I. Writing Plan Cover Page

Please fill in the gray areas on this form.

14 May 2018

First Edition of Writing Plan: Spring 2018 (to begin Fall 2018)

School of Mathematics

WEC Unit Name

Mathematics

Department

College

Craig Westerland

Associate Professor

WEC Faculty Liaison (print name)

cwesterl@umn.edu

Title

Email

Phone

Writing Plan ratified by Faculty

Note: This section needs to be completed regardless of Writing Plan edition.

Date: 25 May 2018

If Vote: # yes / # total

Process by which Writing Plan was ratified within unit (vote, consensus, other- please explain):
The Writing Plan was ratified by consent. Specifically, it was sent to regular faculty members for a period of 7 days for comment and for them to indicate whether or not they support the plan. Several faculty members wrote back indicating support, one indicated that he neither supported nor opposed it, and none indicated opposition.
II. **Unit Profile:** School of Mathematics

*Please fill in the gray areas on this form.*

**Number of Tenured and Tenure-Track Faculty:**

<table>
<thead>
<tr>
<th>Faculty Title</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professors</td>
<td>41</td>
</tr>
<tr>
<td>Associate Professors</td>
<td>13</td>
</tr>
<tr>
<td>Assistant Professors</td>
<td>7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>61</td>
</tr>
</tbody>
</table>

In addition to the tenure-stream faculty (the vast majority of which participate in undergraduate teaching), the department employs 4 contract associate or assistant professors whose duties are oriented towards teaching and administration. There are additionally 19 postdocs (whose duties include teaching), 7 faculty members associated with the Minnesota Center for Financial and Actuarial Mathematics, 3 instructors, and 17 lecturers and teaching specialists.

**Major(s)**

*Please list each major your Unit offers:*

<table>
<thead>
<tr>
<th>Major</th>
<th>Total # students enrolled in major as of Spring 2018</th>
<th>Total # students graduating with major AY 2017-2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bachelor of Science, Mathematics</td>
<td>306</td>
<td>136</td>
</tr>
<tr>
<td>Bachelor of Arts, Mathematics</td>
<td>320</td>
<td>114</td>
</tr>
</tbody>
</table>

**Total:**

|                   | 626 | 250 |

**WEC Process**

<table>
<thead>
<tr>
<th>WEC Process</th>
<th>Date</th>
<th># participated</th>
<th># invited</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meeting #1 (surveys, sections 1,2)</td>
<td>10/19/2017</td>
<td>19</td>
<td>70</td>
</tr>
<tr>
<td>Meeting #2 (section 2, 3)</td>
<td>11/14/2017</td>
<td>10</td>
<td>70</td>
</tr>
<tr>
<td>Meeting #3 (curriculum, criteria)</td>
<td>2/15/2018</td>
<td>13</td>
<td>70</td>
</tr>
<tr>
<td>Meeting #4 (criteria)</td>
<td>3/20/2018</td>
<td>13</td>
<td>70</td>
</tr>
<tr>
<td>Meeting #4.5 (supplementary criteria)</td>
<td>4/3/2018</td>
<td>8</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
III. Signature Page

Signatures needed regardless of Writing Plan edition. Please fill in the gray areas on this form.

If this page is submitted as a hard copy, and electronic signatures were obtained, please include a print out of the electronic signature chain here.

WEC Faculty Liaison

Craig Westerland
WEC Faculty Liaison (print name)

Associate Professor
Title

Signature
8/20/18
Date

Department Head/Chair

Peter Olver
Print Name

Professor and Head
Title

Signature
8/27/18
Date

Associate Dean

Paul Strykowski
Print Name

Professor and Associate Dean
Title

Signature
8/23/18
Date
IV. Writing Plan Narrative, 1st Edition

Please retain section headers and prompts in your plan.

Introductory summary:
Briefly describe the reason(s) this unit (department, school, college) become involved in the WEC project, key findings resulted from the process of developing this plan, and the implementation activities are proposed in this Writing Plan. (1/2 page maximum)

The School of Mathematics has identified communicating effectively as one of the central learning outcomes for its students. Communicating about mathematics in both spoken and written words involves a balance between the logical precision required to create new mathematical facts and the recognition of the informal language that reflects how we think about and assimilate new mathematics.

