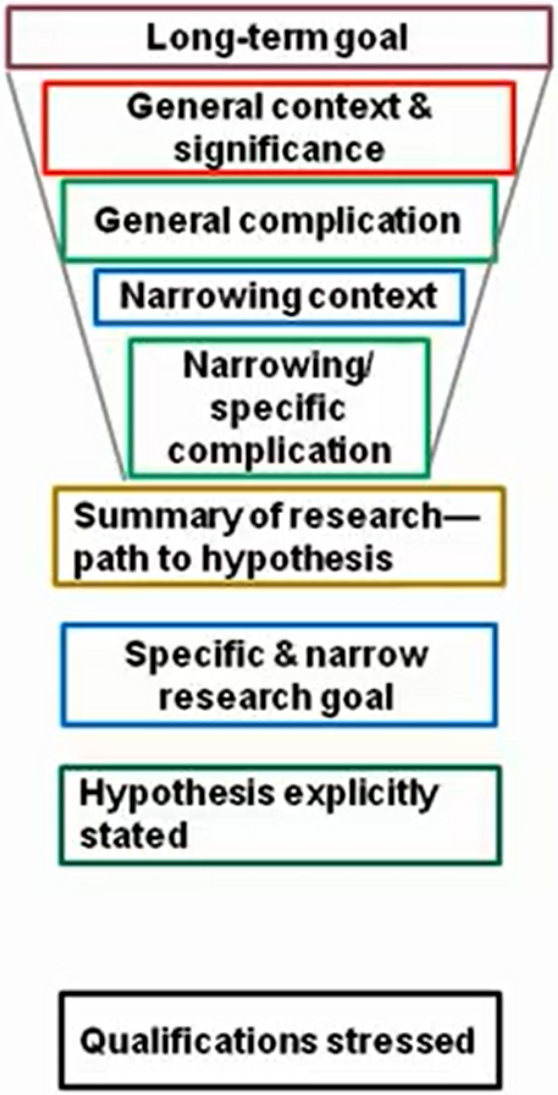
Adamantanes have historically been used in the treatment and prevention of influenza A virus infections (1). Recently, viruses that are resistant to these inexpensive drugs have emerged, rendering them less useful for the therapy of influenza (2, 3). Neuraminidase inhibitors represent a new class of agents for use against type A and type B influenza virus infections (1). While shown to be effective, there have been instances of emergence of resistance or reduced sensitivity during therapy with neuraminidase inhibitors (4-6). This has been seen especially in children where high clearances for these agents in general and oseltamivir in specific are the norm (5).

The hollow fiber infection model (HFIM) system has been used to determine the optimal dose and schedule of administration of antibacterial, antifungal and antiviral compounds for use in the treatment of individuals infected with bacteria, fungi, and viruses (7-16). We propose to use the HFIM system to study the effects of amantadine and the neuraminidase inhibitor, oseltamivir carboxylate, on the replication of influenza viruses and to identify the pharmacodynamically-linked variables for these antiviral drugs, alone and in combination, with respect to inhibition of virus replication. We also propose to identify whether a different pharmacodynamically-linked variable is present for suppression of emergence of resistance. We hypothesize that the HFIM system can be used to provide information on resistance selection in humans and that the HFIM system can be used to determine the dose and administration schedule of antiviral compounds and combinations of antiviral compounds that will inhibit the replication of influenza viruses while preventing the emergence of resistance.

Our research strategy involves a multifaceted, translational collaboration designed to optimize the move from research discovery to clinical application. The collaborators in this activity include a nonprofit research institute (Ordway Research Institute. Albany, NY), a non-profit genomics research institute (Translational Genomics Research Institute, Flagstaff, AZ), and a private biotech company (Adamas Pharmaceuticals, Inc, Emeryville, CA). This strategy has proven successful in other activities including a current and ongoing research project involving the above partners



So, let's look at the two rhetorical patterns, side by side—similar components different sequence



