Mentoring Undergraduate Research in Mathematics, in the Age of Physical Isolation

UR SIGMAA and CUR's Division of Mathematics & Computer Science

Spring and Summer 2020 is going to be an individualized professional experience for each of us. For some, it will produce more productivity as they have a chance to focus without distraction, while for others there will be aspects of trauma that will follow them into their careers for the years to come. Recognizing this, we start out by acknowledging, whatever you do that supports you and your students is the right thing. None of what we have done in the past is going to directly apply to this situation. All that said, here are a few ideas for those of you who are hoping to mentor undergraduate research virtually.

And the Survey says… In March, we asked faculty across the country what they believed were the most effective practices for doing undergraduate research (UR) virtually. These are their responses and shared resources …

- **Try to meet with your students at least once a week**, maybe even a few times during the week (depending on the spring vs summer experience).
    - *"It was no different from meeting in person. The student would show their new results and we would work together on parts where they were stuck. I would then propose the next step."*
    - *"This has been hard. I'm mostly just trying to make it seem the same as before remote face-to-face started. So, I pretend we are in the same room and ask them to write in a shared whiteboard."*
- When you do meet (via the Online Conferencing Tool of your choice) there is not one "right-way" to set up the schedule, but a majority of faculty who have done this previously recommend **meeting with an agenda/focus**. This agenda can be set by either the faculty or the students involved in the research, but having an agenda is preferred.
    - *"My undergraduate research group has moved to Zoom, with one student joining the group only yesterday. It was clunky at first, just like teaching, but if you have good technology (in my case an iPad with apple pencil, which you can share as a "screen" from the ipad to Zoom on Windows) then it can work. One thing that we found uniquely nice about online research discussions is the ability to record our conversations. It gives the students something to look back on and periodically pause/rewind when sorting through the details on their own at home."*

    - *“Plan to have regular check-ins and well-defined tasks for students to work on between each meeting.”*
    - *“I found video meetings to be much more helpful than just email, etc., in keeping a sense of comradery.”*
- **To track the progress of students, they should have some form of online research journal or LaTeX file with comments, sharing their work.** All faculty surveyed recommend students use **Overleaf.com.** Beyond that, there is not one perfect tool to set up this documentation progress. Additional software recommendations included:
    - Google Suite (Google Docs, Sheets, Blogs)
    - Dropbox or other shared folder
    - Coauthor by Eric Demaine https://github.com/edemaine/coauthor/
    - A faculty member also reminded us that the students often have their own ideas about what tools we should use. Try their suggestions, since they may be productive when utilizing their own ideas. For example, some students recommended Discord (a gaming software) or Slack
    - Use Online Conferencing Tool Shared Whiteboards
    - *“I think teams will maintain a journal/overleaf document with greater integrity than they would at a single location.”*
    - *“Since my student was on his own and could not sit in my office, I felt that the key was to keep the goals quite small in the beginning. If there was an email exchange indicating a goal had been met, then the next one was already in mind. Another key for me on any student project is that you need to be pretty sure you know how to solve the problem (at least the first part) if you just sat down for a day or so. That makes it easy to guide. Done right, the student still makes the discoveries and progresses. Eventually, they own it and start asking questions. P.S. Our outcome was good in the sense that there was a paper.”*

Beyond the logistics of mentoring virtual undergraduate research, we asked our experienced faculty to talk about how we can support and encourage each other while doing this work. As one faculty member said, “*I am confident the research goals can be attained. The social experience is the challenge.*” Here are a few recommendations:

- *“Have frequent discussions with the students to put the research in context, reminding everyone what was previously known and what is not known. When a new conjecture or proof is made, emphasize how no one knows this except us! It's new knowledge! Students need to hear this. It energizes them! And it helps us, the faculty, as well.*

(There's nothing special to virtual research about that, except perhaps that such discussions need to happen more often if you never meet face-to-face.)"

- *"Spend time talking about how the students' lives are going."*

Virtual Team Building Recommendations:

- *"I ask the students to create a chat. I require everyone to join in the chat discussions."*
- *"Students who don't know each other need to meet on their own, without the faculty mentor, to build relationships. Making excuses for them to meet **in pairs** to work on a specific task helps the team building process. For example, at an REU that started online for a week before becoming face-to-face, I sent each student a paper to read on background material. I put them in pairs and told them to meet over Google Hangouts to explain their paper to their partner, with instructions to ask each other as many questions as they can. Then the whole group met with me and each student gave a presentation on their paper to everyone. This helped them all learn background material while helping them get to know each other."*
- *"Use collaborative puzzles like the ones offered through Harvard's CS50x Puzzle Day (past contest puzzles are available online -- pick two or three for a small group to work on)."*

A final thought from an experienced mentor:

"The biggest challenge I've found with virtual undergraduate research is the potential for a lack of focus on the part of the students. The challenges here vary a lot depending on if its summer research, like for an REU, versus research during the school year. But focusing on a summer REU, the research mentor needs to provide virtual structure to substitute for the natural structure that a face-to-face REU would provide. The students should have scheduled time where they are supposed to meet online; I suggest twice a day, say in the morning and late afternoon or evening. The mentor needs to have regular, scheduled check-in progress reports with the students. Mentors should resist the tendency of some in-person REU directors to leave the students on their own for a week while the mentor attends a conference. The students need to treat the virtual REU like a full-time job, but one where they get to go home and have more flexibility than if they were to travel to a campus for the summer."

Is it worth it? Mentors share one thing that they have enjoyed about doing virtual research:

- *"There is more flexibility. Students also may be more likely to work after the REU time frame since they will be in the habit of working remotely."*

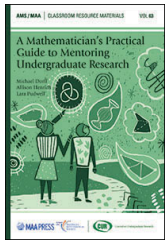
- *“Structured properly, virtual undergrad research forces the students to pay more attention to their written communications. It's harder for them to wave their hands at a whiteboard and convince others when everything is online. But they need good tools and a structured workflow (set by the mentor) to encourage them to develop their written math communication skills. I found Erik Demaine's Coauthor platform to be perfect for this, and the students respond VERY well to it because it feels exciting and gives them a feeling of ownership to their work.”*
- *“It was fun seeing the students at JMM where they presented their results after the research experience. We also met at other conferences.”*
- *“I could still do it while doing summer travel (for both conferences and family vacations).”*
- *“The virtual format allows us to keep continuity of work even while students/faculty are traveling home, to conferences, etc.”*
- *“We plan on having an online Zoom musical concert. Guest lectures will cost $0. “*
- *“We can be hopeful. At a meeting a few days ago, a colleague said that these times *will* lead to mistakes and missteps, but also much more educational innovation.”*

We thank all who contributed to this quick set of recommendations. It doesn’t capture all the information that was shared, but perhaps it will help get you started. We will share more as we all learn more. Until then, all the best to you and yours!

More resources for Undergraduate Research

Council on Undergraduate Research (CUR) has more UR resources: http://www.mathcscur.org/index.php/aboutmathcscur/ur-sigmaa/

Check out A Mathematician’s Practical Guide to Mentoring Undergraduate Research



Authors: Michael Dorff: Brigham Young University, Provo, UT,
Allison Henrich: Seattle University, Seattle, WA,
Lara Pudwell: Valparaiso University, Valparaiso, IN

A complete how-to manual on starting an undergraduate research program. Readers will find advice on setting appropriate problems, directing student progress, managing group dynamics, obtaining external funding, publishing student results, and a myriad of other relevant issues. The authors have decades of experience and have accumulated knowledge that other mathematicians will find extremely useful. Purchase the book today! https://bookstore.ams.org/clrm-63

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