Our efforts to develop students’ skills in mathematical communication are complicated by the fact that the courses in our lower-division curriculum -- Calculus I and II, Linear Algebra and Differential Equations, and Multivariable Calculus -- emphasize computational tasks and assess these skills in a way that does not place equal emphasis on the communication of those ideas. These large service courses are not primarily designed for mathematics majors, and indeed, many majors can avoid some or all of these courses based on their previous mathematics experience.

At the upper-division level, instructors expect their math major students to engage in deeper mathematics and communicate effectively about it. Undergraduate majors regularly participate in courses at the 5000 level and above depending upon their preparation and specialization. At present, the Mathematics department places a large burden on our Sequences, Series, and Foundations courses, MATH 2283 and 3283W, to train students in the techniques of mathematical proof and clear exposition of those proofs. While many students are successful in these so called “transition courses,” members of the department agree that student performance can be improved with more practice and feedback on writing and communication.

Recognizing that training in mathematical communication requires intervention throughout the curriculum, the undergraduate curriculum committee voted unanimously to apply to the Writing-enriched Curriculum program in 2017-2018. In addition to the members of the curriculum committee, a growing core of faculty committed to taking a fresh approach to improving outcomes for our undergraduate mathematics students participated in our meetings and in the development of this plan.

Our first plan will attempt to engage members of the faculty more broadly in the effort. While many of our faculty principally offer specialized courses in our graduate program, almost all faculty members teach in the undergraduate curriculum on a regular rotation. In our first year of implementation, we hope to make the case that identifying what makes good mathematical writing in a systematic way and developing tools for instructors throughout the curriculum to promote it are worthwhile tasks that will create richer mathematical experiences for faculty and students.
Section 1: DISCIPLINE-SPECIFIC WRITING CHARACTERISTICS

What characterizes academic and professional communication in this discipline?

Fundamentally, writing in mathematics is characterized by logical arguments and deductions. In formal settings, this is codified in the notion of a proof—a logical argument that has its own stylized form—but even in informal communication the emphasis is on careful, internally consistent, deductive reasoning.

Good mathematical writing is characterized by clarity and precision of explanation and the use of valid and sound logical arguments to establish results. Because mathematics relies on rigorous definitions of its terms, these definitions (and associated notation) must be clear and unambiguous. Arguments are often illustrated by (but not necessarily established with) well-chosen examples and counterexamples.

Stylistically, good mathematical writing is often concise, well-organized, and follows a focused and sequential development of the argument (without unnecessary detours or descriptions). Arguments should be well-motivated (often with explicit justifications) and, in longer forms, accompanied by an introductory roadmap, clearly marked transitions, and internal summaries. Ideally, mathematical writing is tailored to its audience, acknowledging the wealth of different backgrounds in the subject. A mathematically prepared reader should be able to understand and reconstruct the argument on their own, and mathematical operations and choices may need to be explained for lay readers.

Fundamentally, a proof is a logical argument designed to convince the reader of the truth of a claim. As such, it must clearly convey an idea, not merely move symbols about. In longer work, good writing highlights the most critical components of an argument. Finally, as with all writing in English, mathematical writing must employ correct grammar and sentence structures.

Section 2: DESIRED WRITING ABILITIES

With which writing abilities should students in this unit’s major(s) graduate?

The demands of mathematical writing are substantial, being dictated by a high bar of rigor and logical precision. This is the foundation of mathematical writing, and perhaps its most important aspect. Secondary to that, exposition should be structured to illustrate the logical flow of an argument. Finally, mathematical writing addresses the needs of the intended audience. As such, a very well-prepared mathematics major should graduate with the following writing abilities, given in those three clusters:

Precision & Rigor:

1. Assess whether an argument, whether logical or mathematical, is complete and correct.
2. Explain and justify choices in method or approach when considering a problem or question. Be able to explain their choices and show their work.
3. Know and follow conventions for mathematical exposition, including standard patterns of proof and English grammar and usage.

**Exposition, Explanation, & Argumentation:**

1. Employ choices in language that illustrate the logical progression of the argument. In problems and shorter forms, organize writing in ways that illustrates the goal or main idea. In writing a mathematical paper or longer forms, establish a clear plan (roadmap) for writing.
2. Draw attention to the critical components of a logical argument by highlighting themes and giving a sense of the big picture.
3. Select illustrative examples and visualizations to amplify and clarify the argument being made.
4. Write concisely, recognizing and eliminating extraneous information.

