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Papers, posters, and presentations as outlets for undergraduate research

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Presented in this paper are the findings of the panel entitled *Outlets for undergraduate research* as delivered at the Trends in Undergraduate Research in Mathematical Sciences (TURMS) in Chicago on October 27, 2012. We specifically discuss venues and best practices for student papers, posters, and presentations.

1. Introduction

With the dramatic increase in the number of undergraduate students conducting research, there are more opportunities than ever for students to share their work with others. We focus on preparing students for three such outlets: papers, posters, and presentations. While most readers are familiar with a wide variety of opportunities for student presentations, we also provide a number of venues for posters and written publications. Additional information on these topics can be found in [Gallian and Higgins 2007].

2. Papers: Brigitte Servatius

Print publication is to date the most lasting outlet for (student) research. Our times put immense pressure on researchers to publish their work. Publications in refereed journals are considered more important, because quality is typically better, and publications reviewed on MathSciNet are of even greater weight. Another easy measure of impact is the number of citations an article receives. However, citations usually take longer to appear than the span of an undergraduate career.

To prepare an article for publication it is important to choose an appropriate journal. Most student researchers need help from their advisor in doing this, because students do not normally read research journals. To foster student research and encourage students to publish their work, it is a good idea to have students read published papers early on. Journals such as the *Pi Mu Epsilon Journal* or *The*

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College Mathematics Journal, whose target readership is an undergrad math major or a faculty member at a primarily undergraduate institution, could be kept in a student lounge. A problem-solving group can be used for good writing exercises. Solving problems from the current issue of a journal is a good exercise in reading, writing, and using math. Members of a problem-solving group act simultaneously as researchers and peer reviewers and there is a natural time pressure set by the deadline for submission of solutions. The *Pi Mu Epsilon Journal*, for example, publishes student solutions to its posted problems. Such a published solution is a very nice and fast first publication. Students can also submit problems for solution to appear in the problems column of a journal. Again, this is an excellent mathematical writing exercise and fast publication.

Advisors of student research may gain valuable experience by serving as referees for research in their specific field and for student research in a broader context. Refereeing is, without doubt, additional work. Since blind or even double-blind refereeing is customary it is a bit tricky for young faculty to have this activity counted appropriately among annual activities toward tenure. However, most journals will send a "thank you" that can be used as documentation of your service to the profession.

Preparing research results for publication is a serious step beyond obtaining the results. The introduction should be directed to the main readership of the journal. If it is a journal for undergraduate students, the introduction should be of broad interest and also understandable to the mathematically inclined advanced undergrad. If it is a research journal in topology, a metric space need not be defined. The introduction and bibliography are of fundamental importance. The journal editor will select a referee whose research interest matches the topic of the paper. The editor will therefore scan the introduction as well as the bibliography for ideas for referees. Misleading introductions as well as missing or wrong citations can have a devastating effect even before the paper is read. Before a paper is sent to a journal it should be meticulously proofread. It is not the responsibility of a referee to check proofs or to correct spelling and grammar. Once the editor has sent the paper to the referees, no changes or corrections are possible until the editor receives the referees' reports and asks for specific changes. Never send off a paper before you think it is absolutely perfect. Once the paper is ready, make sure you are aware of the journal's instructions for authors. Some journals require paper submission and want your manuscript in triplicate; some journals accept email submission of files of a certain format; some journals require web submission; and some allow more than one option. In all cases, you are expected to write a cover letter. Make sure it is dated, contains your permanent address and email, the title of your paper, and the name of the journal in which you want your paper to appear. Some editors are editing several different journals simultaneously. They may receive a flood of

mail, and might misplace your article if this information is not apparent. If possible, also put that on the cover page. If your journal has double-blind review, put this information on top of a cover page with author information removed.

MathSciNet is a great research tool. It enables even a novice undergrad to find publications using a set of key words. These hits produce a reading list. The reviews together with the paper abstracts will give a good idea of the usefulness of the paper toward the research goal. The citations point toward other venues. The number of hits a particular key word produces gives a first idea about the importance of the concept. Writing reviews for MathSciNet is about as time consuming as refereeing, but is easier to highlight on your annual report. I recommend it highly to potential advisors of student research.

