

The Impact of the COVID-19 Pandemic on Undergraduate Research for Engineering Students and Possible Strategies to Promote Research

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Abstract— The COVID-19 pandemic has affected undergraduate research activities for college students. The purpose of this study is to assess the effect of the pandemic on undergraduate research for engineering students at a teaching-focused university. Data for research grants were obtained before, during, and after the pandemic. The results showed a gradual increase in funding opportunities and awarded grants for faculty members. On the other hand, there was a reduction in the number of undergraduate students involved in these research activities. The study also discussed potential strategies and solutions that enable engineering students at the undergraduate level to conduct research. Most of these strategies focus on gathering and analyzing data without the need for fieldwork, laboratory work, or in-person interactions.

Keywords—Undergraduate research, COVID-19 pandemic, capstone projects, senior projects, undergraduate grants

I. INTRODUCTION

Involving engineering students at the undergraduate level in hands-on research is considered one of the key methods to improving the quality of the learning experience at a university or a college [1, 2]. It can also students promote and encourage students to seek postgraduate degrees in the engineering field. Because many universities had many limitations due to the COVID-19 epidemic, research laboratories have been closed. This situation affected faculty and students productively. It also created significant challenges for students who seek research opportunities to improve their learning experience. In the engineering field, undergraduate students who lack research experience may be less competitive for future careers and graduate degrees. Similarly, engineering faculty are required to conduct research activities to improve their academic careers while adhering to physically remote regulations.

The spread of COVID-19 has had a significant impact on how research with students can be undertaken [3-5]. Participating in undergraduate student research has numerous and well-documented advantages. The more students contribute to research, the more engaged they are in the process. Research enhances student learning, responsibility, and confidence, and eventually transfers to other areas of academic and intellectual performance [6-10]. This study aims to investigate the impact of COVID-19 on undergraduate research activities in engineering using a case study from Utah Valley University (UVU).

II. METHODS

This quantitative study examined secondary data of undergraduate students enrolled in research activities funded by the Office of Engaged Learning (OEL) at Utah Valley University (UVU), addressing the 2018-2021 timeframe. The Institutional Review Board approved the study at UVU, and the requirement for consent was waived on account of the secondary study design.

OEL is responsible for tracking and assessing the impact of high-impact practices (HIPs), including undergraduate research and creative works. For example, OEL requires all faculty who participate in research projects to report the research progress and students' IDs involved in their research as part of the funding process. In addition, OEL works with Institutional Research (IR) Office to gather students' demographics, GPA, enrollment status, and other information to study the impact of HIPs on students' persistence, retention, and success.

III. ANALYSIS

A. Grants Opportunities for Undergraduate Students

Undergraduate students at UVU can be involved in research activities through a variety of grants. One of the main grants offered at UVU is the Grants for Engaged Learning (GEL). This grant funds a variety of engaged learning projects, including but not limited to non-classroom projects, service learning, undergraduate research, learning communities, and inquiry-based learning. These initiatives might be extracurricular, co-curricular, or curricular, and they should promote knowledge application to the communities supported by the institution. The GEL program's goal is to fund projects that benefit the academic or UVU community in a broad and long-term fashion. The goal of the GEL Grant programs is to give these projects start-up funds to collect the required data to verify the possibility of pursuing further long-term financial support.

