**Exploring the Efficacy of Virtual Research Mentorship for Online Undergraduate Projects**

Emily Faulconer1, Brent Terwilliger2\*, Darryl Chamberlain2, Robert Deters2, & Cheryl Kam

1Monash University

2Embry-Riddle Aeronautical University-Worldwide

\*Corresponding Author

Abstract

Virtual undergraduate research mentorship is gaining traction, offering key support for student participation in high-impact research. However, limited research exists on its effectiveness. This study features an examination of faculty mentorship in online undergraduate research using the validated Mentoring Competency Assessment. While mentors rated themselves highly, mentees rated them even higher, suggesting effective virtual mentoring in combination with potential mentor self-confidence issues. These findings support virtual mentorship’s value and highlight areas for targeted professional development.

***Keywords:*** virtual mentorship, undergraduate research, mentor competencies

**Exploring the Efficacy of Virtual Research Mentorship for Online Undergraduate Projects**

Undergraduate research is a high-impact practice, defined by the Council on Undergraduate Research (CUR) as “a mentored investigation or creative inquiry conducted by undergraduates that seeks to make a scholarly or artistic contribution to knowledge” (Undergraduate Research Definition Task Force, n.d., para. 1). Mentorship is central to this experience, benefiting both students by improving research persistence (Cooper et al., 2019) and self-efficacy (Estrada et al., 2018; Sams et al., 2015) and faculty, who gain research assistance, mentoring skills, and student feedback (Faulconer et al., 2020a; King & Imai, 2022). However, mentoring presents challenges, including personal, student-centered, and institutional barriers (Faulconer et al., 2020a; King & Imai, 2022). Undergraduate curricula may lack research integration (Adebisi, 2022), and adjunct faculty, often students’ closest content experts, may have limited research experience. A central motivation to this research is to better understand how mentors evaluate their own competencies and how mentees perceive their guidance within a fully online, globally dispersed undergraduate research mentorship program. In this model, research mentors and supervisors fulfill distinct roles. The investigation seeks to answer: 1) *Do mentors self-perceive strong competencies across all six mentoring domains?*; 2) *Do mentees perceive strong competencies in their mentors?*; and 3) *Is there strong alignment between mentor self-assessments and mentee evaluations?*

**Literature Review**

Research often conflates the roles of a research mentor and supervisor, despite their distinct functions. While both share responsibilities, mentorship emphasizes long-term professional growth, guiding students from research curiosity to engagement, while supervision provides disciplinary expertise for project execution. The National Research Mentoring Network defines mentoring as a structured, evolving relationship focused on career progression (NRMN, n.d.), yet there remains a need for clearer definitions, role delineation, and relationship context (Pfund, 2016). Addressing faculty barriers to undergraduate research support could involve separating mentorship from supervision. Mentors would foster skill development, self-reflection, and career readiness, while supervisors focus on project-specific expertise. Virtual research mentorship is gaining attention, with models like mentor constellations and cohort mentoring showing promise (Hall et al., 2021; Johnson & Knox, 2022). Benefits include improved research understanding, employability, and inclusivity, especially for underrepresented groups (Faulconer et al., 2024; Knox et al., 2023), though direct comparisons between virtual and in-person mentoring remain scarce.

Studies highlight discrepancies between mentor and mentee perspectives on research skills and feedback. Mentees often underestimate their abilities, and mentors may lack sufficient interaction to assess skills accurately (Lev et al., 2010; Feldon et al., 2015). Differences in mentoring expectations also influence how feedback is received and applied (Korver & Tillema, 2014). Formal mentor training is critical, but underutilized, with only seven-percent reporting significant training (Stolzenberg et al., 2019). Effective in-person and online training can enhance cultural competence and mentoring effectiveness (Byars-Winston et al., 2020). Efforts to assess mentoring effectiveness have led to tools such as the Mentor Evaluation Tool (Yukawa et al., 2020) and the Mentoring Competency Assessment (Fleming et al., 2013), which aligns mentor and mentee perspectives. Notably, studies reveal gender disparities, with male mentors rating their skills higher than female mentees do, particularly in fostering independence and professional development (Orsini et al., 2019). Addressing these gaps through improved metrics and training can enhance mentoring relationships and research outcomes.