3. Posters: Aparna Higgins

A poster session is an efficient way for a large number of researchers to showcase their work simultaneously. Many institutions have poster sessions associated with an annual celebration of student work, and there are regional opportunities for poster sessions as well. For example, the Mathematical Association of America (MAA) section meetings frequently have poster sessions for undergraduates, and several of the MAA–National Science Foundation (NSF) sponsored Regional Undergraduate Mathematics Conferences hold similar such sessions. The MAA website (www.maa.org) provides information on both of these opportunities.

National meetings of the professional societies in math also organize poster sessions; the biggest of these is at the Joint Mathematics Meetings (JMM), held annually in January. Started in the early 1990s, the poster session had a dozen to fifteen posters. By the late 1990s, there were forty posters. Sixty posters were presented in 2000, eighty posters were presented in 2002, and over 250 posters were presented in 2012. The 2013 JMM in San Diego had over 320 posters. More information on the subject of posters can be found in [Martelli 2002].

The poster session at the JMM is always exciting — the room is humming with energy from enthusiastic students explaining the results of their research to faculty, some of whom are judges for the posters. Under an initiative of Joe Gallian, MAA President 2007–2008, travel support is available to students who present posters (see maa.org/programs/students/meetings-conferences/student-travel-grants). For many years, several monetary prizes were awarded based on judging conducted by attending faculty. In recent years, the monetary prizes have been discontinued, but faculty continue to judge posters in an organized and formal manner, providing valuable feedback to the student researchers on their work and presentations. The poster session is always in need of judges; see http://www.maa.org/students/undergrad/judges.html.

It is important for research directors to help students understand the differences between preparing posters, presentations and papers for publication. Some advice on this matter can be found in [Hammarling and Higham 2013]. Additionally, here are some suggestions that I make to students who are preparing posters under my direction.

- Keep in mind who your audience is, and how little time they will be at your poster.
- It is very helpful for your audience if your poster indicates clearly what kind of objects are being studied (groups or manifolds or graphs or knots, for example), and what aspect of these objects is being studied (for example, a particular invariant or a product of two of these objects or a mapping between two of these objects). It helps the viewer if the poster presenter explains why this work may be interesting (for example, the sharpening or realization of a previously known bound).
- The font size used should be large enough to be legible from two or three feet away.
- The poster should contain the title of the project, the names of the researchers and their affiliations, the name of the program that sponsored this research (as in an REU), and the names of the advisors of the project, if they have not already been included as coresearchers.
- The poster should contain many pictures to help illustrate concepts. It is helpful to have both examples and nonexamples listed so that the contrast is evident and helps to clarify any definitions used.
- If abbreviations for techniques or objects are used, it is helpful to indicate, in a footnote, say, what the abbreviation stands for.
- If a proof is provided, it is better to provide broad strokes of the idea of the proof, rather than all the technical details. If the result is proved by breaking down the problem into many cases, it suffices to present the proof of only one case.
- Students should create a two-minute-or-less guided tour of the work that the poster illustrates. It is best to script this ahead of time and practice it.
- Have a handout ready with the names and email addresses of the researchers and the name of the organization where the work was done, name and date of the meeting, and a couple of the main results. This handout is a useful tool for networking, and can be given to anyone who is interested in the work presented by the student.

Posters can serve as vehicles of dissemination of results, but they can also serve as ways of getting feedback on partial results.

4. Presentations: Lew Ludwig

For over ten years I have been instructing students on ways to improve their oral communication skills. Not only has this work made for a number of successful student presentations, some winning national awards, but it has also prepared my students for life beyond my classroom. Whether my students attend grad school or join the work force, communication skills are a critical asset towards their success. Indeed, in the National Association of Colleges and Employers (NACE) *Job Outlook 2013* report [NACE 2013], employers rank "ability to verbally communicate with persons inside and outside the organization" as the number one candidate skill/quality they seek in future hires. As we prepare our math majors to present their senior project or summer research for that sectional meeting or department colloquium, we need to keep in mind that we are not only helping them convey their work to others, but we are helping them develop a life skill that will reach far beyond that one presentation experience.