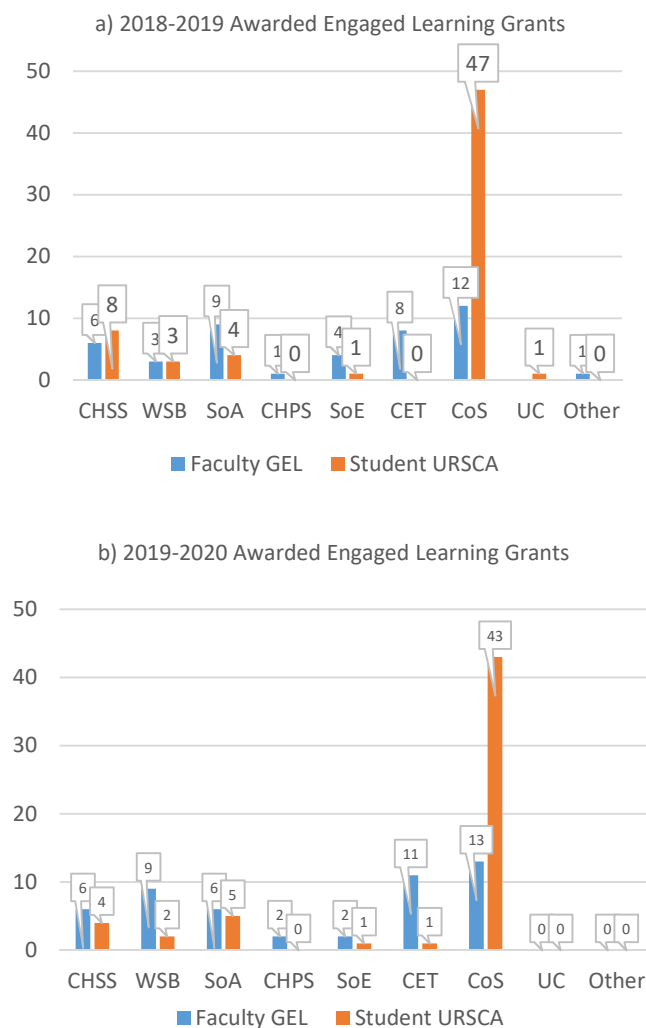
GEL initiatives should be developed to aid in the realization of UVU's two involvement categories. Curricular Engagement refers to the teaching, learning, and scholarship that brings together staff, students, and the community in mutually beneficial and respectful cooperation. Their interactions meet specific community needs, deepen students' civic and academic learning, and strengthen community. Outreach and collaboration are two distinct but connected approaches to community participation. The first focuses on

the use and provision of institutional resources for community usage, with advantages to both the university and the community. The latter focuses on collaborative engagement with the community and associated scholarship for mutually beneficial knowledge, information, and resource exchange, discovery, and application (research, capacity building, economic development, etc.).

The Undergraduate Research Scholarly and Creative Activities Scholarship (URSCA) is another undergraduate grant available at UVU. Upper-division students collaborate with faculty mentors to perform extensive research or creative work in their chosen field of study. This initiative gives funds to help these projects be completed. Students are only eligible for one URSCA Research grant per academic year. Travel, materials, or student hourly salaries are all possible uses for awards. The Scholarly and Creative Activities Council will pick winners after reviewing proposals.

B. Grants Before and During the Pandemic

As shown in Fig. 1, the data collected showed a steady increase in engineering grants. In the 2018-2019 academic year, eight GEL grants and no URSCA grants were awarded. These numbers increase to GEL grants and one URSCA grant during the 2019-2020 academic year. In the 2020-2021 academic year, these numbers increase to 12 GEL grants and three URSCA grants.



c) 2020-2021 Awarded Engaged Learning Grants

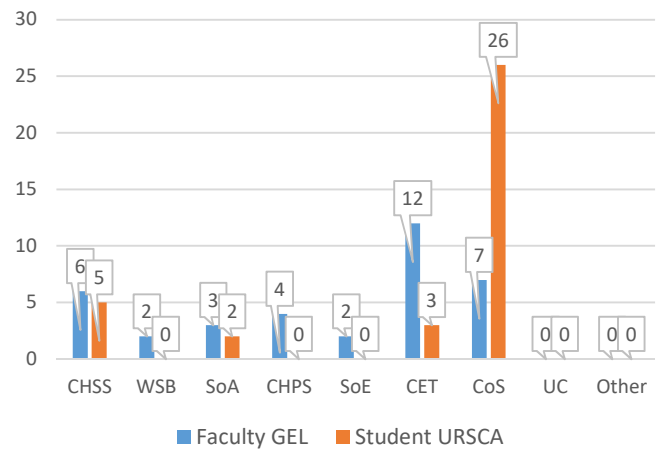


Fig. 1 Grants by academic year

C. Undergraduate Grants

Three academic years, 2018-2019, 2019-2020, and 2020-2021 served as the data source for the research activities. A total of 919 students at UVU participated in research activities funded by the OEL office during this period, as shown in Fig. 2.

