

Undergraduate students are the "secret sauce" to help research programs be successful

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Abstract

In most universities, faculty are evaluated on three criteria: teaching, service, and research. While all are important, research is often weighted more heavily, especially at larger R1 universities. Even universities that emphasize teaching frequently have research expectations whether it be disciplinary or documenting novel educational/classroom activities. Either way, undergraduates are one of the most overlooked resources to help with research. This “Work in Progress” makes the case for using undergraduates in research by discussing the benefits of using them in research programs; it also identifies some pitfalls. Based on these observations and the literature, the recommendation is made to engage undergraduates in research early in their academic career, during their first or second year. Benefits for undergraduates in research over their academic career can result in these students continuing with the graduate program at their home institution or at other institutions.

The Kern Foundation recognized the importance of undergraduates in research and sponsored a Request for Proposal (RFP) to address this topic. A collaboration of five universities from the Kern Entrepreneurial Engineering Network (KEEN) answered the RFP and were selected to address this topic. To assist faculty with integrating undergraduates in research, a series of initiatives are being developed to address student early exposure to the concept of research, training of students in research topics, and helping faculty see the value of using undergraduates in their research programs. For all initiatives, videos and accompanying activities will be available for use at any university. The specific area of focus for this paper is faculty development. The aim of faculty development is to help faculty see the need for undergraduates and to help them with recruitment and mentoring. For the two faculty development modules, videos and accompanying activities are envisioned to be delivered in a seminar setting targeting all faculty who do research. The first seminar entitled “Engaging Undergraduates in Your Research: Worth the Effort!” makes the connection of undergraduate students to research and highlights the value of research to both the student and the professor. The second seminar entitled “Boost Undergraduate Research Productivity with Entrepreneurially Minded Learning (EML) – Curiosity, Connections, and Creating Value” helps faculty understand the obvious connection between EML and research. These much needed seminars should encourage both new and experienced faculty to accept EML and to see the benefit of including undergraduates in their research programs. Examples of professors who are successfully integrating undergraduates in research will be presented in the workshops. This should encourage all faculty and motivate them to include more undergraduates in their programs.

Introduction

Basic research, usually accomplished by curious individuals, has been part of civilization for centuries. Scientists such as Archimedes, Democritus, Euclid, Pythagoras, and Ptolemy marveled at the world around them and attempted to explain what they observed. Their curiosity laid the foundation for what would be called research. During the renaissance, men such as Leonardo da Vinci made discoveries to improve society and the quality of life, innovations such

as the printing press, telescope, and eyeglasses resulted. These inventors worked individually on topics that interested them. While research was not a new idea, it was in the late 1700s that research was harnessed to address specific needs of society. Countries, and later industries would gather groups of scientific individuals to solve challenges related to particular topics. The industrial age brought many advances revolutionizing how things were made. World wars also contributed to the need for targeted research. It was in the 1950s that the relationship between research and development (R & D) was recognized [1], connecting research to the development of new products and new forms of old products. This connection became the foundation for R & D at the university. Since WWII, innovative research activity has been the single, most important component of long-term economic growth [2]. Research programs have been an important part of R1 and other research-active universities. Research will continue to be an increasingly important dimension of a faculty member's receiving tenure and continued promotion to the rank of professor.

Teaching, Research, and Service

Each university has its own specific criteria for promotion and tenure, but in general a successful engineering professor is an effective teacher, engages in creative activities that include research and publications, and serves their profession. Schimanski and Alperin studied the evolution of scholarship evaluation in the university environment. In the 1980s many universities required faculty to be excellent in only one of these areas. In the 2000s universities required excellence in all three, with the most focus placed on research [3].

Successful faculty strive to improve their teaching, by attending workshops and conferences (such as ASEE), by observing other professors in the classroom, and by studying the literature. Being an excellent teacher takes time and effort. It is often thought—perhaps wishfully—that teaching and research complement each other; however, early studies, as described by Prince et al., showed that there was no correlation between teaching and research [4]. In more recent years, there has been a trend to include research in classroom activities, with the goal to expose students to the possibility of participating in research.

Service is often the most undervalued activity of faculty, by faculty and administrators alike, but it is nevertheless expected. Faculty at both “teaching” and “research” universities report service and administrative responsibilities which require a significant, occasionally overwhelming, amount of time [3]. Typical forms of service include service to the profession (such as organizing conferences), service to the institution (campus, college, or department), or broader societal service through outreach or extension services.

At many universities, research is judged the most important faculty activity. Establishing an impactful, sustainable research program, and demonstrating intellectual independence and leadership is necessary for promotion. However, the important and growing contributions of specialized teaching faculty has been accompanied by a growing acceptance of educational research as valued, creative scholarship. For any academic research program, engaging students is important. One often overlooked source of student engagement in research is undergraduates.

Undergraduates in Research

Faculty should be encouraged to engage undergraduate students in their research programs. Madan and Teitge [5] found that “a significant number of first-year students are overwhelmed by the academic process and do not even know that research is an option for them, let alone how to get involved.” Faculty are under tremendous pressures to be successful and often do not have time to recruit or train undergraduate students. The development of a training program to help faculty connect with undergraduates and see the value of adding them to their research teams is the subject of this paper. Undergraduates bring diversity to the research team. Undergraduates impact research by bringing fresh ideas and unique perspectives to the team. They can help formulate questions and contribute to any brainstorming activities to solve research challenges. Out-of-the-box thinking is more likely with someone new to the program. Having additional lab workers can help with productivity in the lab. Russell et al. [6] found that undergraduate research does lead to interest in STEM careers and graduate study.

According to Keller [7], the characteristics that motivate students to participate in research can take many forms. He lists some as: (1) research to answer questions you cannot look up on your own or to develop things not yet answered; (2) every topic looks different; (3) a lot of time, it is interdisciplinary; (4) research can be artistic; (5) it is possible to get grants or even get paid; (6) research can be a great way to improve critical thinking; (7) meet mentors; (8) position yourself well for graduate school.

