PROFILE OF A LIVING PHYSICIST: A CLASS PROJECT TO LEARN ABOUT WORKING AS A PHYSICIST

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It is difficult for undergraduate students to know what it is like to work as a physicist. This paper presents a term project designed to address this issue, wherein each student interviews a physicist to learn about that person's work and about the education and career path that lead there.

INTRODUCTION

There is a big difference between undergraduate course work and the work done after graduation. It is entirely possible for a student to enjoy learning physics in a class setting but to be less than thrilled by physics research. Equally, a student may have the inquisitive mind needed to become a good physicist but be uninspired by course work. How do we help the first student choose a path that will expose him to exciting science without involving inquiry-based work? How do we motivate the second student to persevere through the laying of groundwork necessary for an inquiry-based career?

To address this, I have introduced an interview-based project in two of my upper level courses. As part of this project, each student investigates the work of a living physicist then interviews that person to find out more about his/her work and how the interviewee came to be in his/her current position.

The initial implementation of the Profile of a Living Physicist project was part of the winter 2010 offering of "Nuclear and Particle Physics" which was completed by eight students. In winter 2011, an improved version of the project was run with the nine students in "Introductory Astrophysics".

IMPLEMENTATION

The project's timeline is shown in Figure 1 and its key stages are described in detail below.

The Volunteers

In order to open the students' eyes to the variety of possible career paths, it is important to recruit potential interviewees representing a broad spectrum of relevant endeavours and work styles. It is also beneficial to have volunteers representing all career stages. The younger volunteers can provide detailed information and advice about the next few steps after undergraduate studies. The mid-career scientists are possible future thesis advisors or employers. The late career scientists and emeriti have a rich experience to share. Finally, including a few physicists working abroad highlights the international character of scientific endeavours.

When the project is first announced, the students are pointed to a web page that includes the names of the volunteers, their institutional affiliations, and brief descriptions of the type of work they do. Where possible the volunteer's name is linked to his/her web page, otherwise a link is made to his/her institution or some additional information is given, *e.g.* one volunteer suggested three representative publications.

The Initial Stages of Research

To hold a productive interview, the student first must become somewhat familiar with his/her subject's work. For research-

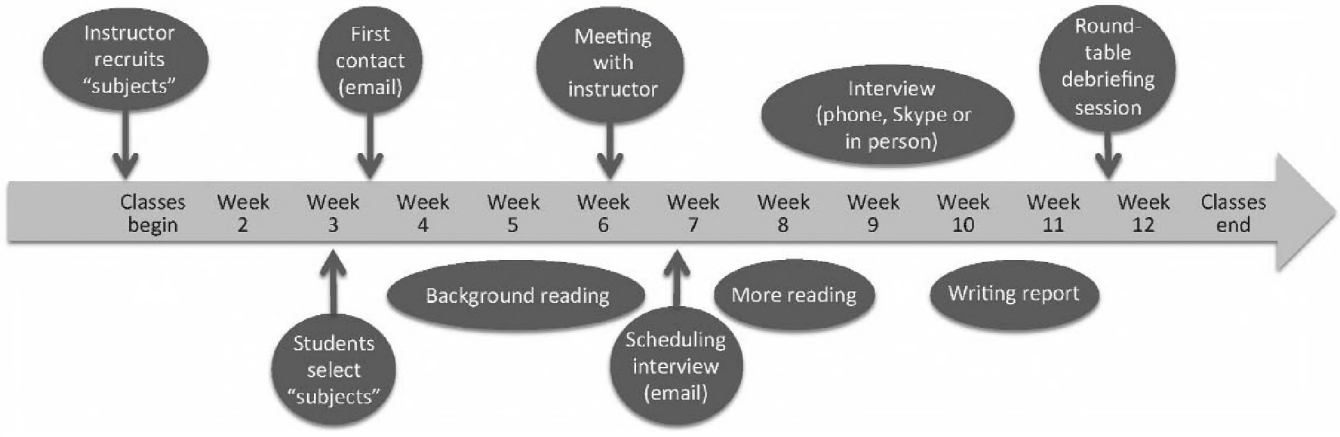

Fig. 1 Timeline

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active volunteers, this involves first carrying out literature searches to ascertain major topics of interest, then consulting textbooks to lay groundwork and learn the context in which the research is done. The students are not expected to fully understand their subjects' scientific papers but they must understand the general context. By the end of the project, the students should be familiar with their subjects' work at the level of a magazine like Scientific American. It is beneficial at this stage to spend some time introducing the students to literature search engines and databases; a session with a science librarian can be extremely helpful.

