

Exposure to Research in Science and Engineering Undergraduate Studies

Tomorrow's Research

Message Number: 1794

In addition, we also asked the lecturers to include in their presentation one of their graduate students so that the students in the course could be exposed to the experiences of graduate students who are in a similar age.

Folks:

The posting below describes a course taught to undergraduates at the Technion (Israel Institute of Technology). It has been quite successful in contributing to the students understanding an appreciation of the wide range of research underway at the institution and could serve as a model elsewhere. It is by Orit Hazzan and Avital Binah-Pollak of the Technion, Israel Institute of Technology, Haifa, Israel. Copyright © 2020 Orit Hazzan and Avital Binah-Pollak. All rights reserved. Reprinted with permission. For further information contact: Orit Hazzan <oritha@ed.technion.ac.il>

Regards,

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UP NEXT: A Birds-Eye View from California Community Colleges Faculty During the COVID-19 Crisis

Tomorrow's Research

----- 1,816 words -----

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The Case of the Technion's "Exposure to Research at the Technion" Course

Introduction

This posting continues the discussion about the integration of research in undergraduate programs published in TP Msg. #1785 "Course-Based Undergraduate Research - Crazy Observations, Audacious Questions", offering a different approach for exposing undergraduate student to research. While the TP Msg. #1785 discusses course-based research, which is the inclusion of research projects in the curriculum, in this posting we introduce the implementation of a new undergraduate course - 'Exposure to Research at the Technion', whose main goal is to expose undergraduate students to research carried out in the Technion – Israel Institute of Technology – campus. In this course, students' exposure to research occurs in several stages:

- 1) Students listen to lectures by Technion researchers and are exposed to research ideas and studies from various areas which take place at the Technion.
- 2) Students participate in meetings with researchers in their labs.
- 3) Each week students write a reflection on the research they were exposed to. This step is a significant type of involvement in research because it encourages students to express their opinions as well as to offer a new perspective about the research they heard, rather than being only passive listeners.

Based on our findings, we argue that the course is highly beneficial for undergraduate students for four main reasons:

- 1) In many cases, when research is promoted among undergraduate students, it is usually through special programs aimed at excellent students. This course is open to all Technion undergraduate students as an elective course.
- 2) Undergraduate research programs are often short and are guided by one researcher. In this course, students are exposed to research from a variety of faculties.
- 3) Each lecture is self-contained; in this sense, if a student missed one lecture it would not influence their understanding of the following lecture.
- 4) Research is accessible: the visits to the labs are provided with thorough explanations about the labs' goals and activities.

In addition, we found that the exposure to research turned out to be a dialectical process which benefits both the students and the lecturers: While the initial purpose was that students will be exposed to the research that takes place at the Technion, the outcome was that the lecturers, who presented their research in the course, expressed their interest to expose their research to new and broader audiences from different fields of knowledge. A researcher from the faculty of medicine explained: "I decided to lecture in the course to raise interest in students who are not from medical science, and to hear from them how do they see things from a different perspective, their perspectives as engineers". A lecturer from the faculty of civil and environmental engineering mentioned that, "research today in the civil and environmental engineering faculty is very interdisciplinary and there is a need to get researchers from other fields of knowledge. The course is one way to achieve that".

Course environment

The Technion – Israel Institute of Technology – is a science and engineering university that ranks among the top 100 universities worldwide (Academic Ranking of World Universities, 2018). It is the major supplier of scientists and engineers to the Israeli industry and played a central role in Israel's becoming *The Startup Nation* (Senor and Singer 2008). About ten thousand undergraduate students are enrolled at the Technion's 17 science and engineering faculties. In addition, the Department of Humanities and Arts provides elective courses in social sciences and liberal arts, one of which is the course 'Exposure to Research at the Technion', which is the focus of this paper.

Hazzan and Levontin (2018, TP Msg. #1674 "Study-Work Conflict in Science and Engineering Higher Education") described how the Technion realized the importance of the attention it should provide to implicit teaching of research skills. As a result, the Technion has initiated the *#Ladders* program. The program's purpose is to expose the Technion undergraduate students to the research that takes place on campus. The course 'Exposure to the Research at the Technion' was developed as part of this program.

The course 'Exposure to the Research at the Technion' is an elective course, learned in the framework of the 10 credits in humanities all Technion undergraduate students are required to learn in order to complete their 4-year engineering degree or 3-year science degree (out of 155 or 120 credits, respectively). Students are offered a list of courses from which they select 10 points (about 5 courses). The course takes place two hours a week over the course of 13 weeks of the semester. Accordingly, by the end of the course, students are expected to have a global perspective of what research means in general and what characterizes the research that takes place at the Technion, its breakthrough developments and research findings. However, the course goes beyond this specific target, and promotes several sub-targets: First, as research is a useful tool also at the industry, especially in Israel, where many multinational companies established R&D centers, lecturers from the industry are also invited to present the role of research in the industry and the competitive advantage one may gain in case he/she acquires also research skills; and second, , the course aims at broadening specific research skills, which can be performed in the framework of such a course, e.g., familiarity with the library research services and developing reflection skills in the spirit of the Reflective Practitioner (Schön, 1983, 1987).