Erickson [8] also highlights the benefits for students to be involved in research and describes these topics in more detail. Research: (1) enables students to make better choices about graduate school; (2) gives relevance to principles and concepts being studied; (3) gives students a motivation for learning; (4) can provide financial support; (5) develop mentoring relationships with faculty; (6) challenges students to frame problems; (7) helps to develop team skills; (8) improves writing and presentation skills; (9) provides memorable experiences of undergraduate years.

Biddie and Collins [9] conducted a survey of 71 faculty members at a large primarily undergraduate state university. They included a list of 17 skills which would be improved by an undergraduate participating in research. Faculty were to rate each based on a five-point scale: 1 (not at all improved), 2 (a little bit improved), 3 (somewhat improved), 4 (a good deal improved), and 5 (very much improved). Average scores are included below.

1. Working independently 3.39
2. General writing skills 3.48
3. Summarizing/synthesizing past research 3.48
4. Getting along with people who are different 3.50
5. Oral communication skills 3.55
6. Using technology and computer programs 3.58
7. Locating past research on a topic 3.57
8. Evaluating past research on a topic 3.63
9. Research design 3.70
10. Thinking creatively 3.73

11. Understanding the ethics of research 3.79
12. Data analysis 3.82
13. Data interpretation 3.86
14. Data entry 3.88
15. Formulating a hypothesis 3.91
16. Thinking like a scientist 4.07
17. Critical thinking 4.16

As can be seen, there are a wide variety of student skills that can be improved through participation in research with critical thinking being the most important to the faculty.

Faculty and Undergraduates in Research

Biddie and Collins took the research one step further and examined faculty perceptions of undergraduate research. Faculty must be certain of the benefit of having undergraduate researchers. Biddie and Collins had faculty who mentor undergraduates in research rate the benefits of supervising these students. The list below is the benefits considered and their average score using a five-point scale: 1 (not a benefit), 2 (small benefit), 3 (moderate benefit), 4 (large benefit), and 5 (very large benefit) and shows the averages.

1. Enjoy teaching students about research 3.94
2. Able to prepare students for graduate school 3.76
3. Able to prepare students for work experience 3.55
4. Able to work one-on-one with a student 3.42
5. Receive help from undergraduates on research 2.97
6. Students bring new ideas to research 2.50
7. Viewed positively for merit/annual review 3.21
8. Receive credit toward tenure 2.76

Many faculty get personal satisfaction working with undergraduates on research which is at the top of the list. Supervising undergraduates gives the faculty member professional and intellectual growth. Biddie and Collins also surveyed barriers to faculty working with undergraduates in research. The list below uses the five-point scale and shows the averages: 1 (not a barrier), 2 (small barrier), 3 (moderate barrier), 4 (large barrier), and 5 (very large barrier).

1. Time consuming 3.59
2. Students are underprepared 2.76
3. Students lack motivation 2.50
4. Low-quality research 2.79
5. Students graduate before finishing 2.59
6. Research not suitable for undergraduates 1.85
7. Does not help with tenure/promotion 1.94
8. Not valued by my college 2.06
9. Not valued by colleagues 1.76
10. Not valued by department 1.85

Working with undergraduates usually means slower rates of research progress which may be unacceptable for a tenure track faculty. Since this survey was at a predominantly undergraduate institution, it does not necessarily reflect what might be at a research university. The last four topics in the list are of primary importance at these universities [9]. Unless the institution values mentoring undergraduates, the faculty would see mentoring undergraduate students will not help with their professional development. Undergraduate research can result in publications but often does not. These students need a great deal of supervision, flexibility in their schedule, and patience on the part of the faculty mentor. The students often do not see the “Big Picture” of the research being accomplished. Undergraduate students can graduate without completing their research task. Biddie and Collins stated that intellectual gains may be especially pronounced for students who start undergraduate research in their first or second years. However, at this point in their careers, students are unprepared for the research environment and do require the faculty member’s time to bridge that gap. In fact, the biggest barrier for faculty in mentoring undergraduate researchers is a lack of time as seen at the top of this list. Eagan et al. also concludes that a heavy workload with a reward system that does not incentivize mentoring students, given the amount of time it takes to mentor and train undergraduate researchers, does not interest faculty to use undergraduates in research [10].

Davis et al. state that research has shown faculty engaging students in undergraduate research positively benefits their research and teaching goals [11]. Their research shows that mentoring of undergraduate students is the most important aspect of having undergraduates in research. Mentoring is considered an “extra-role” and is not typically part of the tenure and promotion process. They point out that traditional one-on-one mentoring can be very time intensive and limit the number of students that can be served in this capacity. One solution for this time factor is to use post-docs and senior graduate students in the mentoring role. Another solution is part of this proposal, that of providing some student training modules to reduce the load on faculty. While mentorship is important to the success of undergraduates in research, Davis et al. point out that faculty will not be encouraged to participate in mentoring undergraduates unless there is perceived institutional support for this activity.