**Methods**

This study employed a structured methodology, detailing contextual roles, the mentoring program, materials, participant procedures, and the data analysis plan to ensure rigor and coherence. At the subject institution, research mentors and supervisors have distinct roles. Mentors provide long-term guidance, supporting students from initial research interest to project completion through psychosocial, role-modeling, and career functions (Abedin et al., 2012; Pfund, 2016; Thiry & Laursen, 2011). They meet regularly with mentees, often remotely, and coordinate with institutional mentoring programs. Supervisors, typically subject matter experts, focus on short-term project management, methodology, and data analysis, ensuring research completion. Coaching may fall under either role, with mentors emphasizing broader research concepts, such as funding and professional development. The voluntary research mentoring program matches students with mentors based on academic discipline and goals. Mentors, typically support 4–8 students, complete online training, and develop a mentoring philosophy. Participants come from diverse STEM fields, including physical sciences, digital humanities, and mathematics.

The Mentoring Competency Assessment (MCA), a validated tool with six subscales (communication, expectations, understanding, independence, diversity, and professional development) was used to evaluate mentor competencies (Fleming et al., 2013; Hyun et al., 2022). A 21-item survey utilized a 7-point Likert scale, with mentors self-assessing skills and mentees rating their mentors. Demographic data were also collected. Following Institutional Review Board approval (#23-103), participants were recruited via email and completed surveys through Qualtrics. The study included 29 respondents (23 mentees, six mentors), with an analyzed sample of eight (six mentees, two mentors). Response rates aligned with prior studies (Orsini et al., 2019; Wisker et al., 2022). Data Analysis focused on mentoring competency using t-tests to compare mentor and mentee ratings across six domains. Mentees were divided into Mentor Groups A and B, with Group C excluded due to mentor non-participation. Despite the small sample size (n=8), analysis provided preliminary insights to guide future research. Ratings of 6+ indicated strong competency, with the null hypothesis assuming an average rating of 6. Rejection of the null hypothesis confirmed perceived strong skills.

**Results**

This work represents an assessment of mentor and mentee competency perceptions, testing the null hypothesis that their average ratings were equal. Alignment was confirmed, if the null hypothesis was not rejected. Mentor self-assessments across six competencies showed no significant differences between Groups A and B, allowing their ratings to be combined. Mentors rated themselves as strong (mean ≥6) in *Aligning Expectations* (6.63, p ≤ 0.05) and in three competencies at the 0.10 level: *Aligning Expectations, Assessing Understanding* (6.33), and *Fostering Independence* (6.50). Mentees rated their mentors across the same competencies, with scores ranging from 6.44 (*Fostering Independence*, Group A) to 7.00 (*Addressing Diversity*, Groups A & B). No significant differences between mentee groups allowed for their ratings to be combined, leading to the null hypothesis being rejected at both significance levels; the result indicates mentees consistently viewed their mentors as highly skilled. Comparing mentor self-ratings to mentee evaluations, Group A showed alignment in four competencies, while Group B aligned in one (*Aligning Expectations*). In all cases of misalignment, mentees rated their mentors higher than the mentors rated themselves, suggesting mentors either concurred with mentee perceptions or underestimated their own competencies.

**Discussion**

The analysis of mentor and mentee perceptions identified areas of alignment and discrepancy in mentoring competencies. Mentors rated themselves highly in *Aligning Expectations, Assessing Understanding*, and *Fostering Independence* at the 0.10 significance level, with *Addressing Diversity* and *Promoting Professional Development* averaging 6 or higher. *Effective Communication* had the lowest average (5.75), yet mentees consistently rated their mentors higher across all competencies. While Mentor A’s ratings aligned with mentees in four areas, Mentor B aligned in only one, suggesting differences in self-perception rather than skill deficits. *Effective communication* is crucial in mentoring (Bennett et al., 2022; VanAlstine & Holmes, 2018) yet can be challenging in virtual settings due to technological constraints (Owen, 2015). Mentees rated their mentors highly, though mentors saw room for improvement, mirroring in-person findings (Harker et al., 2019). Unlike in-person mentoring, where misalignment is common (Harker et al., 2019; Orsini & Stedman, 2022), virtual mentoring showed stronger alignment; particularly in *Assessing Understanding*, a critical factor in effective mentorship (Greenberg, 2018; Stephenson et al., 2022). However, misjudging mentee knowledge can hinder success, especially in cross-disciplinary mentoring, where targeted training may help. *Fostering Independence* is central to undergraduate research (Pfund, 2016; Walkington et al., 2020), with confidence playing a key role (Greenberg, 2018). While mentees rated this competency highly, one mentor rated themselves lower, aligning with prior research (Harker et al., 2019). *Effective mentorship* requires balancing guidance and autonomy through intentional strategies (Bennett et al., 2022; Ghebreyessus et al., 2022). *Diversity mentoring* also presents challenges as mentors influence career trajectories (Carpi et al., 2017; Jones & Lerner, 2019). Mentees rated diversity mentoring highly, though mentor self-assessments varied from past studies (Harker et al., 2019). *Faculty development* programs can enhance cultural competency (Byars-Winston et al., 2023), supporting diversity through networking and research dissemination (Walkington et al., 2020). Professional development ratings were high, but varied, which is consistent with in-person studies (Harker et al., 2019; Orsini & Stedman, 2022). Work-life balance (Bennett et al., 2022) and access to multiple mentors (Bradley, 2017) further contribute to effective mentoring.