For the second run of this project, I met with each student before they contacted their subjects. They related what they had learned thus far and listed their sources. I then clarified a few matters and suggested other sources to consult or threads to follow. If they demonstrated that they were on track, I suggested that they contact their subjects soon to set up a date and time for the interview. It is important that they should do this well in advance of the interview, that they not wait until they feel ready for the interview, because their subject may not be available when it suits them. This was particularly important for the astrophysics course because several of the subjects had research-only positions and were therefore not tied to their institution during our term time.

The Interview

The only restriction on the format of the interview was that it be "live"; email was not an approved mode. Most students conducted their interviews by phone. Some used Skype, which had the advantage of offering a visual interaction. Each year, one student did his interview in person, taking advantage of a previously planned trip to visit his subject on home turf.

The interviews are meant to focus on three main topics: 1) the subject's work, 2) the subject's education and career path, and 3) what it is like to work in the subject's field. The first provides additional content that complements what is studied in class. The second is meant to give the students some ideas of options to consider if they are interested in pursuing a career in this field. Which courses were most valuable to the interviewee? How did the interviewee decide where to go for graduate work? Does the interviewee have any regrets related to choices made as a student? How did the interviewee go about finding a job after graduation? The third topic is particularly important and it is here that the interview is most useful. The stories told in the course of the interview give a glimpse into the working life of a physicist.

Sharing Information

Because the main goal of this project is to inform students about possible careers, it is important that they learn about all the interviewees. Each student is given a copy of all the reports but, on its own, this would be a waste of paper as it is unlikely that they would read the documents. To pique their curiosity and insure that at least the essential points are transmitted, a round-table debriefing session is held. This format leads to relaxed discussions wherein the students are comfortable asking follow-up questions and remarking on elements mentioned by others which they encountered in their own interview. This brings to the fore common threads from the different careers.

The sessions highlighted a few aspects of working as a physicist that the students had not anticipated. They were struck by the prevalence of collaborative work. They had been aware of the existence of small research groups within an institution but had not appreciated that multi-institution collaborations, some of them quite large, are common. Further, the discussions brought home the international character of physics research. The students were surprised by the ubiquity of international collaborations and by the fact that most interviewees had studied and worked in more than one country. Finally, arguably the greatest discovery for the students was the importance of communication skills, particularly written communication. Every student spoke of their subject's grant proposals, observing proposals, etc., and several shared that their subject had stressed that writing well and convincingly can make a big difference in a physicist's career.

RESULTS AND FEEDBACK

From the Students

The first implementation of the project, in Introductory Nuclear and Particle Physics, was a mitigated success. There was no obligatory meeting with me prior to contacting their subject to insure that the background reading had been done well and in a timely manner; this meeting is crucial for most students who otherwise delay far too much. In addition to procrastination-induced problems, it is simply more difficult with some research topics than with others to grasp the essence without understanding the details, and particle physics surely ranks among the most difficult. This contributed to several students struggling with the project. Without the debriefing session, it is likely that few would have been positive about the project, however the round-table discussion was lively and reminded them of how much they had learned. They took pleasure in sharing with their classmates and realized the value of the project.

For the astrophysics version of the project, feedback was gathered using anonymous end-of-term surveys. Figure 2 summarizes the results. Most of the students enjoyed doing the project but one was on the negative side and another was neutral about the experience. When asked how much they had learned from the project, all agreed that they had learned substantially, even the student who disliked doing the project. The student who disliked doing the project considered that it was a poor use of his time investment for this class, suggesting that she or he would have preferred to work on more standard problem sets, while the others considered that it had been a good use of their time for this course.