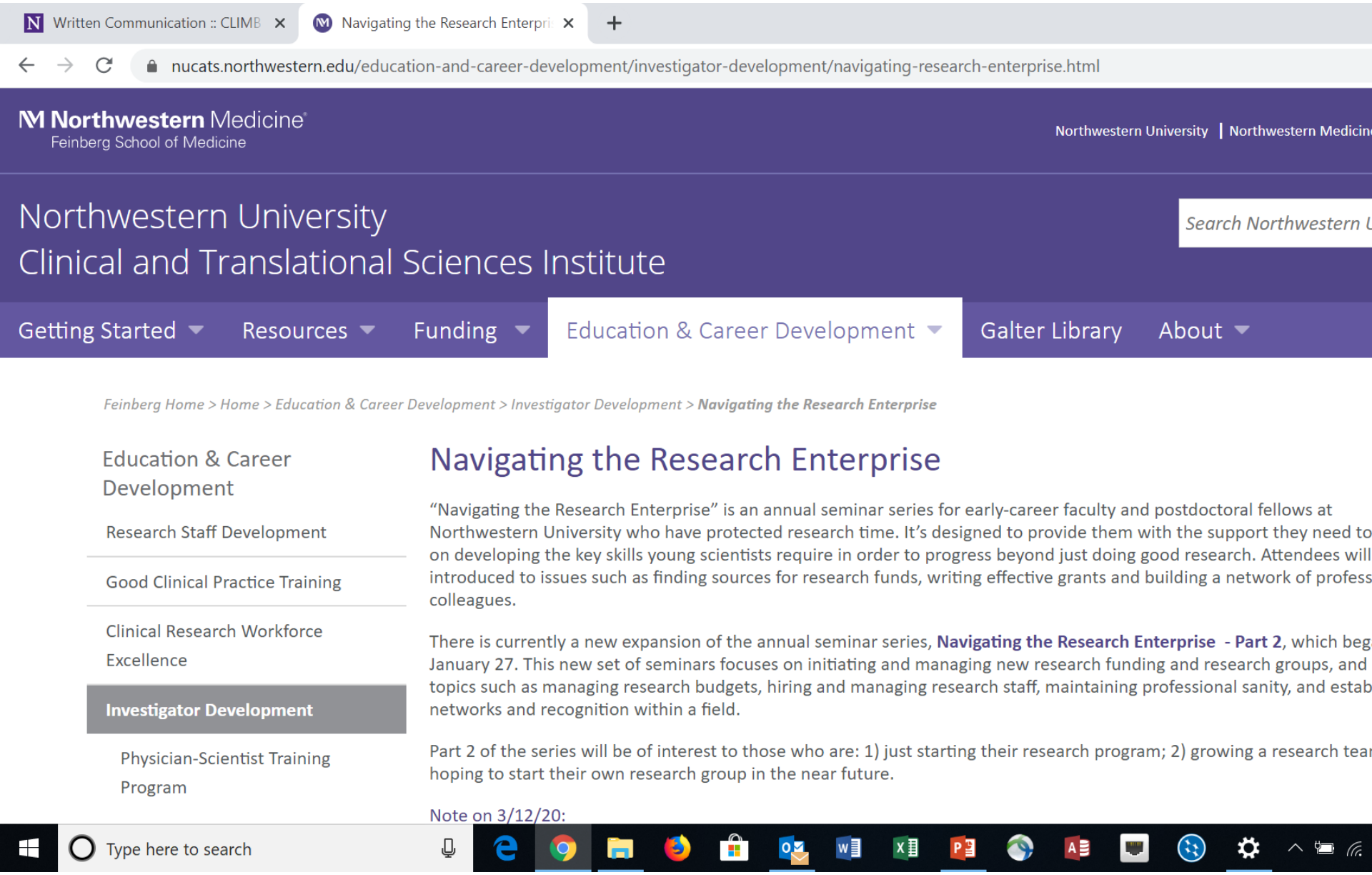
Your challenge is to identify these components for your research, arrange them logically; this template can help

General context & significance	What is "big picture" for research? Why is it important?
Narrowing context	What is known and accepted in your research area?
Your research contribution	Has your previous work contributed? How?
Complication	What is the problem, roadblock, the unknown?
Long-term goal	What final "big result" will research will help achieve?
Specific goal of this research	What is "specific narrow goal" of this research?
Summary of research—path to hypothesis	How does previous research lead to hypothesis?
Hypothesis	What do you believe to be the answer to the complication?
Qualifications stressed	What makes you the right person to undertake this research?