Research and Entrepreneurially Minded Learning

Both faculty and students need to connect research with the concepts of EML, or more specifically curiosity, connections and creating value. Research and engineering education are often thought of as separate topics but they are linked. Involvement in research, for either students or faculty, addresses the need to develop curiosity and the ability to ask the right question. KEEN [12] developed a framework to supplement the engineering skills already being taught in classrooms with outcomes that support the development of being “entrepreneurially minded,” hence, the phrase Entrepreneurially Minded Learning. Entrepreneurially minded individuals are powerful agents of societal good, progress, and human flourishing, especially when disciplinary skills are complemented by excellent collaboration and communication skills and are founded on character. Individuals who exercise an entrepreneurial mindset recognize problems as opportunities, assess potential impact of solutions, and use their skills to create value for others. This is what is desired in undergraduate students. Students need to be exposed to these concepts early in their academic career and by doing so, this could lead to an interest in research. An entrepreneurial mindset is characterized by an insatiable, yet productive curiosity, a

habit of making mental connections, and a relentless focus on creating value; these are KEEN's 3C's. Students and faculty involved in research must understand the need for EML and how it fits with and enhances research. EML brings to research the following qualities [13]:

1. Understand the motivations and perspectives of others
2. Convey an engineering solution in economic terms
3. Assessment of risk (contingencies)
4. Test concepts via customer engagement
5. Assess policy and regulatory issues
6. Discovery through curiosity which leads to identification of unexpected opportunities to create extraordinary value
7. Exploring a contrarian view of accepted solutions

EML then emphasizes discovery, opportunity identification, and value creation by approaching engineering problems and challenges in a more entrepreneurial manner. It prepares students to identify problems and solve them in innovative ways. EML can be measured by how a student's knowledge, thinking patterns, skills, and attitudes are changed. It is important that students make this connection between EML and research.

To educate and aid faculty with integrating undergraduates in research, a series of modules are being developed to address student early exposure to the concept of research, training of students in research topics, and helping faculty see the value of using undergraduates in their research programs. For all initiatives, videos and accompanying activities will be available for use at any university. Specifically for faculty development, the subject of emphasis in this paper, two videos and accompanying activities are envisioned to be delivered in a seminar setting targeting all faculty who do research. The first seminar entitled "Engaging Undergraduates in Your Research: Worth the Effort!" makes the connection of undergraduate students to research programs and their value to both the student and the professor. The second seminar entitled "Boost UG Research Productivity with EML – Curiosity, Connections, and Creating Value" reinforces this obvious connection between EML and research. These much needed seminars should encourage both new and experienced faculty to embrace EML and to see the benefit of including undergraduates in research programs. Seeing some of the examples of successfully integrating undergraduates in research that will be presented in the workshops should encourage all faculty and motivate them to include more undergraduates in their programs.

Project Description

The desire of this initial project was to expose undergraduate students to research early in their academic career. KEEN first sponsored a workshop entitled "EML through Research" in the fall of 2019. The workshop helped to explore the connection between research and EML. This workshop has been offered several more times since then. The results of these workshops were developed into Engineering Unleashed Cards published on the KEEN website by the participants. The cards highlighted the research participants conducted or were hoping to conduct

with undergraduates. The modules touched on curiosity, connections, and creating value in the context of these projects.

Research can miss the connection to EML. KEEN proposed a RFP linking EML with research to help make this connection. The concept behind the RFP was that “research active faculty will benefit from more entrepreneurially minded students in their research programs. This would result in high quality research and improved student learning within undergraduate research experiences. Although EML is implicit in the research ecosystem, the resulting benefits to students and society would be greater if the 3C’s were explicitly embedded in students’ research experiences [14].” According to KEEN, this RFP is aimed at:

1. Increasing the Network’s capacity to bring EML into the research area of the undergraduate engineering education enterprise
2. Leveraging collaboration wherever possible to increase impact and scale
3. Focusing on practical action and urgency of the moment to accomplish goals
4. Creating transferrable modules or models that expand the capacity of campuses and KEEN to integrate EM and broaden access to these mindset outcomes within the research enterprise

KEEN partner schools were encouraged to submit a proposal which was subsequently evaluated by KEEN. There were six partner institutions that submitted similar proposals dealing with student exposure and training. After the review process, these schools were encouraged to collaborate developing one proposal which encompassed the ideas from all six schools. Only five proceeded with the proposal process. These schools were Lawrence Technological University, Rose-Hulman Institute of Technology, Baylor University, Georgia Institute of Technology, and the University of Illinois Urbana-Champaign. A merged proposal addressing the interests of each institution was submitted to KEEN. This combined proposal was entitled “An EM-Driven Framework for Undergraduate Research.” The areas being developed are listed as shown in Figure 1. The areas are titled Early Exposure & Awareness, Understand Student Motivation, Efficient Team Training, Faculty & Mentor Development, and Dissemination & Collaboration.



Figure 1. An EM-Driven Framework for Undergraduate Research

To educate and aid faculty with integrating undergraduates in research, a series of initiatives are being developed to focus on student early exposure to the concept of research, training of students in research topics, and helping faculty see the value of using undergraduates in their research programs. For all initiatives, videos and accompanying activities will be available for use at any university. The universities represented in this project are diverse. There are public and private universities and both large and small universities as well. The challenge of the project is to develop materials which can be applicable to all universities. This challenge has been a guiding factor. Specifically for faculty development, two videos and accompanying activities are envisioned to be delivered in a seminar setting targeting all faculty who do research. The first seminar entitled “Engaging Undergraduates in Your Research: Worth the Effort!” makes the connection of undergraduate students to research programs and their value to both the student and the professor. The second seminar entitled “Boost UG Research Productivity with EML – Curiosity, Connections, and Creating Value” reinforces this obviously.

Institutional efforts at **Early Exposure and Awareness** to research for students is crucial to the success of undergraduate research programs. Yet many institutions, including those represented in this project, have difficulties in such efforts. For example, Dr. Tammy Adair, Co-Director of Baylor University’s Undergraduate Research and Scholarly Achievement program, has stated that past surveys on Baylor’s campus showed that students may not learn about research early enough to get involved in a meaningful way. To address this problem the goal will be to produce interventions for early and broad student exposure to research opportunities with a focus on EML and its impact. These interventions will be aimed at shaping a student’s perspective on research as opportunities are made more visible and inviting.

This topic area will first develop a range of materials consisting of videos, presentations, and additional written materials which compose a “EM in Research 101” package. This “EM in Research 101” package will address common questions students have about engaging in research as well as introduce EM 101 concepts in the context of research. The series of videos will be professionally produced. These videos will be short, inviting, and targeted to addressing key research and EM topics as well as sparking a passion for impactful work. Written materials may include reflection exercises and group modules utilizing EML for giving students a sense of how and why engineers conduct research.