Each lesson, two Technion researchers present their research. A week before each talk, a message with a description of the course's framework is sent to the lectures. Most lectures were videoed, and then a link to the video was sent to the lecturer and pending on his/her approval, the link was then uploaded to the course website. In addition, we also asked the lecturers to include in their presentation one of their graduate students so that the students in the course could be exposed to the experiences of graduate students who are in a similar age. Another request from the lecturers was to share some of their academic background and provide the students a personal perspective of what they believed it means to become a researcher.

The final grade of the course is calculated as follows:

- 1) 14% of the grade is determined by weekly assignments. Throughout the semester, the students are obligated to submit seven reflection papers which are based on lectures they attended. They are asked to address questions such as: What would you like to explore in case you had the opportunity to participate in this research? How could you contribute to the said research? How is the research presented at class connected to my area of studies?
- 2) 10% of the grade is set by active participation in research (e.g., visiting a lab of one of the researchers who present in the course, participating in a research, etc.);
- 3) 6% of the grade is determined by 3 questionnaires the students are asked to fill during the course: at the beginning, middle and end of the semester;
- 4) 70% of the grade is based on a final exam which is based on the content of the lectures they were exposed to throughout the semester.

Course participants

Most of the students enrolled in the course study in the engineering faculties; about one half of them are at the beginning of their third year (out of four). This fact further increases the potential the will reach out to a lecturer from a different faculty and inquire about the option to be involved in the research.

Course Impact

To explore the impact of the course on students' familiarity of the research which takes place at the Technion, we asked the students: "How well do you know the studies which take place at the Technion"? at the beginning, middle and end of each semester. Our data indicates that students found the course highly beneficial to their exposure to research which takes place on campus.

Based on the results we received in the beginning of each semester, we learn that even students who are at an advanced stage of their undergraduate studies, have very little knowledge of the research which takes place at the Technion. In the spring semester of 2017-18 we received the following results: 38.4% of the students chose 1, meaning they do not know anything about the research which takes place on campus; 40% chose 2, 21.5% chose 3 and none chose 4 or 5. In the winter semester of 2018-19 we received similar replies: 29.5% of the students chose 1, 52.1% chose 2, 16.9% chose 3, one student (1.4%) chose 4 and none chose 5. In the spring semester of 2018-19 we received similar replies: 27.1% of the students chose 1, 52.1% chose 2, 16.7% chose 3, one student (2.1%) chose 4 and 5 (2.1%).

In the middle of the semester, after close to 10 lectures (2 lectures in each lesson), the results changed, and the students indicated that they have become more familiar with the research which takes place on campus: In the spring semester of 2017-18 we received the following results: 15.3% of the students chose 1, 23% chose 2, 43.5% chose 3, 17.9% chose 4 and none chose 5. In the winter semester of 2018-19 students' replies demonstrated more familiarity with research than in the previous semester: only 5.5% of the students chose 1, 22.2% chose 2, 42.5% chose 3, 24% chose 4 and 3 students (5.5%) chose 5. In the spring semester of 2018-19, none of the students chose 1, 13.9% chose 2, 58.3% chose 3, 25% chose 4 and only 1 student (2.8%) chose 5.

The result we receive at the end of the semester clearly demonstrate that in the students' perspective, the course contributed to their understanding of the research which takes place at the Technion: In the spring semester of 2017-18 we received the following results: Only 2 students (5.2%) chose 1, 2 students chose 2, 39.4% chose 3, 50% chose 4 and none chose 5. In the winter semester of 2018-19 we received similar replies: 3.7% of the students chose 1, 13.2% chose 2, 41.5% chose 3, 32% chose 4 and 5 students (9.4%) chose 5. In the spring semester of 2018-19, none of the students chose 1, 7.5% chose 2, 42.5% chose 3, 45% chose 4, and 5% chose 5.

The data presented above demonstrates that as the course progressed students felt more confident about their knowledge of the research which takes place at the Technion.

Conclusions

We argue that research is not simply a skill required for academic research, especially in the context of science and engineering, but, that research skills should be part of students' habitus where they are exposed to complex problems they might have an interest to solve. Being exposed to scientific research projects is a highly beneficial opportunity for students to acquire and sharpen qualities that can assist them not only as undergraduate students but also as future researchers, innovators and entrepreneurs.

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