**Implications**

This study highlights the strengths of virtual research mentoring, while identifying self-perception gaps between mentors and mentees. Mentees consistently rated mentors higher, underscoring the need for structured training to address perception discrepancies and improve diversity mentoring. Not all faculty excel in mentoring (Johnson et al., 2015), but online training enhances ability and confidence (Behar-Horenstein et al., 2019; Weber-Main et al., 2019), improving communication, expectation alignment, and engagement (Young & Stormes, 2020). Strong mentoring boosts research output and student belonging (Morales et al., 2017), with inexperienced students benefiting the most in online settings (Monarrez et al., 2020; Faulconer et al., 2020b).

**Key Takeaways, and Future Direction**

This work relied on refinement of Pfund’s (2016) undergraduate mentoring framework to provide insights into virtual mentoring using a validated mentor-mentee comparison metric. While many institutions adopted virtual mentoring during COVID-19 (Erickson et al., 2022), long-term sustainability remains uncertain. Results exhibit mentor-mentee agreement in key competencies: communication, expectation alignment, assessing understanding, fostering independence, diversity, and professional development. Though a small sample limits generalizability, this study establishes a foundation for future research comparing virtual and in-person mentoring. For future efforts, a larger, more diverse sample would improve statistical reliability. Expanding the sample would allow degree-level comparisons, given that mentoring needs differ between undergraduates and graduate students (Gonzalez, 2001; Butz & Branchaw, 2020). Data from a single institution also limits generalizability, and a small mentor sample prevented analysis of heterogeneity effects. While gender was not a predictor of mentor self-evaluation, larger studies suggest that gender, research area, mentoring frequency, and academic rank may influence results (Mickel et al., 2018; Orsini et al., 2019). Bias is also a concern, as self-reported data may be influenced by social desirability, and voluntary participation could introduce selection bias. Nonresponse error may affect representativeness, though recruitment efforts aimed to mitigate this. Expanding participation would enhance reliability and applicability.

**Conclusion**

This study offers insights into the competencies of virtual research mentors, including the identification of strengths in areas such as communication, aligning expectations, and fostering independence. However, differences between mentor and mentee perspectives, particularly on communication, suggest areas for deeper exploration. The limited sample size restricts generalizability, indicating the need for larger, longitudinal studies to better assess the long-term impacts of virtual mentoring. Future research should also focus on how mentor development programs can enhance skills in key areas like diversity management and promoting mentee independence. Overall, this study sets the stage for future research into improving virtual mentoring practices and mentor training.

**Declaration of Conflicting Interests**

Authors disclose employment at the institution studied as a potential conflict of interest.

**Acknowledgments**

This work was supported by the National Science Foundation [grant numbers 2021221 and 2315560]. This paper represents a condensed version of a larger manuscript, titled “*Virtual Mentorship for Online Undergraduate Research: Analysis of Mentors and Mentees' Perspectives.*”

**References**

Adebisi, Y. A. (2022). Undergraduate students’ involvement in research: Values, benefits, barriers and recommendations. *Annals of Medicine and Surgery*, *81*, 104384. https://doi.org/10.1016/j.amsu.2022.104384

Association for Experiential Education. (n.d.). *What is experiential education?* https://www.aee.org/what-is-experiential-education

Behar-Horenstein, L.S., Roberts, K.W., & Dix, A.C. (2010). Mentoring Undergraduate Researchers: An Exploratory

Study of Students’ and Professors’ Perceptions. *Mentoring & Tutoring: Partnership in Learning, 18*, 269-291.

Butz, A. R., & Branchaw, J. L. (2020). Entering Research Learning Assessment (ERLA): Validity evidence for an instrument to measure undergraduate and graduate research trainee development. *CBE—Life Sciences Education, 19*(2), ar18. https://doi.org/10.1187/cbe.19-07-0146

Byars-Winston, A., Leverett, P., Benbow, R. J., Pfund, C., Thayer-Hart, N. & Branchaw, J. (2020). Race and

ethnicity in biology research mentoring relationships. *J Divers High Educ,* *13*(3), 240-253. https://doi.org/10.1037/dhe0000106

Clark, R. A., Harden, S. L., & Johnson, W. B. (2000). Mentor relationships in clinical psychology doctoral training: Results of a national survey. *Teaching of Psychology, 27*, 262–268.

