Making the Most of Undergraduate Research

Andrea Danyluk, *Williams College*
Susan Rodger, *Duke University*
Lori Pollock, *University of Delaware*
Margaret Martonosi, *Princeton University*
Kathryn S McKinley, *The University of Texas at Austin*

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All speakers are members of the CRA-W Board.
Slides will be archived at: http://cra-w.org/SIGCSE11Mentoring/

Agenda

- Role playing: Mentoring gone bad (45 minutes)
- Advice to Mentors (45 minutes)
- Break (15 minutes)
- Breakout sessions (30 minutes)
- Sharing from breakouts (45 minutes)

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Here's who you are:
(as of 3/7/11)

- 0 Undergraduates
- 1 Graduate student
- 1 Post doc
- 2 Faculty at research institutions
- 1 Faculty at Masters-granting institution
- 6 at primarily undergraduate institutions
- 1 at 2-year minority-serving institution

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How many undergrads have you mentored?

None	0
A few (1-3)	4
Several (4-10)	3
Many (> 10)	3

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Goals

- Role playing good/bad mentoring experiences
  - practical ideas for dealing with challenges!
- Advice on best practices
- Point to and develop new mentoring resources
- Introduce exercises that you can do with your students
- Brainstorm ways to make successful undergraduate research experiences

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Role Playing

Advice to Mentors

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How is Undergrad Research Mentoring different from Grad Research Mentoring?

- Motivation and Goals:
  - Undergrad goals might be to understand what research is, or to gain software/implementation experience or reference letters.
  - Unlikely to feel tied to one particular CS sub-area
  - Publishing may not be their main goal.
- Maturity:
  - Undergrads often have less technical and overall maturity
  - But it can be fun to feed off their idealism! They know less about what is "impossible"!
- Time:
  - Balancing other courses and obligations
- Other factors:
  - Social network and where they get their knowledge: More from you, and perhaps less from friends or officemates with whom they can brainstorm.

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Summer vs. Academic Year

- Summer is a great time for research:

  Student has more time per day. Prof has more time too!
- But requires a bit of planning:
  - fewer weeks in the summer so equipment purchases and software setup best done in advance.
  - Summer research students may need more out-of-office help. How to get apartments, groceries, etc.
  - Who will guide them during your 2-week vacation?
  - Avoid isolation: Introduce them to other summer students/visitors.

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Consider…

- Course credit or paid hourly or based on milestones
- Is the project during the academic year (very part time) or summer (full-time)
- One semester/summer or longer?
- Type of school: faculty teaching load, type of undergraduate students, presence of grad students,
- Remember undergrads not at same level as graduate students. They take more time to supervise.
- Graduate students can help mentor them.

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How to get started (as an adviser)?

- Picking a topic that's appropriate
- Picking compelling topics
- Defining a project that's interesting
- Finding funding for undergraduates
  - NSF REU
  - add funding for undergrads when apply for grants
  - CRA-W DREU, CREU
  - Small grants at your school

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For Advisers: How to pick a student?

- Motivated, organized, curious, collaborative!
- Students you know, did well in your class, come ask you about your work, etc.
- Encourage students, especially URMs, in the fall to start thinking about summer research
  - competition from study abroad/industry
- Encourage faculty teaching lower level courses to encourage students to think about research
- Ask for recommendations from other Faculty

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For students: How to pick an adviser

- Prepare first!
  1. read their research web site
  2. read about a topic
  3. Then talk with a professor

- Get involved with student ACM Chapter or start one
  - Invite faculty or students to talk about their research to your group

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Picking a topic

- Tie the topic to a course & your interests
- Tie to real impact on the world
- Empirical work is great for students with little or no research experience
- Choose topic with some information in hand!
  - Suggest two to three general topics
    - your ideas and interests – your passion inspires them!
    - do not pick ideas critical to your research program
  - Assess interest with background reading
  - Assess match of required skills to current skills
    - What skills do they have, want to have, and/or acquire them in the time frame?