**Audience & Context:**

1. Write mathematics (proofs, arguments, and exposition) that a reasonably prepared reader can understand and reconstruct.
2. Consider an audience’s needs and motivation when communicating mathematics and make effective choices about level of detail for non-technical audiences. The audience’s expertise and needs should guide the use of technical terms and level of detail.
3. Use presentation tools, typesetting packages, and mathematical software.

**Section 3: INTEGRATION OF WRITING INTO UNIT’S UNDERGRADUATE CURRICULUM**

How is writing instruction currently positioned in this unit’s undergraduate curriculum (or curricula)? What, if any, course sequencing issues impede an intentional integration of relevant, developmentally appropriate writing instruction?

Due to the large service component of the 1000 and 2000 level classes, very little mathematical writing instruction currently occurs in these courses. Instead, most instructors focus on computation and correct answers to problems. While students write answers to problem sets and homework, they rarely are asked to reflect on their processes or provide explanation beyond a correct answer. Because these service courses serve as prerequisite mathematics for many colleges and departments across the University, it is difficult to focus on expectations for majors in these environments.

In the 3000 level classes, particularly 3283W (Sequences, Series, and Foundations) and 3592H/3593H (Honors Mathematics I/II), instructors begin to incorporate instruction on writing proofs. In these classes, as well as the subsequent 4000 and 5000 level classes (where these skills are developed further), the bulk of writing instruction focuses on the category “Precision & Rigor” described above. The category “Exposition, Explanation, & Argumentation” receives sporadic instruction at this level. Far less attention is paid to the material in the category “Audience & Context,” except for item 1 in that section (which receives a lot of instruction). Specialized courses in the Actuarial Science track pay some explicit attention to practices of reporting in the industry, but still emphasize mathematical modeling and probability.
Surveys of the faculty indicate that students commonly struggle with concision, highlighting critical components of arguments, consideration of an audience’s needs, as well as justification of choices of methods. These struggles are consistent, but are notable in the areas where our curricular survey indicated less writing instruction. With the exception of the last, there is a general willingness amongst faculty responding to the survey to address these issues in the future.

We acknowledge that there is something of a bottleneck in the structure of the major (in the 3000 level classes above which focus on writing). If a student finds an alternate or nonstandard route through the major, students can bypass these courses in a way that can impact the development of their writing skills. The faculty discussed linear algebra as a potential site for attempting additional explicit instruction in writing and as another opportunity for majors to practice writing in context. While these 3000 level classes explicitly focus on writing instruction, instructors in 4000 and subsequent courses felt that the focus of the classes is on working with and writing increasingly complex mathematics rather than explaining mathematics in prose or reflecting on processes of problem solving. Writing instruction mostly happens by positive example or in grading comments. Additionally, many faculty indicate that in passing to the 4000 and 5000 level classes, the level of abstraction (compared to the 3000 level classes) increases substantially, which provides added pressures on students to adapt their writing skills to these new settings.

Section 4: ASSESSMENT OF STUDENT WRITING
What concerns, if any, have unit faculty and undergraduate students voiced about grading practices?

Please include a menu of criteria extrapolated from the list of Desired Writing Abilities provided in Section 2 of this plan. (This menu can be offered to faculty/instructors for selective adaptation and will function as a starting point in the WEC Project’s longitudinal rating process.).

Several concerns have been raised about grading practices. A common theme is that an imposition a writing component of grades will be onerous on the instructor, grader, and student. This is expressed in several ways; firstly, it is not the main purpose of a mathematics department to instruct on English grammar. Secondly, it is our tendency (and many faculty believe rightly so) to grade work entirely or largely on the correctness of the mathematics, and not the quality of the writing. A third concern is that, given the large non-native English-speaking component of our instructional workforce, we are not well-positioned to have any business grading writing.

In contrast, there is also a common feeling that our students are not adequately educated on how to write mathematics properly, and some desire on the part of the faculty to incorporate this into our grading practices. This comes with the caveat of there being a uniform distaste for prescriptive grading guidelines.