The goal of **Efficient Team Training** is to make research training more efficient, foster entrepreneurial-minded thinking through well-designed modules, and make faculty-led training activities more scalable and transferable. For this portion of the project, the plan is to develop a series of self-contained EM training workshops (~1 hour each) for students. These workshops will be designed for flexible deployment at various universities within their existing undergraduate research programs (e.g., summer research fellowship programs, honors thesis courses, undergraduate research opportunity programs). In contrast to the activities developed for early awareness and exposure, these workshops would focus on having students apply EM concepts directly to their own research projects. Proposed workshop topics (among others) include framing research questions with EM, resilience and thriving in a research environment, developing your elevator pitch, using EM to drive effective data presentation, and focusing your next steps in research.

Each workshop will include video content, a workbook, and a moderator guide, with workshops designed to deploy either in-person or virtually with a workshop moderator. The workshops will not rely on the framework of a course (grades, fixed course times, etc.) for successful implementation, and institutions will be able to choose a combination of workshops to present that best fit within the goals and time constraints of their undergraduate programs.

The **Understand Student Motivation** portion of this project seeks to quantify the impact of EM-focused programs and interventions on research productivity of UG students (retention / continued research, student publications and presentations, skill development), and Identify key student motivations for participating in UG Research and how EM activities can be used to enhance and build on those motivations, as well as provide a basis for demonstrating the impact of our programs and convincing additional universities, faculty members, and organizations to adopt the activities developed.

Initial Data from Faculty Survey

A faculty survey was developed and distributed to participating institutions to better understand faculty perceptions and motivations in involving undergraduate students in their research work. This is a work in progress and so far 50 responses were collected from four universities.

As shown in Figure 2, the most represented group are junior faculty (36% with 0 to 6 years in professional academic career). 34% of them are mid-career faculty (6 to 15 years' experience). On average in the past five years, each faculty member worked with 6 volunteers, 4 paid undergraduate assistants, and 7 students participating for independent study, credits, or honors program (see Figure 3). As shown in Figure 4, a majority of students (45%) are engaged in the research project for one year, followed by 32% of students who were involved for one semester. Only 17% of the undergraduate researchers worked with the faculty for more than one year.

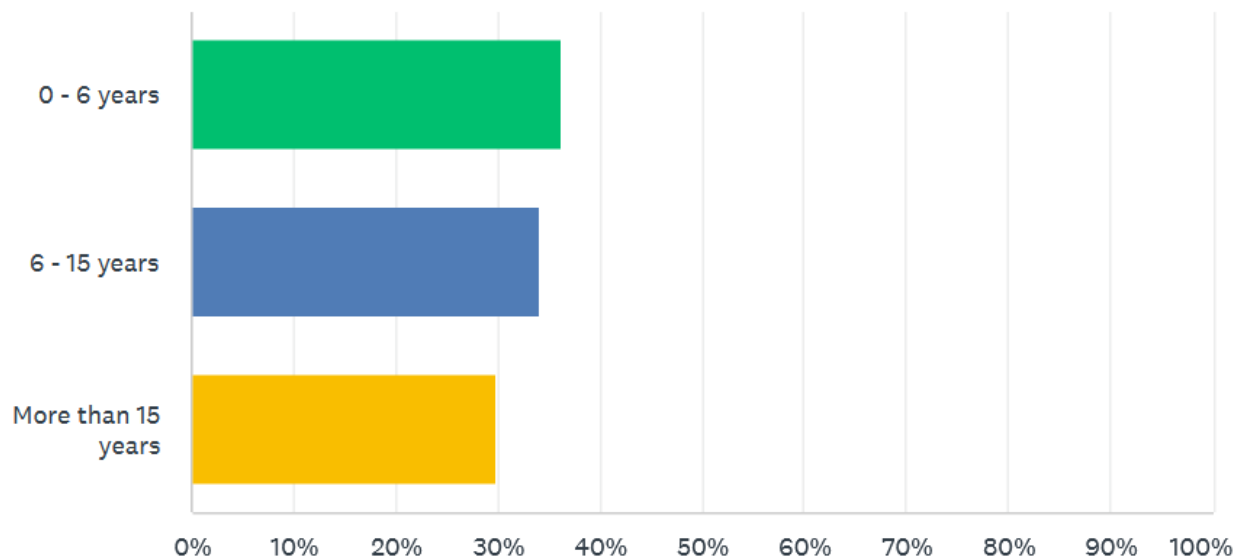


Figure 2. Faculty Responses to Question “Where are you currently in your professional academic career?”