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Group research: Pros and Cons

- Options:
  - Solo undergrad project
  - Pairs of undergrads
  - Groups (>2) of undergrads
  - Undergrad "paired" with PhD student
- Pros and Cons

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Best Practices: The Basics

- Weekly meeting
- Work with students to agree on intermediate milestones and "sub-" deadlines
  - If their program sets up intermediate checkpoints, take them seriously
- Agree in advance on the metrics for success
  - Not just building a system that does XYZ, but also thinking about how to evaluate which system does XYZ better?
- Overall, remember that we are teaching the student how to do research in general, not just helping the student with a particular research topic or project

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The Weekly Meeting

- Meet face-to-face in quiet place – email is not a meeting!
- Define clear expectations
  - Pre-meeting email with agenda, progress report, action items, & discussion topics
- Project schedule and weekly action items
  - plan w/ ideas, implementation, experiments, reading, writing
- Don't assume head nodding means they understand!
  - ask them questions, ask them to explain or restate
- Be encouraging at all times - friendly, but not a friend

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Setting Milestones and Intermediate Deadlines

- Set deadline for parts of project and parts of paper
- Four Stages of Mentoring
  - Initiation Stage – meet more often to get student started
  - Cultivation Stage – set deadline for parts of project and paper
  - Transformation Stage
  - Separation Stage

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Stages of Mentoring

- Initiation Stage
  - Meet more often with face-to-face meetings to get student started
  - Mentor provides background
  - Project planning
- Cultivation Stage
  - Regular meetings to discuss progress/ideas
  - Student should start taking “ownership” of project

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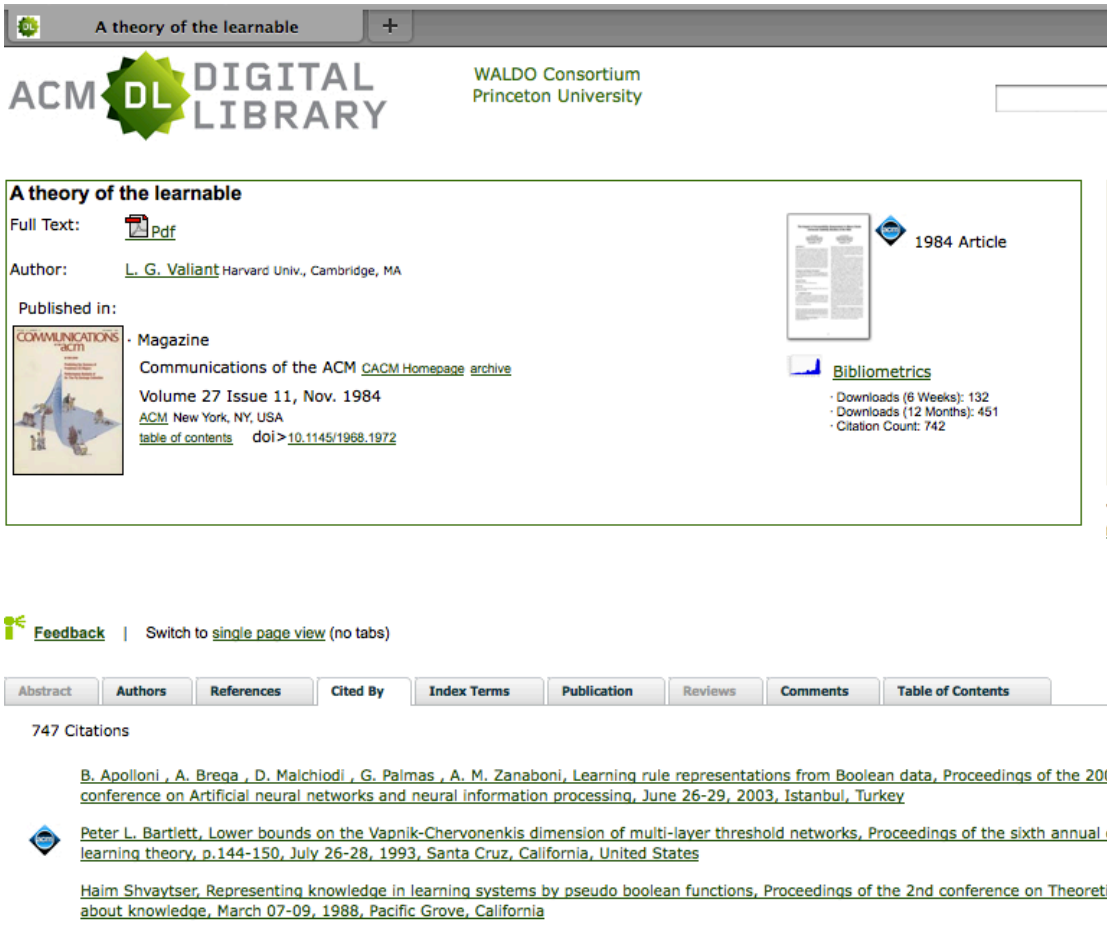
Stages of Mentoring (cont)

