Proceedings of the Conference on
Promoting Undergraduate Research in Mathematics

Helping Students Present Their Research

Joseph A. Gallian and Aparna W. Higgins

INTRODUCTION

With the guidance of an experienced research mathematician, there are many undergraduate students who are capable of professional level work in mathematics. The intent of this article is to assist mathematicians in helping their talented students become fully involved in the research experience. Such an experience will benefit the student, the adviser and the mathematics community.

An essential part of a good research experience is the discipline of writing up the results of the research and presenting them. Presenting one's research provides a good capstone event for a research experience. It helps the student to organize and focus the research results. Fortunately, the number of ways of doing this has increased in recent years, and each student researcher can find one that appeals to her/him personally. Apart from the traditional communication of publication in a printed journal, there are electronic journals, poster sessions and paper sessions at meetings. You can help your undergraduate research students choose the most appropriate methods of communicating their results depending on the depth of the results obtained, the personality of the undergraduate, and the logistical difficulties involved. As an item on a student's resume, communicating the results of a research experience, whether in a journal, or at a mathematics meeting, is valued by graduate schools and potential employers alike.

WRITING UP RESULTS

A well written paper should be a goal of every research endeavor. Such a paper tells the mathematical "story" that the student has created – the origins, the context, the results, the methods, the applications, and possible future investigations. At the same time the student learns to use mathematical type-setting software, such as LaTeX ([5] is an excellent introduction). We strongly recommend that research students write up a paper documenting their results and their proofs and any interesting motivation or applications. It is a good exercise for students to be

Received by the editor December 28, 2006

This article is an updated version of the one with the same title published in [4]. We include it for the convenience of the reader.

able to write their results so that they can be read by others – this changes the research from a collection of isolated computations or proofs into a coherent whole. Moreover, it is often the case that while in the process of formally writing one's results better proofs are found and new questions arise. As with any well written document, attention to good grammar, proper punctuation and correct spelling provide a rewarding pay-off in the final product. Whether or not the paper will be submitted for publication, it should be written as though it will be submitted. In particular, it should include a title, co-authors, an abstract, an introduction, acknowledgments and references.

Such a document is useful in several ways – it provides a starting point for a future publication or poster presentation; it can be included as evidence of accomplishment in reports to administrators who supported the research effort; and it will be a convenient reminder of the student's results when you are called upon to write letters of recommendation for employers, graduate schools and fellowships a year or two later. For those students whose research efforts occur at an institution different from their own schools, the paper is a professional way of showing the department at their home institution exactly what they did during their research experience.

PUBLICATION

Advisers can assist students in preparing papers in several ways. First, a model of a well written paper should be given to the student as a guide. Emphasize to the student that the introduction should tell the reader what the author has done and how it relates to the existing knowledge on the subject. The introduction should persuade the reader that the entire article is worth reading. Advice should be given about the extent of details needed in arguments and the number and kinds of examples to include. Two excellent sources for advice on preparing manuscripts for publication that should be made available to students are [6] and [7]. Since students are not familiar with the literature, the adviser must play a critical role in the decision as to whether and where the article will be submitted. Our advice is to make a realistic assessment of the chances of the paper being accepted by a few particular journals but to be a bit on the conservative side in the final choice. A rejection is a psychological blow to a student. In many cases a student who has a paper rejected by one journal will not submit it to another journal even when an adviser assures the student that paper is worthy of publication. It is not clear whether or not the author of a paper should be identified to the editor of a journal as an undergraduate student. In some cases editors and referees will take pains to help a student get a paper published or, at least, will write a tactful rejection letter, while in other cases they will take the paper less seriously than they do papers written by professionals. Our feeling is that as it becomes more common for undergraduates to publish professional level papers the former scenario will become the norm.

A widely held misconception is that papers written by students are natural candidates for the MAA journals. On the contrary, the MAA journals desire articles that are of broad interest and are exceptionally well written. Like most papers written by professionals, most papers written by students will not meet these criteria. In fact, the rejection rates for the MAA journals are over 80%.