**Precision & Rigor:**

<table>
<thead>
<tr>
<th>1. Assess whether an argument, whether logical or mathematical, is complete and correct.</th>
<th>Addresses the necessary details, using valid logical statements. Points are deducted for erroneous reasoning and for omitting attention to crucial aspects of the conclusion.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Explain and justify choices in method or approach when considering a problem or question.</td>
<td>a. Explains the choice of method in a way that justifies the chosen approach as the best one.</td>
</tr>
<tr>
<td>Choices reflect both sound reasoning and mathematical taste.</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td></td>
</tr>
<tr>
<td>b. Defines terms, definitions, and notations near the beginning and used consistently throughout the document. No ambiguous, undefined, or sloppy terminology.</td>
<td></td>
</tr>
<tr>
<td>3. Know and follow conventions for mathematical exposition, including standard patterns of proof and English grammar and usage.</td>
<td></td>
</tr>
<tr>
<td>Employs correct grammar and usage. Statements have a logical flow and are logically ordered (in paragraphs and in documents as a whole).</td>
<td></td>
</tr>
</tbody>
</table>

**Exposition, Explanation, & Argumentation:**

<table>
<thead>
<tr>
<th>1. Employ choices in language that illustrate the logical progression of the argument. In problems and shorter forms, organize writing in ways that illustrates the goal or main idea. In writing a mathematical paper or longer forms, establish a clear plan (roadmap) for writing.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is organized in a way that makes it clear what the author is doing and makes it clear what conclusion is reached. Deductions are made for work that lacks a clear picture of what is assumed, lack key information that helps the reader through the main part of the proof and/or lacks a clear conclusion which addresses the key issues.</td>
</tr>
<tr>
<td>2. Draw attention to the critical components of a logical argument by highlighting themes and giving a sense of the big picture.</td>
</tr>
<tr>
<td>In detailed exposition, addresses a short list of topics/ideas/themes, which may be subdivided into smaller subsections. Deductions are made for work that doesn't summarize or synthesize key ideas.</td>
</tr>
<tr>
<td>3. Select illustrative examples and visualizations to amplify and clarify the argument being made.</td>
</tr>
<tr>
<td>Clarifies the meaning of the mathematics through examples and illustrations. Examples contain requisite details to explain their meaning and value in context.</td>
</tr>
<tr>
<td>4. Write concisely, recognizing and eliminating extraneous information.</td>
</tr>
<tr>
<td>Is concise. Contains enough detail to be complete and no more.</td>
</tr>
</tbody>
</table>

**Audience & Context:**

<table>
<thead>
<tr>
<th>1. Write mathematics (proofs, arguments, and exposition) that a reasonably prepared reader can understand and reconstruct.</th>
</tr>
</thead>
<tbody>
<tr>
<td>States what the reader is expected to assume to be true and shows sufficient detail that a reader with that level of preparation can follow. Deductions are made for work that spends too much time on easy material that should be assumed. Deductions are made for gaps in the argument that assume too much.</td>
</tr>
<tr>
<td>2. Consider an audience's needs and motivation when communicating mathematics and make effective choices about level of detail for non-technical audiences. The audience’s expertise and needs should guide the use of technical terms and level of detail.</td>
</tr>
<tr>
<td>Tailors to the audience (well-organized, includes the right amount of detail for an identified audience). The writing provides descriptions with enough detail that arguments can be reproduced by a peer.</td>
</tr>
</tbody>
</table>
The third component of Audience & Context, regarding presentation tools and software was stricken from the set of criteria. It was felt that learning to use such tools was advised in mathematics majors, but not an essential criterion of mathematical writing.

Section 5: SUMMARY OF IMPLEMENTATION PLANS, including REQUESTED SUPPORT
What does the unit plan to implement during the period covered by this plan? What forms of instructional support does this unit request to help implement proposed changes? What are the expected outcomes of named support?

The mathematics department proposes a number of different components to the first writing plan:

1. Curricular intervention in Math 5345H Introduction to Topology (Honors), Fall 2018, as well as associated development of writing projects, grading rubrics, etc.

2. No less than four meetings between Daniel Emery (WEC Consultant) and math faculty on development of writing instructional tools, adaptation to the math curriculum, and implementation of the writing plan.

3. TA training for grading of homework in classes with a writing emphasis.

4. A panel on the uses of mathematical writing outside of academia.

5. Development of a senior project/capstone “contract” between majors and their advisors.

In detail:

Curricular intervention

In Fall 2018, (WEC Liaison) Westerland will be teaching Math 5345H Introduction to Topology. He has taught it in the past, with no particular emphasis on development of writing skills, so in some sense this class serves as a good test case for the effects of focused intervention on students’ writing. In particular, he retains a substantial amount of student work from previous semesters that can be used for comparison to the results in 2018.

This class is a small component of the major (it is not required, but fulfills some requirements), and occurs somewhat late in students’ development as math majors. Many students in the class have mastered the mechanics of proof-writing at this stage but have not yet become good mathematical writers. There will be many opportunities for development of writing skills in homework sets and final projects.