- Transformation Stage
  - Student takes over project, Mentor gives advice and feedback
  - Meet less often
- Separation Stage
  - Student more independent – finishing up
  - Mentor less advice

"The Mentoring Role in Undergraduate Research Projects", M.Malachowski, CUR Quarterly, Dec 1996

Background Reading: How to find a useful paper

- Your papers!
- Read abstracts in related top journals/conference proceedings
- Google
- From other relevant papers, follow citations forwards/backwards
  - Google scholar
  - ACM digital library
  - citeseer



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Background reading: How to read a paper?

- Skim the paper first to get a quick overview
- Highlight words and parts you do not understand
- Look up these parts/words, look at their context, ask others
- Read the paper carefully
  - highlight key ideas, write down your questions, comments, confusions
- Write a critique:
  - summary, strengths, weaknesses, what should they do next? what did they forget to do?
- Discuss papers with groups of other students/faculty
- (See the "How to read a paper" exercise.)

Metrics and Evaluation

- Set clear project goals
  - implementation, experiments, project report and/or paper submission
- Set realistic goals
  - optimistic and pessimistic goals!
  - What are the basics that should definitely get done?
  - What are the "might be nice" results?
- What are the consequences?
  - course grade? stipend?
  - warn them when they start to go off schedule, do not surprise them!

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Some common hurdles

1. The smart and eager student who “just doesn’t code well”
2. Codes well if they start from scratch, but has difficulty reading/modifying someone else’s code
3. The not-very-engaged student
4. The technical roadblock

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Just doesn't code well…

- Practice makes perfect
- Form pairs or teams
- Suggest useful books
  - Kernighan & Pike: The Practice of Programming
- Make sure they are using a good debugging environment
- Talk through code with them

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Difficulty modifying existing code base…

Some students are pretty good at coding from scratch, but have trouble reading/modifying existing source code

- Suggestions:
  - Practice makes perfect
  - Good debugging environment
  - Pointers to experienced users of code
  - Email lists and user groups
  - Read & step through code with them (or get someone else to do it)

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The not-very-engaged student

- Weekly meetings
- Mid-week emails to see if they are on-track and/or have questions
- Frequent goals and intermediate milestones
- Split off from group if they are impeding a pair or larger group
- Shield grad students from extra work if the non-engaged student is becoming a time sink
- And finally: consider stopping advising the project.
  - They may do better with a different adviser/topic
  - They may not *need* the project for graduation…

Resources to help with writing a good report

- Write a template for a good research paper, report, etc.
  - helps your graduate students too!
- Read other undergraduate research reports to see format/presentation/ideas
- Read related papers & pattern match structure, related work, key experiments, etc.
- Start early so advisor can give feedback on several drafts
- Advisors give prompt feedback!

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Resources for making a good research poster

- Combine PowerPoint slides into a poster
- Include Pictures
- Poster should be readable from 3 feet away
- Use a large font – size 16 or 18
- Include acknowledgement of funding support

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Publicizing the Work

- Why?
  - For the student:
    - Positive feedback and encouragement
    - Technical input and guidance
    - Sometimes: honors or cash prizes
  - For the adviser:
    - Tangible credit for time spent.
    - Attracts other students
- How?
  - Depends on quality of work
  - Put a poster up in your building and/or with other undergrads to showcase work
  - Submit paper/poster to conference
  - CRA-W undergraduate research conference
  - ACM Student Research Contest has an undergraduate half.

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The Handoff

- When a student "completes" the project, you almost always want to have the work "handed off" to someone else who can take further steps on it. How best to accomplish this?
  - Repository for source code.
    - Don't let it disappear with the student
  - Repository for experimental results
  - Handoff meeting where student brain-dumps to next student, to a grad student, and/or to you
  - Ask if you can stay in touch and ask a few questions later
  - …

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A mentor is more than a research advisor

- Discuss future plans
  - Grad school? Career?
- Fellowships to consider
- Programming and research contests
  - ACM SRC
  - ACM Programming contest
- Balancing Career and Life/Family
- Your own career/research stories
- Encourage and support outreach – talking about their research to other undergrads , H.S. students (visit their H.S.)

