EMBRY-RIDDLE
Aeronautical University™
SCHOLARLY COMMONS

Publications

6-26-2022

Building Undergraduate Research in a Fully Online Engineering Program

Robert Deters
Embry-Riddle Aeronautical University, DETERSR1@erau.edu

Brent Terwilliger
Embry-Riddle Aeronautical University, brent.terwilliger@erau.edu

Emily Faulconer
Embry-Riddle Aeronautical University, faulcone@erau.edu

Kelly A. George
Embry-Riddle Aeronautical University - Worldwide, georged8@erau.edu

Follow this and additional works at: https://commons.erau.edu/publication

Part of the Higher Education Commons, Online and Distance Education Commons, and the Science and Mathematics Education Commons

Scholarly Commons Citation

Building Undergraduate Research in a Fully Online Engineering Program

Robert Deters (Associate Professor)

Robert Deters is an Associate Professor with the Department of Engineering and Technology at Embry-Riddle Aeronautical University – Worldwide. He is the Program Coordinator for the Bachelor of Science in Engineering Technology. His research interests include online engineering education; wind tunnel testing of airfoils, propellers, and propeller-wing configurations; design of testing configurations for thrust performance of propellers and UAVs; and measuring propeller aeroacoustics. Dr. Deters is the technical lead for the Real World Design Challenge, an international high school STEM design competition in aeronautical engineering. He received a Ph.D. and M.S. in Aerospace Engineering from the University of Illinois at Urbana-Champaign, and a B.S. in Aerospace Engineering and Mechanical Engineering from West Virginia University.

Brent Terwilliger

Brent A. Terwilliger Ph.D. is an Associate Professor and the Program Coordinator of the Master of Science in Unmanned Systems (MSUS) at the Embry-Riddle Aeronautical University (ERAU), Worldwide campus, College of Aeronautics. Dr. Terwilliger earned a Ph.D. in Business Administration in Aviation from Northcentral University (2012), as well as a Master's of Aeronautical Science (2005) and B.S. in Aerospace Studies (2000) from ERAU. He has more than 10 years of experience in defense contracting, supporting several federal-level customers, including the U.S. Postal Service for automated sortation technologies and the U.S. Air Force, Army, and Navy on a wide variety of simulation and training programs. As a tenured faculty member at ERAU, Dr. Terwilliger has authored more than 25 peer-reviewed publications, presented research findings at international venues, and provided unmanned systems expertise across a variety of televised, print, and digital media. He currently serves as a board member of the Association for Unmanned Vehicle Systems International (AUVSI) Florida Peninsula Chapter, a member of the National Business Aviation Association (NBAA)'s Emerging Technologies committee, and a reviewer for ERAU's Faculty Innovative Research in Science and Technology program.

Emily Faulconer

Dr. Emily Faulconer is Associate Professor within the Math, Sciences, & Technology Department at Embry-Riddle Aeronautical University – Worldwide Campus. She earned a Ph.D. in Environmental Engineering Sciences from the University of Florida in 2012. Her research interests are within the Scholarship of Teaching and Learning, primarily in undergraduate research and online education. Safety is also an area of interest, and she serves as a founding member of the Academic Safety Committee for Embry-Riddle Aeronautical University. She is also actively involved in national level service through the National Science Teachers Association (NSTA), serving on the advisory board for the Journal of College Science Teaching.

Kelly A George (Professor)

Kelly Whealan George is an Associate Professor with the Department of Graduate Studies at Embry-Riddle Aeronautical University – Worldwide. She is the Graduate Curriculum Chair for all Graduate Programs in the College of Aeronautics. His research interests include online education, aviation and aerospace economics, aviation sustainability and impact studies. Dr. Whealan George is the lead Accreditation Faculty for regional and program accreditations. He received a Ph.D. in Aviation from Embry-Riddle Aeronautical University, an M.A. in Economics and a B.B.A. in Finance from Southern Methodist University.