Cooper, K. M., Gin, L. E., Akeeh, B., Clark, C. E., Hunter, J. S., Roderick, T. B., Elliott, D. B., Gutierrez, L. A., Mello, R. M., Pfeiffer, L. D., Scott, R. A., Arellano, D., Ramirez, D., Valdez, E. M., Vargas, C., Velarde, K., Zheng, Y., & Brownell, S. E. (2019). Factors that predict life sciences student persistence in undergraduate research experiences. *PLOS ONE*, *14*(8), 0220186. https://doi.org/10.1371/journal.pone.0220186

Estrada, M., Hernandez, P. R., & Schultz, P. W. (2018). A longitudinal study of how quality mentorship and research experience integrate underrepresented minorities into STEM careers. *CBE—Life Sciences Education*, *17*(1). https://doi.org/10.1187/cbe.17-04-0066

Faulconer, E., Dixon, Z., Griffith, J., Faulconer, L. (2020a). Perspectives on undergraduate research mentorship: A comparative analysis between online and traditional faculty. *Online Journal of Distance Learning Administration, 23*(2).

Faulconer, E., Griffith, J., Dixon, Z., Roberts, D. (2020b) Comparing online and traditional student engagement and perceptions of undergraduate research. *Scholarship and Practice of Undergraduate Research, 3*(3).

Faulconer, E., Terwilliger, B., Deters, R., & George, K. (2024). Guiding Undergraduate Researchers in the Virtual World: Mentoring Experiences of Globally Distributed Students. *OJDLA, 27*(1). Retrieved from https://commons.erau.edu/publication/2204

Fleming, M., House, S., Shewakramani, V., Yu, L., Garbutt, J., McGee, R., Kroenke, K., Abedin, Z., & Rubio, D. M. (2013). The Mentoring Competency Assessment: Validation of a new instrument to evaluate skills of research mentors. *Academic Medicine: Journal of the Association of American Medical Colleges*, *88*(7), 1002–1008. https://doi.org/10.1097/ACM.0b013e318295e298

Gonzalez, C. (2001). Undergraduate research, graduate mentoring, and the university's mission. science, 293(5535), 1624-1626. https://doi.org/10.1126/science.1062714

Hall, E., Bailey E., Higgins, S., Ketcham, C., Nepocatych, S., & Wittstein, M. (2021) Application of the Salient Practices Framework for Undergraduate Research Mentoring in Virtual Environments. *Journal of Microbiology & Biology Education*. https://doi.org/10.1128/jmbe.v22i1.2287

Harker, K., O’Toole, E., Keshmiripour, S., McIntosh, M., & Sassen, C. (2019). Mixed-methods assessment of a mentoring program. *Journal of Library Administration*, *59*(8), 873–902. https://doi.org/10.1080/01930826.2019.1661745

Hyun, S. H., Rogers, J. G., House, S. C., Sorkness, C. A., & Pfund, C. (2022). Revalidation of the Mentoring Competency Assessment to evaluate skills of research mentors: The MCA-21. *Journal of Clinical and Translational Science*, *6*(1), e46. https://doi.org/10.1017/cts.2022.381

Johnson, M. & Knox, C. (2022). National Summer Undergraduate Research Project (NSURP): A Virtual Research Experience to Deliver REAL (Retention, Equity, Access, and Life-Changing) Outcomes for Underrepresented Minorities in STEM. *Journal of Microbiology & Biology Education*. https://doi.org/10.1128/jmbe.00335-21

Johnson, W. B., Behling, L. L., Miller, P., & Vandermaas-Peeler, M. (2015). Undergraduate research mentoring: Obstacles and opportunities. *Mentoring & Tutoring: Partnership in Learning*, *23*(5). https://doi.org/10.1080/13611267.2015.1126167

King, M. M., & Imai, M. K. (2022). The undergraduate RA: Benefits and challenges for sociology faculty and research assistants. *Teaching Sociology*. https://doi.org/10.1177/0092055X221125783

Knox, C., Ab Latif, F., Cornejo, N., Johnson M. (2024). Mentoring across difference and distance: Building effective virtual research opportunities for underrepresented minority undergraduate students in biological sciences. *mBio.* https://doi.org/10.1128/mbio.01452-23

Korver, B., & Tillema, H.H. (2014). Feedback Provision in Mentoring Conversation--Differing

Mentor and Student Perceptions. *Journal of Education and Training Studies, 2,* 167-175.