One potential writing project is a short paper wherein students explain a mathematical result in an area related to the material of the course, but not covered in the course. Additionally, to train students in writing to different audiences, we will include short projects in which students explain material at different levels – writing for their peers, for a lay audience, and at the level that we expect of formal mathematics.

The size and late nature of the course ensure that the impact of a curricular intervention at this level will be quite small. We regard this as a sort of trial run, in hopes that the results of this intervention can guide the department’s thinking on whether and how to make future writing interventions in its curriculum on a larger scale. We intend to compare the results of this class with its 2017 version using a rating scheme based upon the criteria described in Section 4, above. Our hope and expectation is to see development particularly in the “Exposition, Explanation, & Argumentation” criteria, as these are somewhat more advanced skills, reflecting the advanced nature of 5345H.
With the advanced nature of 5345H in mind, the RA will also assist Bryan Mosher in development of similar materials for Math 3283W Sequences, Series and Foundations, which caters to a much larger slice of the math major. Students are not as far along in their development as mathematical writers. Here more of the focus is on basic mathematical writing skills, such as proof by induction, ordering of quantifiers, or distinguishing between a converse and a contrapositive. However, most of the same general principles outlined Section 4 still apply, so we expect the rubrics and many of the writing projects to still be relevant. The results of the assessments from 5345H will inform choices about writing interventions in 3283W in the future. The differences between the two classes (in size, scope, and preparation of students) will provide an opportunity to explore what sort writing interventions in Math courses are suitable at different stages in the major.

The support requested for this component of the writing plan involves the requested RA (see below), who will assist with the development of writing projects and other tools of writing instruction for students in this course. In addition to tools generated internally and in cooperation with Westerland, the RA will seek out pre-existing tools in use in other mathematics departments around the world. Further, they will explore UMN MathCEP’s collection of writing instructional tools, aiming to adapt them from the K-12 setting to the university setting.

Additionally (in concert with Westerland and Mosher), the RA will develop rubrics for grading mathematical writing tailored to these courses. However, this will be with the intent of establishing general methods which could be applicable to other courses in the major.

**Meetings with WEC consultants**

As an ongoing part of the development of the Writing Enriched Curriculum in the mathematics department, we request several regular meetings with WEC staff, particularly Dan Emery. One of the main challenges of WEC in the math department will be incorporating writing instruction without disrupting mathematical instruction. Many faculty already feel pressed for time to cover the material in their courses and are hesitant to sacrifice time and focus in the classroom to writing instruction. Addressing this issue will be one of the major tasks in scaling up WEC-sponsored writing instruction beyond the limited scope described above. We seek WEC’s support and advice on how to address this topic in mathematics.

Additionally, there is a sense among some members of the faculty who are interested in adding a writing focus to their classes that they have few resources or examples at hand for how to implement this in their teaching. Again, this is a topic that we feel would be well-advised by meetings with WEC consultants. In addition to planning writing projects and assignments, the development of grading rubrics should play some role, as well as the training of TAs to grade both mathematical content and writing.

In addition to these concerns, this can be a forum for those who have incorporated writing in their instruction to talk about what has worked, and what has not. This can lead to the development of a library of projects, rubrics, and general wisdom that the department can make available to any instructor interested in adding a writing focus to their teaching. Lastly, we will solicit topics of interest from the faculty for discussion. This should help build recruitment and retention in these meetings, and allow us to tailor this time to what is most useful to the department, and synchronize with other events like guest speakers.

We imagine these meetings taking the form of lunches between Emery and interested faculty members. Alternatively (or additionally), these meetings could be coordinated with the existing Mathematics Education Seminar (organized through MathCEP).
TA training

As part of the curricular intervention in Introduction to Topology as well as other courses (like Math 3283W, Sequences, Series, and Foundations) with an explicit emphasis on writing, the department seeks to organize an instructional workshop for those teaching assistants involved in these courses. The focus here is to find methods to incorporate aspects of writing to evaluation of homework.

As is generally the case, the difficulty here will be to strike a balance between grading mathematics and grading writing. Development of a solid rubric which is flexible enough to be adapted to many different settings should be a central part of this effort. We imagine this workshop to be jointly organized between members of the math department’s undergraduate curriculum committee and WEC, in the hopes of adapting some common techniques that WEC has developed to the mathematics context.

As part of this process, we will seek feedback from those involved in the TA training regarding its effectiveness, their development of grading skills tailored to mathematical writing, and seek out commentary for improvement in future training sessions.