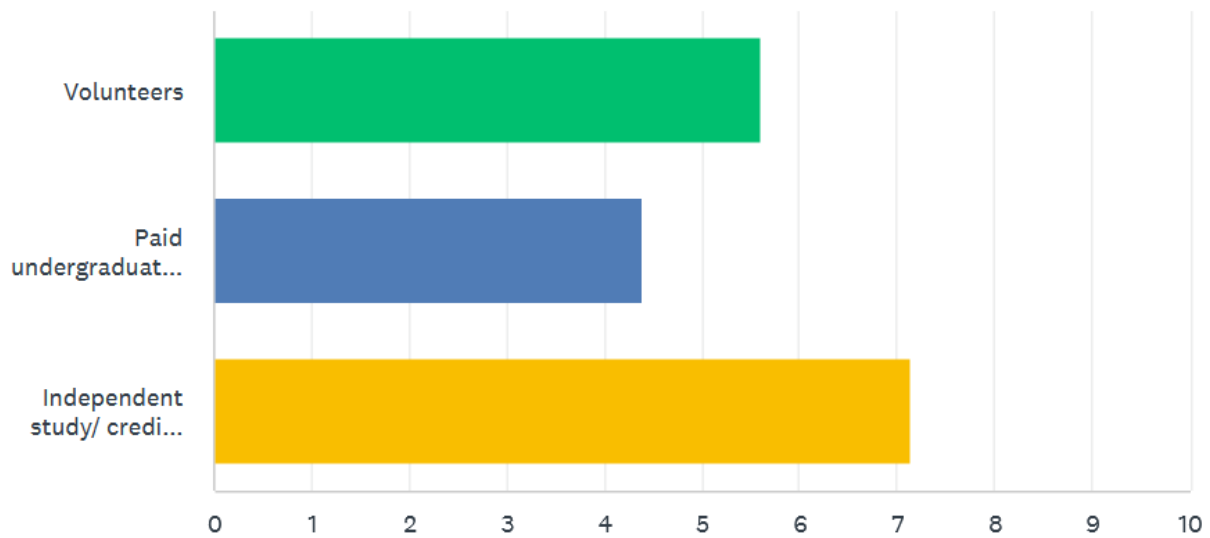


Figure 3. Faculty Responses to Question “In the past five years, how many undergraduate students have you worked with in your research?”

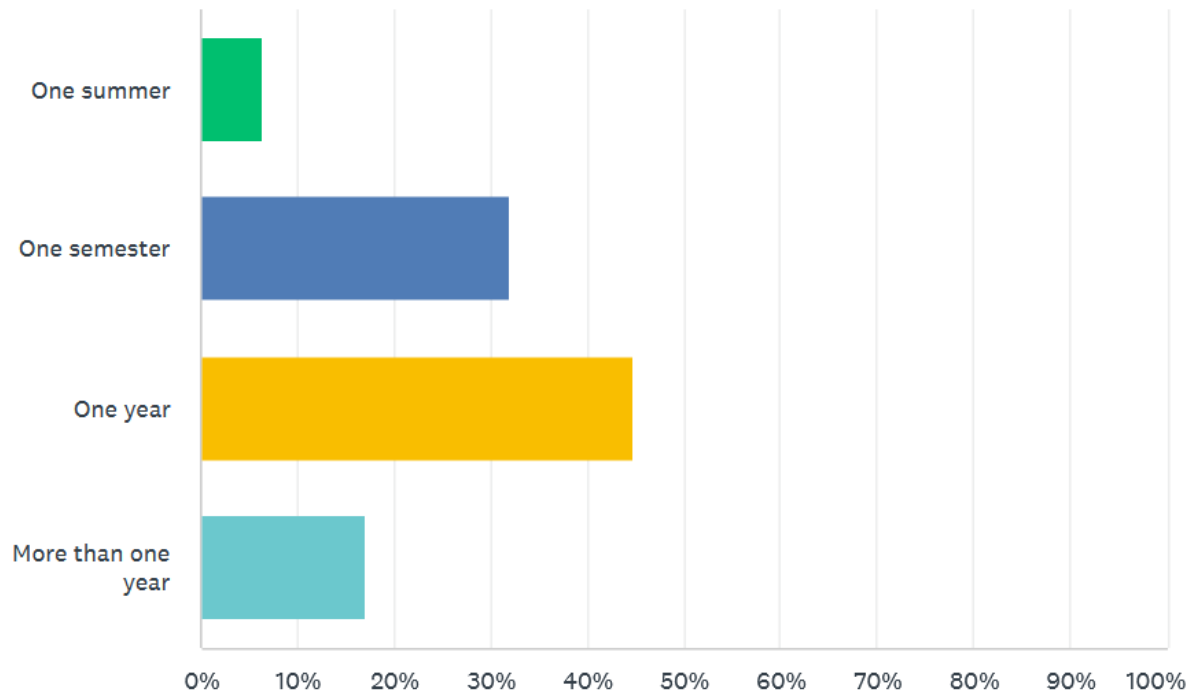


Figure 4. Faculty Responses to Question “On average, what is the duration that an undergraduate works in your lab?”

On a scale of 1 (strongly disagree) to 5 (strongly agree), faculty were asked to rate their own effort in fostering curiosity among undergraduate researchers. According to Figure 5, a majority

of the faculty members believed that they did a great job - 36% rated themselves 5 and another 49% rated 4. Faculty mentioned involving the undergraduate in the weekly meetings of his/her research group, and “help to develop the prototype as per the market requirement”. “I discuss the connection of research topics to everyday experiences, assign students to seek academic papers to discuss, and introduce students to particularly exciting work by others in the field that I think will get them excited and curious”.

Faculty reported an averaged rating of 3.4 out of 5 for their effort in asking undergraduate researchers to explain the impact (societal, economic, intellectual, etc.) of their research projects in presentations or reports.” Many faculty ask their undergraduate researchers on a regular basis to describe the needs and motivations of various stakeholders of their projects, such as industry sponsors, other research groups using the results, or eventual end users of the technology (average rating of 3.3 out of 5).