In addition to preparing students to present their research, I have taught seven sections of the Technical Communication class at Denison University, where students improve their oral communication skills by delivering three mathematical presentations. It is safe to say that through these experiences, and by attending a number of regional and national presentations, I have seen hundreds of student presentations. Interestingly, when a particularly strong or weak talk stands out in my memory, it is not the student's name I recall, but that of the school. We might bear in mind that not only are we better preparing our students for the work force; through proper training of our students in oral communication skills, we are bettering the name of our own institutions.

Many readers will be familiar with Joe Gallian's *Advice on giving a good PowerPoint presentation* article through the MAA website [2006]. In this article, Joe provides a detailed checklist of dos and don'ts for delivering a good presentation including things like font size, use of color, refraining from animations, etc. This article served as a springboard for my NSF-funded website *Technically Speaking* (techspeaking.denison.edu), which provides a video on how to give a good presentation. While such resources have been a great help to students, I find that there are some finer points students often overlook in their presentations, and these can prevent a good presentation from being a great one. Here are a few things to consider.

Know the material well so your audience doesn't have to. During a recent tenure-track search to replace a retiring colleague, my colleague Michael Westmoreland commented how he placed a good deal of emphasis on the research statement. Coming from a national liberal arts college with a high emphasis on teaching, I initially found his focus misplaced, but he further explained. He argued that if

someone really knew her research well enough, she could explain it to a nonexpert audience, much in the same way that quality instructors should be able to explain difficult mathematical concepts at a level appropriate for their students. So in a sense, my colleague was using the research statement to inform him about a candidate's ability to teach.

I think the same can be said for student presentations. If a student has a good understanding of the material contained in the presentation, then he should be able to deliver the concepts to a variety of audiences. Often students make too many assumptions about the audience. They automatically think everyone knows about the mosaic number of a knot, the chromatic number of a graph, or the genus of a surface. The student should know the audience and their limitations. It helps to use simple examples or even props to convey technical ideas. In a 10–15 minute talk, it is enough to convey the main ideas, without all the nitty-gritty details.

Play it again Sam. Why do the refrains of songs or jingles stick in our heads? Not only are they catchy, but they are repeated numerous times — the very definition of refrain. Often I see students deliver a well crafted presentation, but they do not repeat the important things. Everything is given the same weight, it is said once. Just like that jingle, students need to repeat the important parts of their message. This can be done when the idea is first introduced or throughout the presentation or both. If something is important, it bears repeating. When the audience hears something repeatedly, it will begin to take notice. A good gauge of understanding is whether an audience member can state the three most important things from the presentation. Don't forget, if it is important, repeat it.

Read less, talk more. Giving a presentation before a live audience can be nerve-racking. It is natural to get nervous and possibly forget what you want to say. To overcome this, many students print everything, or most everything, they want to say on their slides. Some go so far as to script complete sentences or even paragraphs. While this may lessen the student's anxiety, it is counterproductive for the audience. Any cognitive psychologist will tell you we cannot multitask. We cannot text and drive. We cannot tweet and study. And we surely can't listen to someone speak and read. It is human nature to start reading along with the speaker. More often then not, the audience will begin to read ahead in the written material, thus nullifying the effectiveness of the speaker, who would have done just as well to provide a handout and sit down.

To prevent your student's "talk" from becoming a "read," be sure she uses only keywords or short phrases on the slides. These notes should be cues to the presenter of what needs to be said, not a substitute for listening to the speaker. Most mathematicians are "thrifty" by nature. Encourage your students to embrace their

inner mathematician and be thrifty with the numbers of words per slide. I tell my student each word cost 25 cents.

I offer one more word of advice, as a continuation with the "talk more" theme above. The more often students present in front of a group, the more comfortable they will become. If you plan to have a student present a mathematical topic at a conference, consider having them give a few short warm-up talks just to get used to standing before an audience. This could be as simple as a two-minute presentation on their favorite mathematician or why they chose to attend their school. The content is not as important as shaking out the nerves and gaining confidence. Once this is established, then it is time to focus on the details in Gallian's article or on the *Technically Speaking* website.

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