Lev, E.L., Kolassa, J.E., & Bakken, L.L. (2010). Faculty mentors' and students' perceptions of students' research

self-efficacy. *Nurse Education Today, 30*(2), 169-174.

*Mentoring and Coaching Within NRMN – NRMN*. (n.d.). Retrieved January 27, 2023, from https://nrmnet.net/archives/mentoring-and-coaching-within-nrmn/

Orsini, J., Daroub, S., McAuslane, H., & Stedman, N. (2019). Graduate student and faculty perceptions of mentoring competency. *NACTA Journal*, *64*, 66–78. https://www.jstor.org/stable/27157779

Pfund, C. (2016). *Studying the Role and Impact of Mentoring on Undergraduate Research Experiences* (Committee on Strengthening Research Experiences for Undergraduate STEM Students, Board on Science Education). National Academies of Sciences, Engineering, Medicine. http://nas.edu/STEM\_Undergraduate\_Research\_Mentoring

Rogers, J., Gong, X., Byars-Winston, A., McDaniels, M., Thayer-Hart, N., Cheng, P., Diggs-Andrews, K., Martínez-Hernández, K. J., & Pfund, C. (2022). Comparing the outcomes of face-to-face and synchronous online research mentor training using propensity score matching. *CBE—Life Sciences Education*, *21*(4), ar62. https://doi.org/10.1187/cbe.21-12-0332

Sams, D., Lewis, R., McMullen, R., Bacnik, L., Hammack, J., Richards, R., & Powell, C. (2015). Measuring self-efficacy and scientific literacy across disciplines as value-added outcomes of undergraduate research mentoring: Scale development. *Council on Undergraduate Research Quarterly*, *35*(3), 23–31. https://go.gale.com/ps/i.do?id=GALE%7CA465166023&sid=googleScholar&v=2.1&it=r&linkaccess=abs&issn=10725830&p=AONE&sw=w&userGroupName=anon%7Eed441b25&aty=open-web-entry

Stephenson, S., Kemp, E., Kiraly-Alvarez, A., Costello, P., Lockmiller, C., & Parkhill, B. (2022). Self-Assessments of Mentoring Skills in Healthcare Professions Applicable to Occupational Therapy: A Scoping Review. *Occupational Therapy in Health Care*, 1–21. https://doi.org/10.1080/07380577.2022.2053923

Stolzenberg, E., Eagan, M., Zimmerman, H., Berdan Lozano, J., Cesar-Davis, N., Aragon, M., & Rios-Aguilar, C. (2019). *Undergraduate teaching faculty: The HERI faculty survey 2016–2017*. UCLA. https://vtechworks.lib.vt.edu/handle/10919/100575

Undergraduate Research Definition Task Force. (n.d.). *Council on Undergraduate Research Issues Updated Definition of Undergraduate Research*. Council on Undergraduate Research. https://www.cur.org/council\_on\_undergraduate\_research\_issues\_updated\_definition\_of\_undergraduate\_research/

Vandermaas-Peeler, M., Miller, P. C., & Moore, J. L. (2018). *Excellence in Mentoring Undergraduate Research*. Council on Undergraduate Research.

Yukawa, M., Gansky, S. A., O’Sullivan, P., Teherani, A., & Feldman, M. D. (2020). A new mentor evaluation tool: Evidence of validity. *PLOS ONE*, *15*(6), e0234345. https://doi.org/10.1371/journal.pone.0234345

Emily Faulconer is a Senior Lecturer at Monash University, Clayton VIC 3800, AU. Email: emily.faulconer@monash.edu; ORCA ID: 0000-0002-7392-316X

Brent Terwilliger is an Associate Professor at Embry-Riddle Aeronautical University, Daytona Beach, FL 32114. Email: brent.terwilliger@erau.edu; ORCA ID: 0000-0002-3635-2492

Darryl Chamberlain is an Assistant Professor at Embry-Riddle Aeronautical University, Daytona Beach, FL 32114. Email: darryl.chamberlain@erau.edu; ORCA ID: 0000-0001-9724-3225

Robert Deters is an Associate Professor at Embry-Riddle Aeronautical University, Daytona Beach, FL 32114. Email: robert.deters@erau.edu; ORCA ID: 0000-0002-0923-8838

Cheryl Kam, kjycheryl@gmail.com, ORCA ID: 0009-0000-4295-2585