Important considerations/caveats!

- Don’t feel too constrained by specifics but patterns very helpful to novice getting started
- Examples have more text on capabilities of the research group than is typical, unless a reviewer might be skeptical
- The Aims page is missing the Impact statement on the bottom of the page – critical new element added about 8 years ago

Other resources through Faculty Affairs and NUCATS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Navigating the Research Enterprise
"Navigating the Research Enterprise" is an annual seminar series for early-career faculty and postdoctoral fellows at Northwestern University who have protected research time. It's designed to provide them with the support they need to
on developing the key skills young scientists require in order to progress beyond just doing good research. Attendees will
introduced to issues such as finding sources for research funds, writing effective grants and building a network of profess
colleagues.
There is currently a new expansion of the annual seminar series, Navigating the Research Enterprise - Part 2, which beg
January 27. This new set of seminars focuses on initiating and managing new research funding and research groups, and
topics such as managing research budgets, hiring and managing research staff, maintaining professional sanity, and estab
networks and recognition within a field.
Part 2 of the series will be of interest to those who are: 1) just starting their research program; 2) growing a research tea
hoping to start their own research group in the near future.
Note on 3/12/20:
Type here to search

Navigating the Research Enterprise

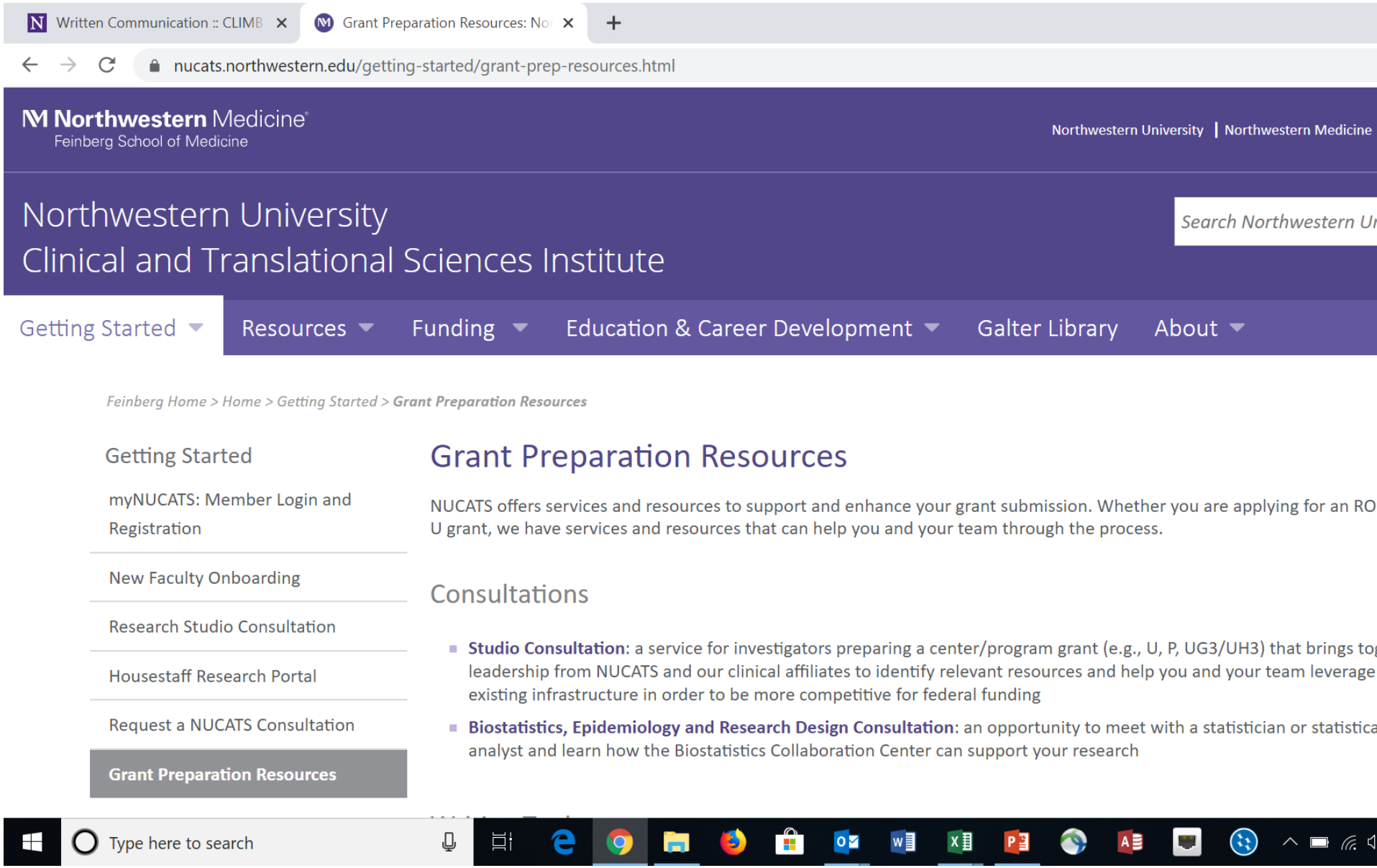
Select Mondays from 12:00-1:00 p.m.
September 16, 2019 through December 9, 2019 (subject to change)
Northwestern University – Chicago Campus
Robert H. Lurie Medical Research Center, 303 E Superior St
and
McGaw Medical Center, 240 E Huron St