Panel on writing in mathematics

Fundamental mathematical writing skills – the ability to consistently and logically argue a point from first principles – is an inherently valuable skill for all of our students. Training these skills in the context of academic mathematics is well-within the abilities of our faculty. However, in recognition that the majority of our students are not likely to end up in academia, it seems prudent to explore how our graduates use their writing skills after graduation.

To that end, we intend to invite a panel of outside speakers to discuss the form that mathematical writing takes in their work, and to give insight in how to develop writing skills used in this context. In addition to illuminating how mathematical writing is used outside of academia, we believe that the focus on tailoring one’s writing to the audience at hand will illuminate students’ approach to their purely academic writing. Many of the skills central to non-academic writing – clarity, brevity, straightforwardness – also make up an important part of academic writing in mathematics.

We imagine the panel consisting of graduates of our program, employers of math majors and PhDs, journalists and other writers in the technical world, actuaries, and others in mathematical fields for whom written communication is a central part of their work. We have already identified a number of candidate members of the panel through our survey of “outside affiliates” at the start of the WEC program.

We request support to organize this panel. Most of the candidate speakers are local, so little is required for travel expenses. In addition to the development of resources for mathematical writing outside of academia, one intent of this project is to inform and inspire our majors as to the career opportunities that exist with a background in mathematics. In hopes that it promote faculty buy-in to the WEC program, this will be broadly advertised to both students and faculty.

Senior project contract

Math majors write a senior project (CSE) or capstone (CLA), supervised by a member of the department. These writing projects are typically 10-20 pages in length and can offer a degree of independence in a long-term project that is uncommon in much of undergraduate mathematics. With that independence comes many opportunities for students to go astray, lose focus on the project, and manage the timing of the semester-long project poorly. Faculty supervisors, occupied with other tasks, can easily forget to check in with their advisees to see if the project is keeping to the intended timeframe.
We propose the development of a basic “contract” between students and advisors that lays out a time frame for when various components of the senior project must be done to ensure on-time completion of a well-written project. There are some existing resources for such a contract; the library assignment calculator:

https://www.lib.umn.edu/ac

and Professor Victor Reiner’s document for the development of a timeline for senior projects. The goal of this part of the proposal is to update and adapt these existing resources in order to develop a simple one- or two-page document that students and supervisors can fill out together to establish when various components of the senior project (reading, research, first draft, revisions, etc.) must be completed. The intent is to give students clear guidelines of what is expected (and when), as well as giving faculty the weight of documentation to ensure that students keep to a schedule in writing these projects.

We envision this as one of the duties of the RA. Working from Reiner’s extant document, and in consultation with Westerland and other members of the Undergraduate Curriculum Committee (particularly Brubaker and Mosher), the RA will develop a succinct form which should be adaptable to most circumstances covered by the senior project.

Additionally, the form will include a short summary of resources for students for the project. Some of this exists in the library assignment calculator, so we expect that some of this development could be done also in concert with Kristine Fowler, the math department librarian. Further, we intend to curate a list of potential topics (based upon discussion with faculty as to projects that have been successful in the past) as well as a collection of examples of excellent mathematical exposition.

**Generalities: Faculty engagement and assessment**

The scope of the curricular intervention at the current stage of this writing plan is small. Our intent is to develop tools in the two indicated courses (5345H and 3283W) which may subsequently be used in other courses by other faculty who are enthusiastic about incorporating writing instruction. If these interventions are successful, we will have data to engender further buy-in. Additionally, we intend to engage with the faculty involved in MathCEP’s programs and take advantage of their extensive development of writing rubrics and other aspects of writing instruction. This, too, should promote further faculty involvement. The same can be said of the TA training, as it will enlarge the pool of TAs equipped with the background to efficiently and effectively incorporate writing into their evaluations.

Most obviously, though, the regular WEC lunch meetings will serve as a very direct method for building support for the program out to a larger group of faculty members. One looming concern is how to incorporate writing instruction into courses when faculty already feel overwhelmed by the amount of mathematical material that must be covered. We aim to hit this topic head-on in an early meeting. We have already started addressing some of these concerns in 5345H by tailoring each problem set to be graded with a certain writing focus (which changes each week). This focuses the efforts of the students, instructor, and TA on individual, manageable writing tasks on a weekly basis which should add up to general improvement in writing instruction on the scale of an entire semester. Our hope is that tools like this one will find broad use and interest across the department.