On the other hand, there are some journals such as the Pi Mu Epsilon Journal, the Pentagon (the official journal of Kappa Mu Epsilon) and the Missouri Journal of Mathematical Sciences that have a policy of welcoming undergraduate work. Several newer journals have been started to showcase student work. Among these are the Rose-Hulman Undergraduate Mathematics Journal, Journal of Undergraduate Sciences, Journal of Young Investigators, and the Furman University Electronic Journal of Undergraduate Mathematics. Information about these are provided at the end of this article.

A good resource article on possible publication outlets is Paul Campbell's "Where Else to Publish" [1].

TALKS

There are increasingly many opportunities for students to present their results at meetings. If attending a meeting is not a viable option for a student, an adviser can arrange for the student to give a talk to his or her department or even at a nearby school.

Careful preparation is required for a successful talk. The best way of ensuring that an oral presentation is good is to practice giving it, and then to practice some more. Advice on how to give a good talk can be found in the articles, "How to Give a Good Talk" [2] and "Advice on Giving a Good Powerpoint Presentation" [3]. Common mistakes made by students and professionals alike are the "too's": writing too small, assuming too much, talking too fast and trying to do too much.

The first transparency for a talk should include the title of the talk and the speaker's name and affiliation. Students should bring several copies of a one-page description of their talk and have it ready to give to anyone in the audience who expresses an interest in knowing more about the results. The information on the sheet should include the title, an extended abstract and all ways of getting in touch with the presenter. A web site where a preprint of the article is available is desirable.

A talk should tell a carefully thought out story. Ten or fifteen-minute talks should be used to disseminate new results, to give a context for the results, to provide an outline of the method of proof, and to suggest future lines of inquiry. Computations should be avoided.

Lack of departmental funds should not deter you from seeking other funds to allow for student travel. Many Deans, Provosts and institutional programs have funds that can be used for academic opportunities such as undergraduate participation in professional meetings. Some Student Governments have funds that they award to clubs. Many math clubs and MAA Student Chapters have fund-raising activities to finance student travel to meetings. Some MAA Sections and conferences that focus on undergraduate presentations have funds from mini-grants that provide for student travel to their meetings. Most meetings have drastically reduced registration fees for undergraduates and many MAA Sections waive registration fees for undergraduates.

There are many opportunities for students to present a paper. The summer meeting of the MAA (MathFest) includes Pi Mu Epsilon and MAA Student Paper Sessions. A member of either organization's Student Chapters can present a paper. Some travel money is available for speakers, and each organization gives five to ten cash prizes for the best presentations (made possible by the generosity of the

AMS, MAA and NSA). Papers can be presented at the AMS or SIAM meetings. An MAA Section meeting that accepts contributed papers is another opportunity for presentation. There are many regional meetings of groups like PME and Kappa Mu Epsilon. There are also many conferences whose main purpose is to promote undergraduate research. Some, such as the Hudson River Undergraduate Mathematics Conference allow paper presentations by students and faculty, while others, such as the Michigan Undergraduate Mathematics Conference, accept contributed papers only from students. Many schools host annual undergraduate conferences. Details are available at
http://www.pme-math.org/conferences/regionalconferences.html
and http://www.maa.org/rumc/upcoming.html.

The National Conference on Undergraduate Research sponsored by CUR (Council on Undergraduate Research) welcomes student papers, as does the annual Argonne Symposium for Undergraduates in Science, Engineering and Mathematics, although these conferences are not limited to mathematics.

In general, we believe that it is preferable for undergraduate research to be presented in a session that is topic-specific, rather than presenter-specific. That is, it is preferable to present a paper on differential equations in a session devoted to differential equations, rather than to present it in a session devoted to undergraduate research. The main reason we feel this way is that in the former kind of session the audience is interested in the topic and consequently the student will likely meet and have the opportunity to network with others who work in the field. Moreover, we feel that at a conference the undergraduates should be treated like professionals and not be segregated according to experience.

We also believe that it is beneficial for students to present at a meeting where there is far more going on than merely contributed papers by other undergraduates. Attending a national meeting of the AMS, the MAA or SIAM provides students the chance to hear some well-known mathematicians give talks, allows them to witness their professors as learners, and gives them the opportunity to meet and network with a variety of mathematicians in different areas and varied types of institutions.