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Advice from the trenches
Do's

Forming research groups / selecting students

- Pick students who are self-motivated with high GPA
- Have a large group; more experienced undergrads help guide/mentor newer undergrads
- Have students work in pairs

Designing a project

- Have an existing project with a well-defined starting point for a new student to step in

Meetings and expectations

- Meet regularly, especially at the beginning
- Maintain regular contact
- Set clear expectations for each meeting
- Set clear deadlines

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Advice from the trenches
Do's

Learning tasks

- Have them design unit tests for their software
- Encourage regular/frequent writing of small documents

Give course credit; Later support through grants, if possible

Give positive feedback whenever appropriate

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Advice from the trenches
Don’ts

Don’t take students with heavy existing commitments

Don’t involve freshmen/sophomores

Don’t take students you don’t want to work with

Don’t expect them to figure out what to do on their own

Don’t assume they understand

Don’t center project on an application you haven’t worked with

Don’t assume research is their top priority

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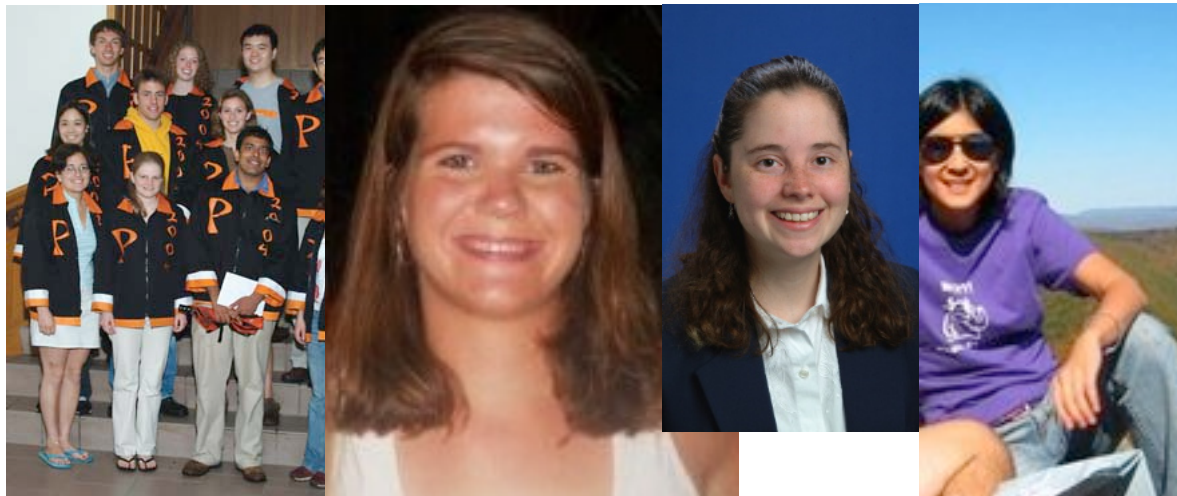
In closing:

Research is a remarkably human process, with all the extraordinary variety that all human endeavors offer.

Have fun!



Exercises

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Break!

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Breakout Sessions

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Breakout Session Topics

Early undergraduate research

- How to get students interested in the first place
- How to involve new students (1st and 2nd years) in research
- How to create interesting problems for students with little background

Keeping up the momentum

- Strategies for keeping a project going; transition from one semester (and set of students) to the next
- Strategies for keeping students motivated

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Breakout Session Topics

Being a “mentor”

- The research mentor/mentee relationship: how does it differ from other advisor/advisee relnships?
- Dealing with students’ self-confidence issues

Designing a project

- How to define a good project
- How much “research” (frontier-pushing) is there in ugrad research?
- How to get publications with students before they apply to grad school

Finding balance

- Balancing autonomy and supervision
- Providing a good learning experience while managine one’s own time

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Sharing from Breakouts

In closing:

Research is a remarkably human process, with all the extraordinary variety that all human endeavors offer.

Have fun!

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Resources

- Buffalo State Mentoring Tips http://www.buffalostate.edu/undergraduateresearch/x460.xml
- "How to Mentor Undergraduate Researchers",
  C.A. Merkel and S.M. Baker, CUR, 2002
- "The Mentoring Role in Undergraduate Research Projects",
  M.Malachowski, CUR Quarterly, Dec 1996
- Writing and presenting a scientific poster http://www.the-aps.org/careers/careers1/gradprof/gposter.htm
- How to read a scientific research paper

http://hampshire.edu/~apmNS/design/RESOURCES/HOW_READ.html