We intend to assess the effectiveness of each component of the plan. In the curricular development we will be able to compare writing samples from before and after implementation in 5345H. A pre/post assessment may not be possible in 3283W, but writing samples can be collected and evaluated in a less comparative way. For the lunch discussions, surveys of the involved faculty will attest to the effectiveness of the meeting, as well as providing an opportunity to select topics for subsequent discussions. We also intend to survey TAs at the end of the TA training as well as at the end
of the semester of grading. After the training our survey will focus on the effectiveness of the training. At the end of the semester we hope to query them as to which tools and methods (whether developed in TA training, or on their own) were effective in their role as a TA, and which were not. With the capstone contract project, we intend to survey faculty after its implementation to see how well the contract works, and what changes they would like to see made.

**Section 6: PROCESS USED TO CREATE THIS WRITING PLAN**

How, and to what degree, were a substantial number of stakeholders in this unit (faculty members, instructors, affiliates, teaching assistants, undergraduates, others) engaged in providing, revising, and approving the content of this Writing Plan?

Surveys of faculty, students, and outside affiliates regarding mathematical writing were collected at the start of this procedure and have informed subsequent discussions.

Faculty members and postdocs were actively invited to participate in the four WEC meetings that lead to the development of this document. Not all did, but a substantial group of about 15 members were regularly involved in this discussion. Further email discussion amongst this group lead to more nuance to this plan.

Transcripts and summaries of these meetings were provided to the complete faculty, and several members who did not attend the meetings contributed to the discussion electronically, often in response to these reports. It has, all in all, engendered a lively discussion amongst a large portion of the department.

A first draft of this writing plan has been submitted to the faculty for a period of comment, prior to submission. Constructive commentary and suggestions was taken into consideration in revising this draft.
V. WEC Research Assistant (RA) Request Form

This form is required if RA funding is requested. If no RA funding is requested please check the box below.

☐ No RA Funding Requested

RAs assist faculty liaisons in the WEC Writing Plan implementation process. The specific duties of the RA are determined in coordination with the unit liaison and the WEC consultant, but should generally meet the following criteria: they are manageable in the time allotted, they are sufficient to their funding, and they have concrete goals and expectations (see below).

RA funding requests are made by appointment percent time (e.g., 25% FTE, 10% FTE, etc.). Appointment times can be split between two or more RAs when applicable (e.g., two 12.5% appointments for a total of 25% FTE request). Total funds (including fringe benefits when applicable) need to be calculated in advance by the liaison, usually in coordination with administrative personnel.

Please note that, outside of duties determined by the liaison, WEC RAs may be required to participate in specific WEC activities, such as meetings, Moodle discussion boards, and surveys.

RA Name (Use TBD for vacancies): TBD

RA Contact Information: email _____, phone _____

Period of appointment (Semester/Year to Semester/Year): Fall 2018-Spring 2019

RA appointment percent time: 25% FTE

Define in detail the tasks that the RA will be completing within the funding period:

The RA will be involved in several important aspects of the projects proposed above. They will assist in the development of forms of writing instruction for Math 5345H and 3283W, working in concert with Westerland and Mosher. Additionally, they will establish rubrics tailored to these classes and adaptations developed for other contexts. Resources will include both libraries of such projects here at the UMN (as developed by MathCEP/UMPTYMP and current instructors who have developed such projects on their own), as well as through external sources at other universities.

Rubrics developed for these class will be adapted for use in training for teaching assistants of writing-intensive courses such as Math 3283W. The RA will be involved in that TA training, or at least in the development of material for the training, particularly in Spring 2019. Additionally, if useful projects and rubrics are developed, this could form portion of a presentation given by the RA at a lunch meeting between the interested faculty and a WEC consultant.

Finally, the RA will be responsible (in consultation with the undergraduate curriculum committee and possibly the math librarian, Fowler) for the development of the senior project contract. Resources will additionally include the extant document developed by Reiner and the library assignment calculator.

Define deadlines as applicable (please note that all deadlines must be completed within the funding period):
In the first semester of academic year 2018-2019, the RA’s focus should be on development of writing projects and rubrics tailored to 5345H. They should be developed in parallel with Westerland’s lectures in the course, but largely completed in the first half of the first semester. In the end of the first and beginning of the second semester, the focus should be on the adaptation of these tools to a more general context, suitable for use in other courses, such as 3283W. Finally, at the end of the academic year, the focus should be on development of the senior project contract.