Building Undergraduate Research in a Fully Online Engineering Program

Abstract

This paper describes the creation and implementation of the support network of the Research Scholars Program at the Worldwide campus of Embry-Riddle Aeronautical University. Funded by an NSF IUSE grant, the purpose of this new program is to increase the opportunity for online engineering and engineering technology students to participate in undergraduate research. Studies have shown that participation in research can have an important impact on students, though online students are likely underrepresented in undergraduate research. The Research Scholars Program uses existing support systems of the campus while also building new components. These new components developed for this project are a research mentoring program, a workshop series, and a guided independent study course. The Research Scholars Program formalizes the process for online students at the Worldwide campus to participate in undergraduate research with a goal of having students publish and present their work.

Introduction

Research indicates that due to access limitations, distance students are likely underrepresented in undergraduate research, a high impact practice that offers disciplinary learning gains [1], [2]. For online students, persistence and retention has been a noted issue [3]. Additionally, certain demographics have shown reduced persistence with engineering education [4], [5]. However, participation in undergraduate research is impactful for minority students [6], [7], [8], [9]. Online students, though, have shown similar interests in participating in undergraduate research as their residential student counterparts [10]. In addition, online faculty have a comparable level of interest in mentoring undergraduate research as residential faculty [11].

In order to take advantage of the potential impact that undergraduate research may have on online students, the authors have implemented the Research Scholars Program at the Worldwide campus of Embry-Riddle Aeronautical University (ERAU). The purpose of the Research Scholars Program is to formalize the process in which online undergraduate students at Worldwide can participate in research and to reduce barriers. Recruitment into the program has focused on engineering technology and engineering students in order to measure its impact on these students. However, the program is open to all undergraduates especially those in other STEM majors. Students who complete the Research Scholars Program are recognized with a certificate and a pin to be worn with graduation regalia. The important first step in implementing the program was to

Figure 1: Support network components of the Research Scholars Program.

develop an extensive support network for students that covers mentoring, workshops, and a guided independent study course. This paper summarizes the creation and implementation of the support network and provides two examples of student research projects.

Support Network

Promoting undergraduate research is important to ERAU and is included as part of the strategic initiatives of the university. Both residential campuses (Daytona Beach and Prescott) have a dedicated office for undergraduate research, and each campus hosts a Discovery Day where undergraduates may present their research (Worldwide students are invited to participate at Daytona Beach's). The university also has the opportunity for undergraduates to publish their research through the peer-reviewed *Beyond: Undergraduate Research Journal.* In support of undergraduate research, the university developed the following six student learning outcomes (SLOs), relative to undergraduate research:

1. Define and/or articulate a research problem

2. Design a course of action to solve a research problem using as appropriate, multidisciplinary approaches

3. Apply ethical principles in research

4. Conduct research independently and/or collaboratively

5. Research decisions or conclusions based on the analysis and synthesis of evidence

6. Communicate research results

As part of this project at the Worldwide campus, these SLOs were used to structure the support network of the Research Scholars Program (Fig. 1): mentoring, workshops, and the independent study course.

The support network discussed below was designed to be complementary to other resources already available to students at the Worldwide campus. These resources include writing guidance and editorial support through the Virtual Environment for Communication: Teaching, Outreach,

and Research (VECTOR) online writing lab [12] and online digital materials and research guides available through the university's Hunt Library [13], [14].

Mentoring

The first step for students who join the Research Scholars Program is to sign up for research mentoring. The College of Arts and Sciences at Worldwide already has the Center of Mentorship Programs & Student Success (COMPASS), so research mentoring was added. Faculty with a strong background in research act as research mentors and guide students along any point in the research process, from conception to publication. When faculty first join COMPASS, they complete a professional development course to ensure consistent preparation as a research mentor. The partnership between student and research mentor is designed to be long term, with durations typically around an academic year. Research mentors provide advice and information about the research process and do not need to be familiar with the specific research area or project the student will work on. For their research project, the undergraduate student will work closely with a research supervisor, where more information is provided later in the paper. Currently there are 13 undergraduate students active in the research mentorship program divided among four research mentors.