From the Volunteers

It is important to consider whether or not participating was a good use of the volunteers' time. In addition, having the subject

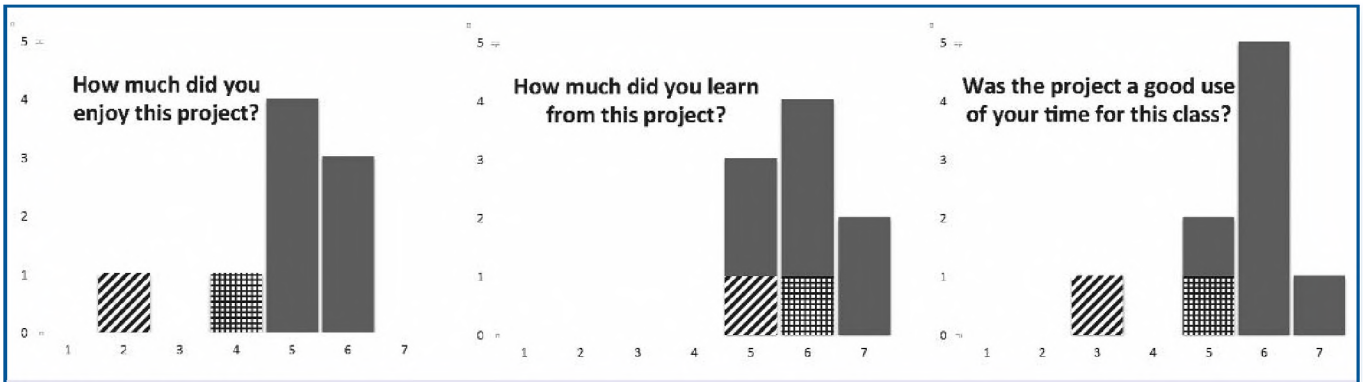

Fig. 2 Student Feedback

of a project give feedback on how the students worked on the project is an interesting twist that yielded suggestions for improvement. Feedback was sought from the astrophysics interviewees, and unsolicited comments were offered by some of the subatomic physicists.

All the volunteers who responded indicated that they would be happy to participate again. One offered that he found the interview to be "a pleasantly stimulating experience." Several volunteers highlighted the interest and enthusiasm of the interviewers. Good preparation by the students was underlined as being key to the process being positive for the interviewees, as one said "the amount of time it took and the knowledge the student brought to the interview made the process very easy and enjoyable."

The interviewees were asked for suggestions that might help improve the project. The most common theme was a desire for some form of preparatory interaction before the interview. Some suggested emailing a few questions or general themes to allow them to prepare. This would need to be weighed against the fact that this increases the time investment for the volunteers and against the danger of the interviews drifting away from being "live". Others suggested that the interview be in two parts or that there be an ice-breaker conversation before the real interview. They felt that this would help the students be more relaxed during the interview. Finally, some of those who were interviewed by phone ventured that a video interview might have been preferable.

CONCLUSIONS

Because this project involves volunteers giving of their time, it should only be undertaken if a high fraction of the students in the class are interested in pursuing studies or a career in this subfield. It is advisable to prepare two versions of the syllabus, one with and one without the project, then distribute the appropriate version after polling the students concerning their interests.

The Profile of a Living Physicist project can open students' eyes to certain career paths and provides information concerning how to embark on such a path. It gives them a hint of what is involved in the type of work done and the type of people who do it, "real people who are actually more normal than you might think" according to one interviewee. It highlights how different the work done is from course work but also how important course work is to opening doors to interesting future possibilities. In the words of one student: "I'm very glad I did (the project), as it made me realize that I am preparing for my career here, and need to start taking it seriously."

ACKNOWLEDGEMENTS

My thanks to all who agreed to be potential interviewees and particularly to those who shared of their time with my students. Additional thanks go to those who provided feedback.