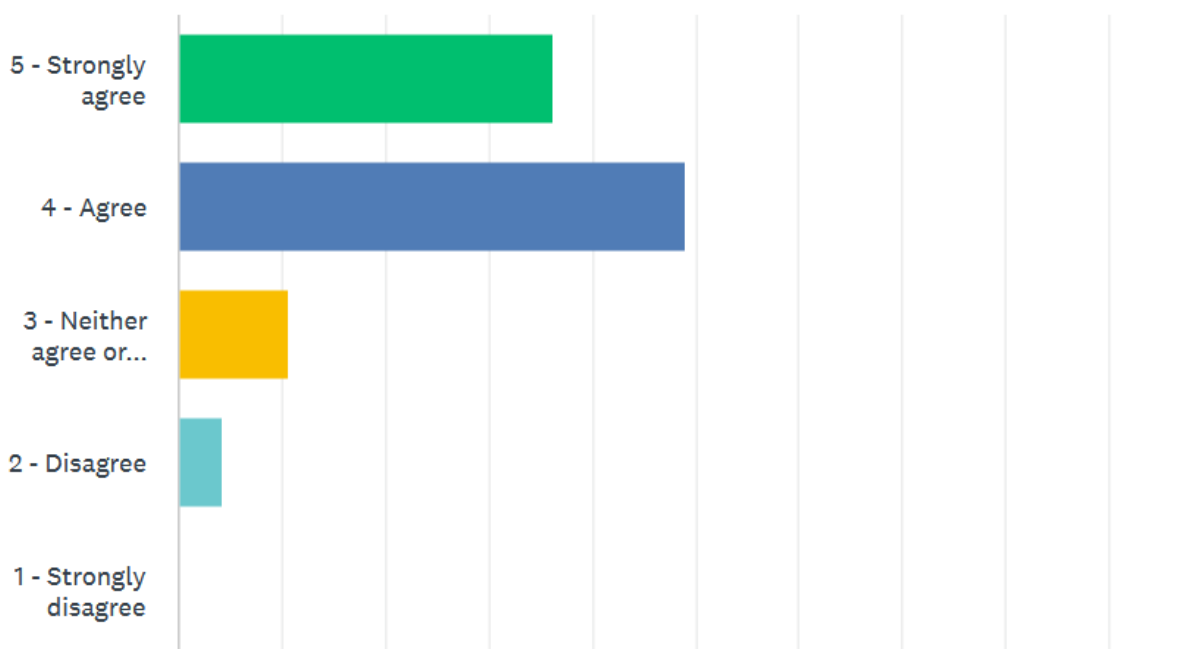


Figure 5. Faculty Responses to Statement “On a regular basis, I make an effort to foster curiosity among my undergraduate researchers.”

The rating was much lower (an averaged response of 2.9 out of 5) to the statement “On a regular basis, I ask my undergraduate researchers to understand a problem in terms of how a discovery could be scaled and/or sustained (such as thoughts of revenue streams, key partners, costs, and key resources).” Most faculty agreed that they provide guidance to their graduate students and post-docs on how to mentor undergraduates (averaged score of 3.3 out of 5).

When asked the question “From your perspective, what motivates undergraduate students to participate in research?”, the top three motivation for students to participate in research (from a faculty point of view) are:

1. Gain hands-on experience in their research
2. Explore their interest in science / engineering

3. Enhance their resume

“Clarify whether they wanted to pursue a career in research“ is also a popular selection following the top three mentioned above. It will be interesting to see how this correlates with the student survey results.

As shown in Figure 6, 38% of the responses indicate that faculty spend 1 to 2 hours per week mentoring each undergraduate student in research, and another 34% spend 30 minutes to 1 hour on each student. Most of them (86%) had one or more undergraduates co-authoring publications or presentations (Figure 7). Data shown in Figure 7 also correlates very well with the number of undergraduates who ended up continuing their research endeavors after graduation (e.g., went to graduate school or industry position focused on research).

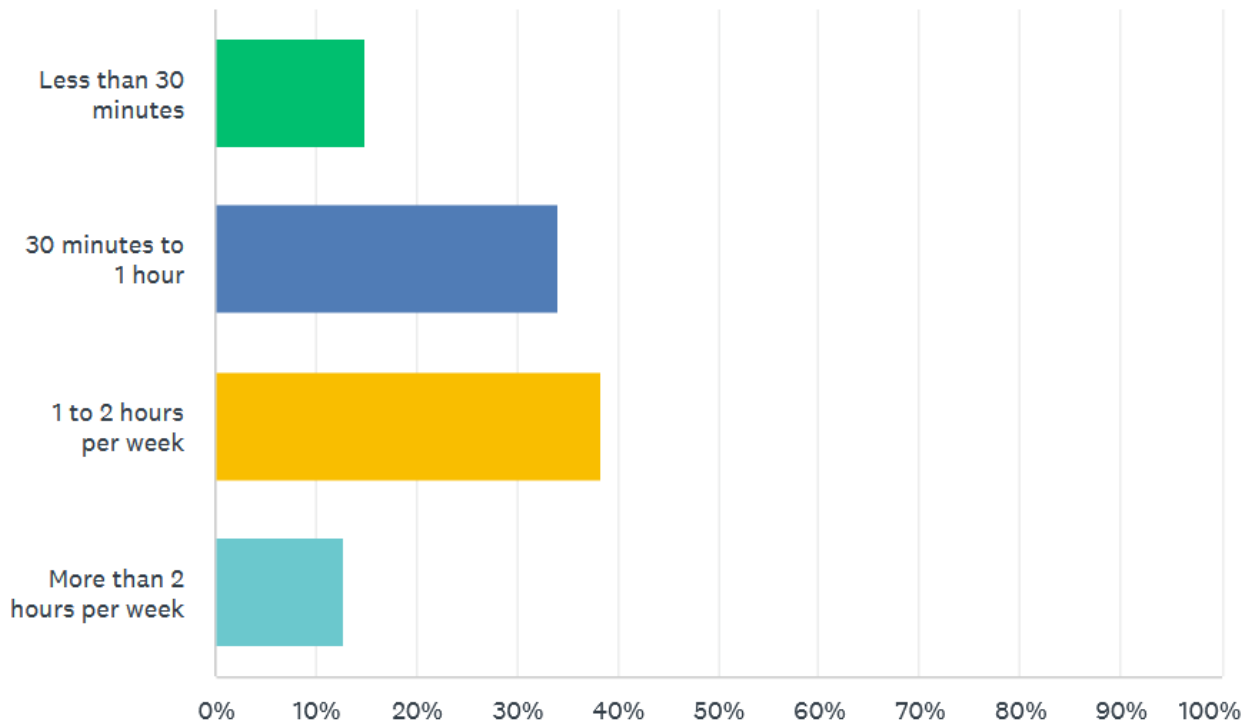


Figure 6. Faculty Responses to Question “On average, how many hours per week do you spend mentoring each undergraduate student in research?”