Workshops

As part of the Research Scholars Program, the following workshops were developed to introduce students to different aspects of research:

1. Formulating Your Research Vision

2. Submission & Review Process

3. Getting Your Paper Noticed

4. Academic vs. Industry Research

5. Research Next Steps: Building into Grad School and/or Entrepreneurship

6. Promoting Undergraduate Research on Your Resume

The first workshop is aimed towards students just starting on their research journey while most of the other workshops are aimed at showing students how they can use their research experience to advance their academic and professional careers. The workshops are organized and hosted by the authors with guest speakers invited to share their expertise. These workshops are open to all students to attend, and recordings are made so they can be viewed later. The recordings are stored on a dedicated Research Scholars Program course hosted on Worldwide's learning management system. Each workshop has an open discussion area for students to ask questions about the workshop topics at any time. A series of follow up workshops covering additional research-related concepts, processes, and materials (e.g., faculty-led topics, undergraduate experience narratives, proposal development, non-traditional publication, conference overview, and poster presentation preparation) are in development.

Independent Study

The final aspect of the support network is a guided independent research course (RSCH 395) for
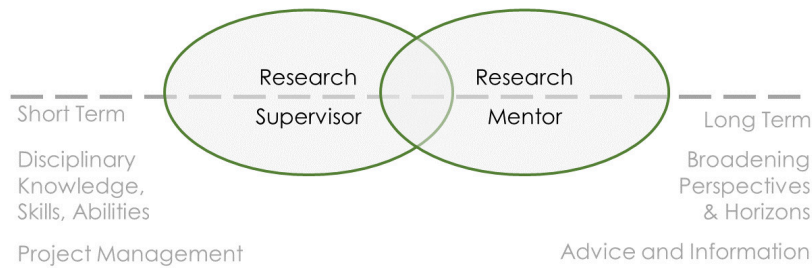
Figure 2: Distinction between research mentor and research supervisor.

the students. The purpose of the course is for students to earn academic credit towards their degree program by finishing their research project and preparing a draft manuscript of their findings. Prior to taking RSCH 395, students will already have been working on their research project under a research supervisor. A research supervisor is a faculty member who has expertise in the research area of the project. The role of a research supervisor is different than that of the research mentor (Fig. 2). The mentor provides guidance about all aspects of the research process and works with the student throughout their whole research journey. The supervisor works directly with the student on their research project, oversees the student's progress, and helps with project management. For many of the research projects, the student is working on a project that is part of a larger research project from the supervisor. Part of the research mentor's responsibilities is to help match students with a research supervisor.

When a student is ready to take RSCH 395, their research supervisor will be their instructor. The course is held during one of Worldwide's 9-week terms and is divided into three modules.

Module 1 (2 weeks)

- Project management plan
- Literature review

Module 2 (5 weeks)

- Data analysis
- Writing

Module 3 (2 weeks)

- Draft manuscript
- Dissemination plan

During the first module, the student finishes their preparation with a project management plan and final literature review. The second module is for the student to finish their data analysis and start writing. In the third module, the student finishes the draft manuscript and creates a plan for dissemination. Throughout the course, the student is also asked to reflect on different aspects of the research process and discuss with the research supervisor. The final product of the course is a

draft manuscript that can be used to disseminate the results of student's research. The course provides deadlines and structure to help ensure that the student reaches the goal of a manuscript.

Student Research Projects

The goal of the Research Scholars Program is to increase the number of undergraduates active in research at the Worldwide campus, especially the engineering technology and engineering students. For the projects that the students will complete, there are two main models for topic development: student conceptualized or faculty led. A hybrid with elements of the two models is also possible. With the student-conceptualized model, students interested in performing research may come into the Research Scholars Program with a research project already in mind. The student will work with their research mentor to find a faculty member who has similar interests and expertise in that research area. The student will then work with this faculty member (research supervisor) to refine the student's concept into a defined research project.