POSTER PRESENTATIONS

Increasingly, mathematics conferences are including poster presentations as a method of communicating research results. As a matter of fact, many students are more comfortable talking informally about their work to one or two people at a time, as is the case in a poster session, than they are giving a formal talk in front of an audience of experts. Good advice on poster presentations can be found at the web site http://www.maa.org/students/undergrad/meetings.html.

A poster must tell its story by itself. It is usually best to have several sheets of 8-1/2 x 11 inch paper with the results, motivation, applications and indications of methods of proof, mounted on contrasting colored construction paper. Much of what was said in the above section on presenting talks holds true here. Despite the fact that the "audience" for a poster stands close to it, font size should be large enough to allow the poster to be viewed comfortably from a short distance. Pictures and colors are very effective in this visual set-up.

Students should have ready a brief, under-two-minutes presentation that is a synopsis of their results. Such a speech points out the highlights of the work. At the

annual joint winter meetings, the MAA sponsors a student research poster session and cash prizes are awarded for the best posters.

In helping their students prepare a poster, advisers should comment on such things as poor grammar, awkward style or displeasing appearance. Anything you do to help the student learn to communicate mathematics better is important. Emphasize to your students that effectively communicating mathematics is as important as getting good results. Any difficulty in understanding the work should be due to the depth of the mathematics, and not due to the author's exposition.

AFTER THE PRESENTATION

If a student from your own institution gives a talk, presents a poster at a mathematics meeting, or gets a paper published, it is important to publicize this information. Let the campus newspaper know about it. An item in the newspaper will be read by other faculty on campus and will reflect well on your department. Let the Dean, the student's adviser and head of the department know about the presentation or publication. Deans often send congratulatory notes to students, which are appreciated. The student will be pleased with a thank you from you for taking the time and effort to make a professional presentation.

It is our experience that most students enjoy presenting their research at a mathematics meeting and having the opportunity to hear other mathematicians speak. Students are delighted when someone at a meeting asks them about their work. It is not uncommon for a student who has presented at a meeting to present at future meetings. Such students often have an enthusiasm for mathematics meetings that is infectious, and fellow students get caught up in the excitement of undergraduate research and its presentation.

PUBLICATION OUTLETS FOR UNDERGRADUATE RESEARCH

1. Pi Mu Epsilon Journal, http://www.pme-math.org/journal/overview.html
2. The Pentagon, official journal of Kappa Mu Epsilon, http://kappamuepsilon.org/pages/pentagon_staff1.html
3. The Missouri Journal of Mathematical Sciences, http://www.math-cs.cmsu.edu/~mjms/mjms.html
4. Rose-Hulman Undergraduate Mathematics Journal, http://www.rose-hulman.edu/mathjournal/
5. The Journal of Undergraduate Sciences, http://www.hcs.harvard.edu/~jus/home.html
6. Journal of Young Investigators, http://www.jyi.org
7. Furman University Electronic Journal of Undergraduate Mathematics, http://math.furman.edu/~mwoodard/fuejum/welcome.html

REFERENCES

1. Paul J. Campbell and Kunio Mitsumi, Where else to publish, UMAP Journal 26:2 (Summer 2005), 93-114.
2. Joseph A. Gallian, How to give a good talk, Math Horizons, April 1998 29-30. (Available at http://www.d.umn.edu/~jgallian/advice.pdf)

3. Joseph A. Gallian, Advice on giving a good Powerpoint presentation, Math Horizons, April 2006 25-27.
(Available at http://www.d.umn.edu/~jgallian/goodPPtalk.pdf)
4. Joseph A. Gallian and Aparna Higgins, Helping students present their research, Proceedings of the Conference on Summer Undergraduate Mathematics Research Programs, Amer. Math. Soc. (2000) 289-295. (Available at http://www.ams.org/employment/REUproceedings.pdf.)
5. David F. Griffiths and Desmond J. Higham, Learning LaTeX, SIAM, Philadelphia, 1997.
6. Nicholas J. Higham, Handbook of Writing for the Mathematical Sciences, Second Edition, SIAM, Philadelphia, 1998.
7. Steven G. Krantz, A Primer of Mathematical Writing, AMS, Providence, 1997.

University of Minnesota Duluth, Duluth, MN 55812
E-mail address: jgallian@d.umn.edu

University of Dayton, Dayton, Ohio, 45469
E-mail address: Aparna.Higgins@notes.udayton.edu