

Learning to Ask Questions

Convocation Remarks
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In the twenty-six years I have been at the University of Dayton, I have enjoyed teaching many courses, but the most professionally satisfying experiences of my career have been directing the Honors theses of twelve undergraduates.

In the next four years, you will have two kinds of opportunities to advance academically – taking classes, and engaging in scholarship individually with faculty members. Your professors are eager to discuss their research, share their results, and pose and ponder questions with those who enjoy their disciplines – they will seek out colleagues and students. I believe that learning to ask “good” questions is a distinguishing feature of research.

Many of you are familiar with The Birthday Problem. There are over 1000 people in this room today. Of those, there are at least two people who share the same birthday. Actually, many people can leave this room and we can still conclude with certainty that there are two people in this room who share the same birthday. After all, there are only 365 different days in a year (ignore 29 February for technical reasons). Suppose we started asking you one-by-one what your birthday was, and the first 365 people we queried each had a birthday different from the others, the *next* person – the 366th person – would have to share a birthday with one of the previous 365. This is an illustration of the aptly-named Pigeonhole Principle in mathematics – if you must place objects in boxes, and if the objects outnumber the boxes, then at least one box will have more than one object in it.

So, if we had “only” 366 people in this room, we would have a shared birthday. How does the probability change when the number of people in a room drops? What is the probability that there is a shared birthday in my 41-student MTH 114 course this semester? 90%! The smallest number of people in a room with a better-than-50% chance of finding a shared birthday is 23. (Surprising? Answers to “good” questions in mathematics often are!) I am sure several of you knew the answer to the Birthday Problem already. Perhaps some of you even know how to prove the assertions I made regarding the probabilities.

But there are some of you in the audience who are already wondering what number of people guarantees that the chance of someone sharing *your* birthday (or any *particular* day) is greater than 50%. [If you *are* wondering, please come and talk to any of the faculty in the Department of Mathematics in the Science Center – we can offer you a major that is sure to interest you!] In order to have a better-than-even chance of finding two people who are born on a *specific* day, we need 253 people, which is considerably larger than the 23 people needed when we left the date unspecified. Are there other questions that one could ask related to the Birthday Problem?

Tomorrow you will begin classes. You will work hard in your classes and get good grades. Courses are necessarily structured to deliver material efficiently, which limits the tools you can use and the extent to which you can explore. In a course, you will largely be working on tasks that you are told to work on. Courses are wonderful ways to learn vast amounts of information, to be introduced to new topics, to hear diverse opinions, to engage in co-operative (and sometimes competitive) learning.

However, you will find that studying an issue in depth with a faculty member is different from taking classes, both in form and in reward. Artificial constraints of time (a class period, a semester) are lifted; you

can connect various areas of studies in a very natural manner instead of thinking of a technique as belonging to geometry, say, and worrying about its use in algebra. The faculty member's experience as a scholar will help her decide when it may be necessary to introduce you to a new tool, or to provide you with a research paper that explored a similar question. You will have the privilege of helping create new knowledge in your field; some of you may even have your results published in mainstream research journals. Your advisor will probably become a mentor to you, and her letters of recommendation for you will be detailed and insightful. However, the most thrilling reward of undergraduate research is that *you* will be *the* expert in some area of an academic discipline.

Learning how to ask good questions takes time, patience and discipline. So what must you do now – in the next two years – as you broaden your knowledge – to prepare yourself to participate in an experience where you will deepen your knowledge about some specific topic? Here are four tips.

One, be intellectually curious. Gain knowledge from sources that are respected in your discipline. Analyze information for patterns. Tackle challenging ideas, because it is often necessary to struggle with some concept or idea to make it your own. Learn context along with content. Become fluent in the language of your discipline. You will then have the appropriate vocabulary with which to express your ideas.

Two, learn to collaborate. When working in a group for a class, come to group meetings prepared with the assigned readings, and having thought about the project. Listen to other group members' ideas, contribute your own ideas, volunteer to do your share of the work, and then be responsible about getting your share done on time.

Three, learn to have sustained thoughts. When you are given an assignment that is not due immediately, you are expected to use the lead time to think about the assignment, to read pertinent material, to wrestle with the ideas, to let the ideas simmer on the back burner, to consult with the faculty member for clarification if necessary, and to spend time in writing your analysis cogently.

Four, learn to think deeply and critically. Read fiction and non-fiction books that are not assigned for your courses. Reading acts as a catalyst for thinking. Reading lets you into the past, keeps you informed about the present, and forces you to think about the future. It compels you to consider someone else's words and rhythms and language. It increases your means of expression, and makes you a better writer. Reading helps you cultivate the art of having *informed* opinions. You will be able to nuance your arguments by incorporating the ideas of those whom you agree with, while the ideas with which you disagree will help you anticipate gaps that you may have to justify.

Following these pointers will position you well for independent academic explorations, working side-by-side with a faculty member. And you will be learning with someone who is already impassioned and knowledgeable about the subject, and you will see what job satisfaction is, and you will want to have this feeling for your own. That's when you will start *asking* the important questions and answering them to experience academic satisfaction and, paradoxically, you will generate in yourself a yearning for more academic stimulation.

That's when you will have the satisfaction of knowing that you can learn on your own, and your thirst for knowledge will be unquenchable.

And you might even ask, as a variation of that Birthday Problem, "What is the minimum number of people needed so that there is a 50-50 chance of finding two people whose birthdays are within a day of each other?"

Thank you.