However, it is understandable that students new to research may not have a topic in mind or know how research can be done in an online environment. In this case, students may be a better fit with a faculty-led project. Many faculty at Worldwide have current research projects that are looking for student helpers or have project ideas. These faculty projects are shared with students during recruitment to the scholars program and are shared with mentors to aid with student-supervisor matching. Some of the faculty research project ideas shared with students include evaluation of mentorship, evaluation of safety culture in higher education, propulsion sizing of small unmanned aircraft systems (sUAS), analysis of flight profiles of sUAS, and evaluating commercial off-the-shelf sUAS modeling and simulation tools.

At the time of writing, the scholars program has four students active in research projects and an additional two students being matched with research supervisors. Two of the active research projects are provided as examples. In the first example, two student researchers joined a faculty-led research project. The second provides an example of a hybrid case, where the student originally joined a faculty-led project that evolved into another idea that was independent of the original project.

Project 1

The project for this example is a continuation of research from two faculty. The purpose of this project is to understand the reasons behind why students withdraw from asynchronous online STEM courses. The literature has noted that the drop and withdrawal rates for online courses is greater than that of traditional courses [15], [16], [17], [18], [19]. Knowing the reasons behind withdrawing may lead to possible interventions aimed at course persistence and degree retention. Two important research questions focus on answering what categories (learning characteristics, external factors, internal factors, or student expectations) predominate the withdrawal reasons and whether there is a difference between general education versus degree support online STEM courses.

The role of one of the undergraduate researchers is primarily on data curation and analysis. This student is working closely with one of the faculty members on the statistical analysis of the data.

The second undergraduate researcher is working with the other faculty member on preparing the data visualization, discussion, and possible conclusions. Both students are also helping with the writing of their respective sections of a manuscript for publication and presentation.

Project 2

For this second example, the project originated as a continuation of faculty-led research, but circumstances provided an opportunity for the project to change to a more student-conceptualized project. The ongoing research from the faculty is a systematic examination of career development and employment opportunities within the unmanned systems field [20]. The student joined the project with the goal of improving the project data collection mechanisms.

In their role of setting up preliminary routines and processes to improve data collection, the student observed novel limitations and challenges associated with online data capture. As the data gathering limitations continued over several weeks, the student began to casually investigate why such challenges persisted. Discussions with the faculty member led to the student moving away from improving data collection to studying the challenges of online data gathering. Specifically, the student is working toward identifying an ethical framework for the implementation of online data gathering tools, such as web scraping.

Summary

At Embry-Riddle Aeronautical University - Worldwide, the Research Scholars Program has been implemented to increase the number of online undergraduate students active in research. A major component of this program is a support network that formalizes the process for students to participate in undergraduate research, with the end goal of students disseminating their work. In addition to incorporating existing university resources (e.g., VECTOR online writing lab and library research guides), the Research Scholars Program has developed a research mentoring program, a series of workshops covering different aspects of research, and a structured independent study course. To date, 13 students are actively engaged in research mentoring and four students are currently working on research projects. While the initial intent of the project to focus on online undergraduate engineering students has presented a recruitment challenge, the inclusion of students from multidisciplinary, technical degrees has helped with buildout of the framework. Ultimately, the availability of the Research Scholars program to this wider population can provide further guidance, encouragement, and motivation to support their academic development. The observations and insight garnered from student research development within such a framework can help to inform future efforts and investment.

Acknowledgments

References

[1] G. D. Kuh, *High-Impact Education Practices: What they are, Who has Access to them, and Why they Matter*. Washington, DC: Association of American Colleges and Universities, 2008.

[2] D. Lopatto, "Undergraduate research as a high-impact student experience," *Peer Review*, vol. 12, no. 2, 2010.