An important message is that most faculty see the value of having undergraduate students working in their labs. When asked to evaluate the value of involving undergraduates in research (on a scale of 1 - strongly disagree to 5 - strongly agree), an average rating of 4.3 was reported. From faculty’s perspective, the following are the top three metrics of success for an undergraduate researcher:

1. Ability to gather data and analyze/interpret data
2. Understanding the objectives and motivation of the project
3. Publication or presentation

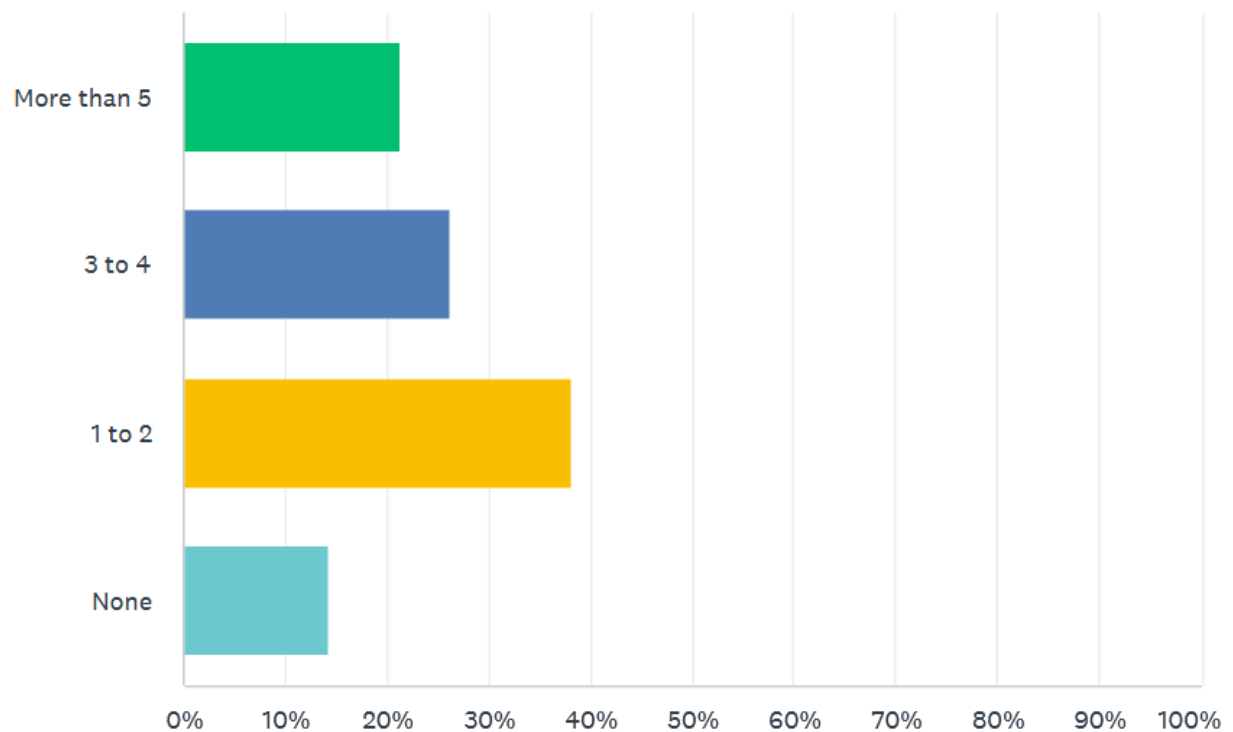


Figure 7. Faculty Responses to Question “In the past five years, how many undergraduates participated with you in co-authoring publications or presentations ”

Faculty responses also mentioned the ability to identify a research question and/or formulate a hypothesis, developing computational models, designing experiments, as well as organization and time management skills.

“When the student sets specific personal goals, achieving these goals may be the most important objective (mastering a particular technical topic, publishing a paper, having fun working on a hands-on project, etc.)” “Time to work. Ability to put in effort.”

When asked the question “What motivates you to work with undergraduate students?” The top three responses received were that faculty wanted to include undergraduates in their research to:

1. Boost their research productivity
2. Identify good candidates for graduate students
3. Impact & educate young engineers

Figure 8 shows faculty’s major concerns about working with undergraduate students. Many mentioned short duration (no deep / prolonged engagement) - 45%, and low rate of return - 16% and lack of research training - 14%. Most responses recorded in “Other concerns” mentioned time commitment, and not enough time to train/mentor them correctly.

“Lack of commitment (of time and efforts)”

“Avoiding overburdening the graduate student mentors of undergraduate researchers”