Describe how frequently the RA will check in with the liaison:
Every two weeks, more frequently if needed under the circumstances.

Describe in detail the RA’s check-in process (e.g., via email, phone, in-person, etc.):
In-person check-in is ideal, and should be suitable for at least half of the regular check-ins. Otherwise email or Skype meetings suffice.

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1 An example for determining funding for appointments can be found on the WEC Liaison Moodle. This is for planning and example purposes only and cannot be used to determine final budget items for the Writing Plan.
VI. WEC Writing Plan Requests

Unit Name: Mathematics
Unit Financial Contact Name/Email: Sam Richter/rich0684@umn.edu
Chart String for fund transfer: 1000-11133-20088-(EID)5011311

Financial Requests (requests cannot include faculty salary support) drop-down choices will appear when cell next to “semester” is selected

Total Financial Request: $21,500.00

<table>
<thead>
<tr>
<th>Semester 1: Fall 2018</th>
<th>Semester 2: Spring 2019</th>
<th>Semester 3:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item</td>
<td>Cost</td>
<td>Item</td>
</tr>
<tr>
<td>Research Assistant</td>
<td>$9,500.00</td>
<td>Research Assistant</td>
</tr>
<tr>
<td>Expenses for panel discussion</td>
<td>$1,000.00</td>
<td>Lunch expenses</td>
</tr>
<tr>
<td>Lunch expenses</td>
<td>$750.00</td>
<td></td>
</tr>
</tbody>
</table>

Semester 1 Total: $11,250.00  Semester 2 Total: $10,250.00  Semester 3 Total: $0.00

Rationale for costs and their schedule of distribution

For two semesters, a 25%FTE research assistantship at level RA3 consists of a stipend of $10,000 and overhead of $9,000. If necessary, this could be lowered to RA1, which is $9,500 stipend and $8,550 overhead. In the expenses for the panel discussion, we envision a four person panel, and budget $250 per panelist as an honorarium. While several of our candidate panelists are local, some will need flight expenses and hotels paid for; the department can handle these expenses. The lunch expenses of $750 each semester are to cover two lunch workshops in each semester with approximately 30 participants each time (at a rate of $12.50 per lunch).

Service Requests drop-down choices will appear when a cell in the "service" column is selected

<table>
<thead>
<tr>
<th>Semester 1: Fall 2018</th>
<th>Semester 2: Spring 2019</th>
<th>Semester 3:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service</td>
<td>Qty</td>
<td>Service</td>
</tr>
</tbody>
</table>

Description and rationale for services

Consultations with Dan Emery will be focused on several topics: how to incorporate a writing focus in instruction without sacrificing time devoted to mathematics, how to scale up the results of our first small-scale curricular intervention to a larger setting, development of general writing projects that can be adaptable to many mathematics classes, and development of grading rubrics. One workshop in each semester is intended as part of TA training for grading writing in those courses that currently emphasize it (e.g., 5345H and 3283W). Additionally, we intend to have four workshops over the course of the year on the four topics of consultation listed above. We envision these as taking the form of discussion over lunch amongst interested faculty members and members of WEC.
Thank you for providing the Office of Undergraduate Education with an updated 1st edition Writing Plan. On behalf of the Department of Mathematics, you have requested the following funding to support that plan’s implementation. We wish the department every success in this ongoing effort to support students in communicating in and about mathematics.

The table below outlines the requested funds in yellow.

<table>
<thead>
<tr>
<th>Mathematics</th>
<th>Fall 2018</th>
<th>$</th>
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</thead>
<tbody>
<tr>
<td>Research Assistant</td>
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<td></td>
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<tr>
<td>Expenses for panel</td>
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<tr>
<td>discussion</td>
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<tr>
<td>Workshop lunch</td>
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<tr>
<td>expense</td>
<td></td>
<td></td>
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<tr>
<td>Spring 2019</td>
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<td></td>
</tr>
<tr>
<td>Research Assistant</td>
<td>$9,500.00</td>
<td></td>
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<tr>
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<td>$750.00</td>
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</tr>
<tr>
<td>expense</td>
<td></td>
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</tbody>
</table>

| TOTAL                | $21,500.00         |             |

All items above have been approved by the Office of Undergraduate Education, for a total of $21,500. These funds are transferred to support implementation of the writing activities that have already occurred and were underwritten by the department. These funds will be transferred in full during the FY19 to your department’s EFS account string: 1000-11133-20088.