[3] P. Bawa, "Retention in online course: Exploring issues and solutions — a literature review," *Sage Open*, vol. 6, no. 1, 2016.

[4] R. Roach, "Under construction: Building the engineering pipeline," *Diverse: Issues in Higher Education*, vol. 23, no. 2, pp. 24–27, 2006.

[5] M. W. Ohland, C. E. Brawner, M. M. Camacho, R. A. Layton, R. A. Long, S. M. Lord, and M. H. Wasburn, "Race, gender, and measures of success in engineering education," *Journal of Engineering Education*, vol. 100, no. 2, 2011.

[6] G. Bangera and S. E. Brownell, "Course-based undergraduate research experiences can make scientific research more inclusive," *CBE—Life Sciences Education*, vol. 13, no. 4, pp. 602–606, 2014.

[7] M. Estrada, M. Burnett, A. G. Campbell, P. B. Campbell, W. F. Denetclaw, S. Gutierrez, S. Hurado, G. H. John, J. Matsui, R. McGee, C. M. Okpodu, T. J. Robinson, M. F. Summers, M. Werner-Washburne, and M. Zavala, "Improving underrepresented minority student persistence in stem," *CBE—Life Sciences Education*, vol. 15, no. 3, p. es5, 2017.

[8] M. T. Jones, A. E. Barlow, and M. Villarejo, "Importance of undergraduate research for minority persistence and achievement in biology," *Journal of Higher Education*, vol. 81, no. 1, pp. 82–115, 2010.

[9] K. N. Simmons, "High-impact education practices: What they are, who has access to them, and why they matter," Ph.D. dissertation, The University of New Mexico, Albuquerque, NM, July 2018.

[10] E. K. Faulconer, J. C. Griffith, Z. Dixon, and D. Roberts, "Comparing online and traditional student engagement and perceptions on undergraduate research," *Scholarship and Practice of Undergraduate Research*, vol. 3, no. 3, pp. 48–59, 2020.

[11] E. K. Faulconer, Z. Dixon, J. Griffith, and L. Faulconer, "Perspectives on undergraduate research mentorship: A comparative analysis between online and traditional faculty," *Online Journal of Distance Learning Administration*, vol. 23, no. 2, 2020.

[12] Embry-Riddle Aeronautical University, "Virtual environment for communication: Teaching, outreach, and research (vector)," https://worldwide.erau.edu/colleges/arts-sciences/vector, accessed: 2022-02-07.

[13] Embry-Riddle Aeronautical University, "Hunt library," https://huntlibrary.erau.edu, accessed: 2022-02-07.

[14] Embry-Riddle Aeronautical University, "Research guides," https://guides.erau.edu, accessed: 2022-02-07.

[15] T. W. Atchley, G. Wingenbach, and C. Akers, "Comparison of course completion and student performance through online and traditional courses," *The International Review of Research in Open and Distributed Learning*, vol. 14, no. 4, 2013.

[16] S. S. Jaggars, N. Edgecombe, and G. W. Stacey, *Creating an effective online instructor presence.* New York, NY: Columbia University: Community College Research Center., 2013.

[17] C. A. Murphy and J. C. Stewart, "On-campus students taking online courses: Factors associated with unsuccessful course completion," *The Internet and Higher Education*, vol. 34, pp. 1–9, 2017.

[18] R. R. Paden, "A comparison of student achievement and retention in an introductory math course delivered online, face to face, and blended modalities," Ph.D. dissertation, Capella University, November 2006.

[19] G. Smith and D. Ferguson, "Student attrition in mathematics e-learning," *Australasian Journal of Educational Technology*, vol. 21, no. 3, pp. 323–334, 2005.

[20] B. Terwilliger, "Unmanned systems career opportunities," https://worldwide.erau.edu/colleges/aeronautics/department-aeronautics-graduate-studies/unmanned-systems-career-opportunities, accessed: 2022-02-07.