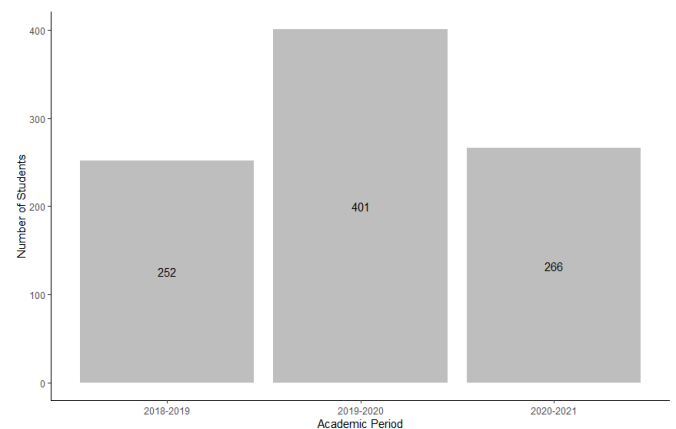


Fig. 2 Enrollment by academic year

More than half of the students, 490 (53.3%), were males, and 706 (76.8%) were White. In addition, 592 students were in the upper level, of which (64.4%) students were seniors, and 194 (21.1%) were juniors. Table 1 shows the descriptive statistics by academic year.

Table 1. Descriptive statistics of all students who participated in research

		2018-2019		2019-2020		2020-2021	
		N	%	N	%	N	%
Gender	Female	108	42.9	187	46.6	134	50.4
	Male	144	57.1	214	53.4	132	49.6
Race	White	197	78.2	306	76.3	203	76.3
	Non-White	55	21.8	95	23.7	63	23.7
Student Level	Freshman	14	5.6	43	10.7	6	2.3
	Sophomore	18	7.1	41	10.2	11	4.1
	Junior	70	27.8	78	19.5	46	17.3
	Senior	150	59.5	239	59.6	203	76.3
College	Engineering	38	15.1	189	47.1	107	40.2
	Other	214	84.9	212	52.9	159	59.8
Total		252		401		266	

In the last three years, the OEL office increased the number of URCW funded projects for faculty and students through internal and external grants. In addition, OEL conducted many workshops, marketing campaigns, and announcements that targeted faculty and students to provide information about the grants and opportunities available and the submission process. Table 1 indicates that the number of students participating in URCW has increased between 2018-2019 and 2019-2020 by 59.1%. In addition, the participation of female, Non-White, and senior students indicated a significant increase during this period by 73.1%, 72.7%, and 59.3%, respectively. However, the COVID-19 pandemic negatively impacted URCW activities during the Academic year 2020-2021, and the participation decreased by 33.6%. Shifting from face-to-face to online teaching, limited access to university labs, and difficulties in hiring students during the period were the main reasons for this decline.

D. Engineering Students Sample

Out of all students involved in research at UVU, 334 (36.3%) students from the College of Engineering and Technology participated in research activities during the period from 2018 to 2021 (Fig. 3). Out of the 334 students, 218 (65.2%), were males, and 236 (70.6%) were white. In addition, 199 (59.5%) students were seniors, and 67 (20%) were Juniors.

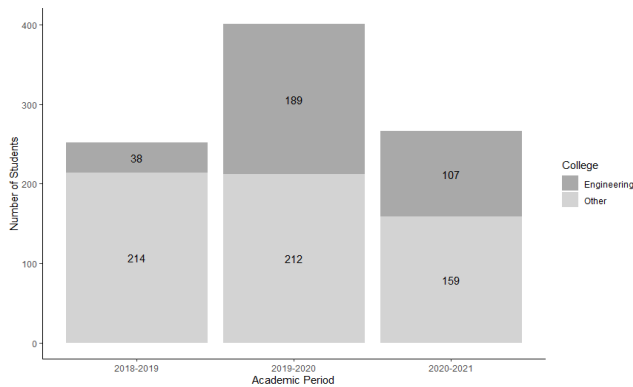


Fig. 3 College of Engineering versus other colleges research enrollment

Table 2 shows that the number of Engineering students who participated in URCW has increased between 2018-2019 and 2019-2020 by 397.4%. In addition, the participation of female, Non-White, and senior students indicated a significant increase during this period by 100%, 256.3%, and 684.6%, respectively. However, as mentioned before, the COVID-19 pandemic negatively impacted engineering students' participation in URCW during the academic year 2020-2021, and the participation decreased by 43.4%.