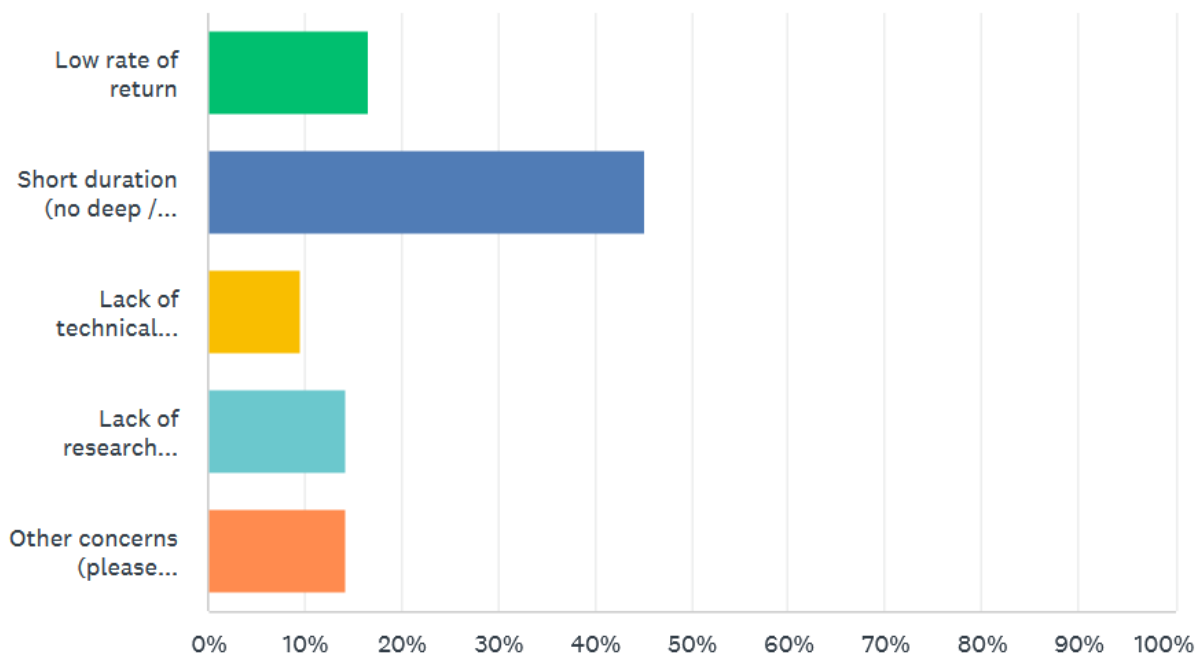


Figure 8. Faculty Responses to Question “What is your biggest concern about working with undergraduate students?”

Faculty and Mentor Development

Faculty are the key for an engaged and inspiring research experience for students. The National Academies Report on Undergraduate Research identifies the need to professionally develop all who mentor undergraduates in research [15]. It further recommends that colleges and universities should network and share resources to foster a cultural change in undergraduate research programs. In order to shape an entrepreneurial mindset (EM) in student researchers. Faculty need to employ EM themselves in order to serve as role models and pass the mindset on to students.

Through faculty/mentor workshops, it is hoped to bring faculty together to brainstorm ideas and share best practices. The project also aims to develop tools to support faculty in EM-based research mentoring. These resources will help faculty better engage and inspire students especially undergraduates in research activities, help them see the connection to a bigger world, recognize interdisciplinary opportunities, and encourage entrepreneurially minded thinking. This is a win-win situation. For the students, it better prepares them for the future, either in graduate school or industry. For the research faculty, they will have very capable lab members that are more productive.

The target groups of faculty for development includes all ranks of research-active faculty including Assistant, Associate and Full Professors in tenure-system and research ranks. The project is to develop and implement two faculty workshops each year at the participating universities. The first faculty workshop has a theme of “Engaging Undergraduate in Your Research - Worth the Effort!” This is a workshop to provide faculty with ideas and tools for

more effective research mentoring, with an emphasis on implementing entrepreneurial mindset skills in research and encourage faculty to better engage undergraduates in their research activities. The workshop will start with a brief introduction of the overall scope of the KEEN project “EM in Research” and key elements of EM. Workshop activities will address ways to implement the 3 C’s in research, emphasizing connections. The workshop will be concluded with some key take-away messages, and attendees will work on a plan to implement EM skills in their research mentoring and submit feedback.

The objectives of Faculty Workshop 1 include:

1. Understand key elements of an entrepreneurial mindset (Curiosity, Connection, Creating Value)
2. Describe several ways to help students see/ make connections during research experience
3. Plan and implement EM-focused strategies in research mentoring

Five activities are planned in this workshop. Depending on the time allowed at each university, activities can be selected and the format can be modified according to the department/college’s culture. More details can be found in the facilitator’s guide (KEEN card link).

Activity 1: Welcome & Ice Breaking Activities

Activity 2: Introduction of EM in Research project

Activity 3: Making the First Connection (20 minutes)

Activity 4: Help Students See Connections, index card-scoring game

Activity 5: Research Mentorship Planning (15 minutes)

The second faculty workshop is more focused on EML in research mentoring. The questions are: 1) How to best engage undergraduates in your research program? and 2) How can undergraduates make meaningful contributions? The questions are designed to encourage discussion on EML, focused on Curiosity and Creating Value. Possible invitees may include faculties of different rank, postdoc fellows and graduate students nominated by faculty which can be adjusted according to the culture/requirements of different universities. Envisioned is that a panel of “experts” will be invited (people local or in the KEEN network) who have been successful in research and have included undergraduates in their research groups. They will share their experience and lead discussion and activities for workshop participants. These faculty workshops can be a part of ongoing KEEN faculty development on any campus. Ideas and input from group discussions and activities are compiled and shared among all participating faculty.

Conclusion

Undergraduates can be a great addition to any research program however, this is an often overlooked resource. There is much evidence that research is beneficial to an undergraduate as it develops many skills and tools necessary to succeed in the workplace or graduate school. The case is made to expose undergraduates to research early in the academic curriculum, preferably as a freshman or sophomore. Students also need to realize the importance of EML to the research process and to understand the three C’s: curiosity, connections, and creating value. Faculty have barriers to involving undergraduates in research, the biggest ones being time involved with

mentoring and the lack of valuing undergraduate mentoring in the tenure process. A collaborative project among five KEEN Partners aims at developing a framework for enhancing the productivity when working with undergraduates. The project desires an understanding of the current status and motivation of undergraduates in research and to develop useful tools and resources that will help faculty members to engage undergraduates in a more effective and efficient way. Two workshops are proposed to address faculty and to get them onboard with the concept of using undergraduates in the laboratory. These workshops will be piloted at the five institutions involved with this project and assessment of the workshops will be accomplished surveying the faculty who attend the workshops. From the assessment the workshops will be improved for future offerings.

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