SERIES CO-DIRECTORS:

William (Bill) Lowe, MD:	Vice Dean of Academic Affairs, Professor of Medicine in Endocrinology
Rick McGee, PhD:	Professor of Medical Education, Associate Dean for Professional Development

OTHER PARTICIPATING INSTRUCTORS:

Keith Herzog:	Institute Administrator, NUCATS Institute
Karen Lapidos Ciola:	Senior Associate Director Office of Research Development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leadership from NUCATS and our clinical affiliates to identify relevant resources and help you and your team leverage
existing infrastructure in order to be more competitive for federal funding
Biostatistics, Epidemiology and Research Design Consultation: an opportunity to meet with a statistician or statistica
analyst and learn how the Biostatistics Collaboration Center can support your research
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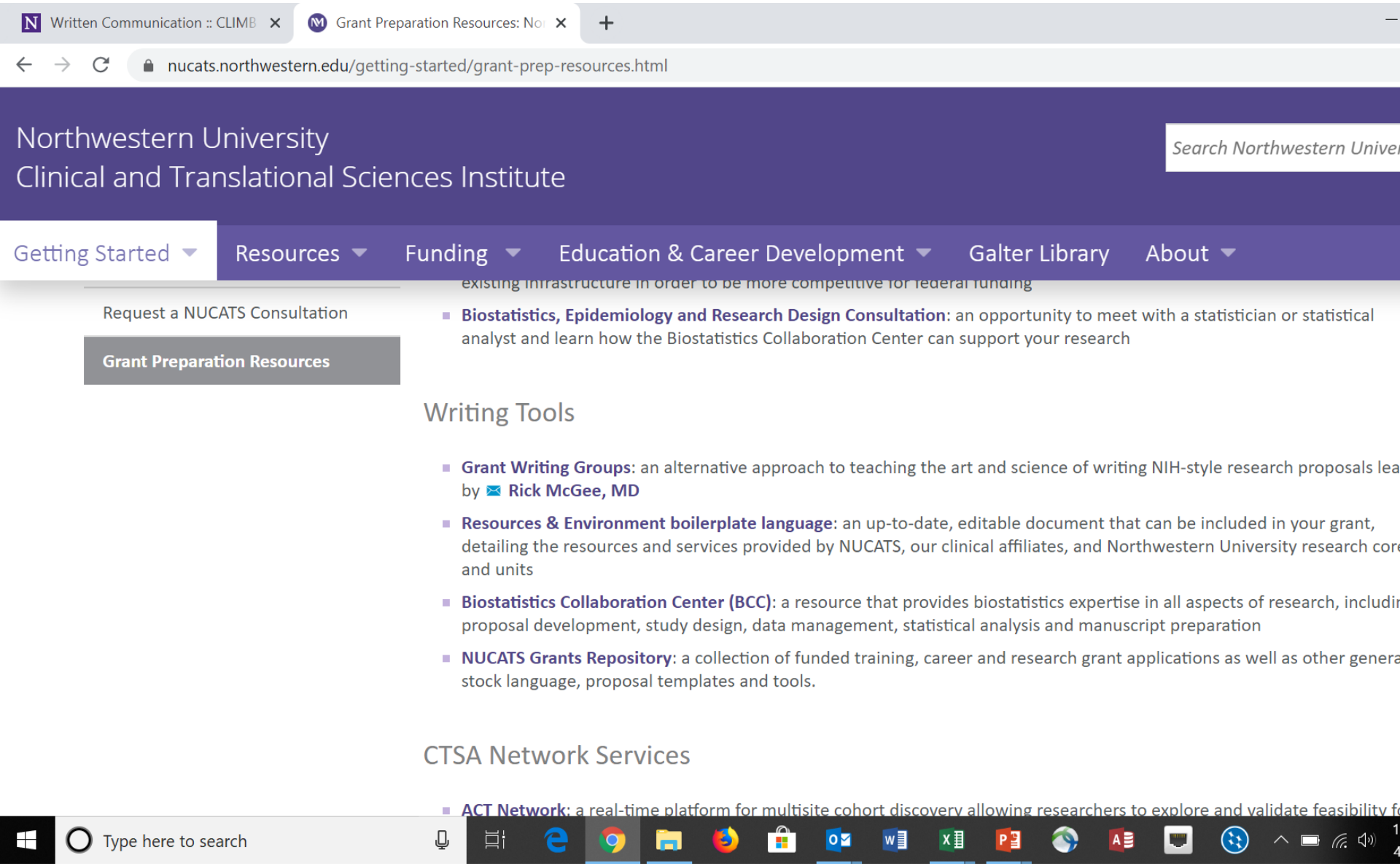
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existing infrastructure in order to be more competitive for federal funding
Biostatistics, Epidemiology and Research Design Consultation: an opportunity to meet with a statistician or statistical analyst and learn how the Biostatistics Collaboration Center can support your research
Writing Tools
Grant Writing Groups: an alternative approach to teaching the art and science of writing NIH-style research proposals lea
by Rick McGee, MD
Resources & Environment boilerplate language: an up-to-date, editable document that can be included in your grant, detailing the resources and services provided by NUCATS, our clinical affiliates, and Northwestern University research cor and units
Biostatistics Collaboration Center (BCC): a resource that provides biostatistics expertise in all aspects of research, includi proposal development, study design, data management, statistical analysis and manuscript preparation
NUCATS Grants Repository: a collection of funded training, career and research grant applications as well as other genera stock language, proposal templates and tools.
CTSA Network Services
ACT Network: a real-time platform for multisite cohort discovery allowing researchers to explore and validate feasibility f
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Pre-Submission Peer Review

Initiated several years ago

2 months before deadline – well-developed Aims Page

- Identify 2 faculty field/peer-review experts – feedback on Aims Page

6 weeks before deadline – full proposal strong draft

- Reviewers provide full review within 2 weeks

4 weeks before deadline – start to finalize well ahead of deadline

Dean provides $250/reviewer – extra pay or research account

Modest use – 1-2/major NIH deadline – Ks and Rs

Very few senior faculty decline to help unless don't have time due to prior commitments like study sections

What have I not covered?

Q and A Time!

I can also stay online after the seminar ends to answer individual questions

Rick McGee - r-mcgee@northwestern.edu

Always happy to have individual conversations about anything related to grant writing – it is what I get paid to do!