Table 2. Descriptive statistics of engineering students who participated in research

		2018-2019		2019-2020		2020-2021	
		N	%	N	%	N	%
Gender	Female	0	0	75	39.7	41	38.3
	Male	38	100	114	60.3	66	61.7
Race	White	22	57.8	132	69.8	82	76.6
	Non-White	16	42.2	57	30.2	25	23.4
Student Level	Freshman	9	23.7	20	10.6	5	4.7
	Sophomore	7	18.4	22	11.6	5	4.7
	Junior	9	23.7	45	23.8	13	12.1
	Senior	13	34.2	102	54	84	78.5

IV. STRATEGIES TO INCREASE RESEARCH ACTIVITIES

Due to the COVID-19 epidemic, there is a need to identify tools to provide a list of strategies for undergraduate students, to move student research forward.

A. Conducting Literature Review

Undergraduate Students might expand on their literature searches by performing a systematic review and meta-analysis. This allows for a more focused question to be asked without the necessity for laboratory data gathering, resulting in fresh higher-level evidence. Undergraduate students can also work on developing literature reviews for a specific topic. This work can be formulated in a paper that can be submitted to a conference or a journal.

B. Applying Different Methodologies

For undergraduate students working on projects, it is not necessary to use novel methodologies in every project. The emphasis should be changed to apply different methodologies to existing data. This type of publication could provide students with valuable training in the creation of replicable procedures and conceptual graphics.

C. Analyzing Existing Data

Students can go back and ask follow-up questions about prior experiments, such as how gender and/or age affect physiology. Such queries would allow for the testing of new hypotheses and the use of existing data as preliminary data. Furthermore, research on sex as a biological process is being conducted.

D. Using Computer simulation and Statistical Methods

Students could statistical software to describe and predict engineering data. Statistical modeling can be accomplished using software that is available at any university such as Excel or SPSS. Another great tool is the use of simulation software to conduct different projects that require testing different scenarios. In these cases, students will need the assistance of a faculty mentor with expertise in the use of these tools.

E. Using Online Data

Students could access online databases to find data that can be used to answer a research question. There are different open-access resources available publicly to provide data sets access from different countries around the world.

F. Using Surveys and Questionnaires

Some research activities could be conducted with limited contact through noninvasive methods such as surveys and questionnaires. In this case, the students need to coordinate with the faculty member to obtain approvals or exemptions from their Institutional Review Board as applicable.

G. Writing Grant Proposals

Students could be involved in proposal writing for grants and preparing their applications, especially since many engineering universities have specific grants allocated for undergraduate students. This can provide undergraduate students with funds to work on their projects and also provides great training for them if they plan to pursue graduate studies.

H. Participating and Attending Virtual Conference

Students should aim to attend and present the outcomes of their work at conferences especially if they are offered online.

I. Aligning Scholarly Activities Related to COVID-19

Students could align their research work to address issues related to COVID-19 and how it affected different engineering areas. For example, studying the impact of the pandemic on public transportation usage, traffic safety on roads, etc.

V. CONCLUSION

The COVID-19 pandemic negatively impacted engineering students' participation in research activities. Faculty and students need to identify ways to conduct research experiences during the COVID-19 pandemic. This study provides a useful starting point for discussing the impact of the COVID-19 pandemic on undergraduate research and developing a plan for how to proceed with undergraduate and graduate student projects. However, promoting undergraduate research through different successful venues such as providing seminars, implementing practical teaching, revising tenure and promotion policies, and developing websites that show available research opportunities [11-15].

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