2026 ASEE ANNUAL CONFERENCE June 21–24, 2026 | Charlotte Convention Center, NC
Host Sponsor UNC Charlotte
Paper ID #50326

WIP: Supporting Faculty Authentic Pedagogy: Development of an Interview Protocol for College-Industry Partnerships with Wastewater Treatment Plants

Dr. Campbell James McColley, Cornell University

Dr. Campbell McColley is a NSF Postdoctoral STEM Ed Research Fellow in the Department of Biomedical Engineering (BME) at Cornell University in the Biomedical Engineering Education Assessment and Research (BEEAR) Group. He received his Ph.D. in Environmental Engineering from Oregon State University, where he investigated microplastics transformations and behavior in aquatic environments. His work focuses on developing and supporting college-industry partnerships in engineering curricula with the wastewater treatment sector.

Alexandra Werth, Cornell University

Alexandra Werth is an assistant professor at the Meinig School of Biomedical Engineering, specializing in Engineering Education Research (EER). She focuses on developing evidence-based teaching methodologies to foster authentic learning environments. Dr. Werth holds a Ph.D. in Electrical and Computer Engineering from Princeton University, where she developed a non-invasive mid-infrared glucose sensor. She later conducted postdoctoral research in physics education at the University of Colorado Boulder, where she helped develop the first large-enrollment introductory physics course-based research experience (CURE).

WIP: Supporting Faculty Authentic Pedagogy: Development of an Interview Protocol for College-Industry Partnerships with Wastewater Treatment Plants

Abstract

This work-in-progress, research paper explores the development and pilot of an interview protocol to investigate the formation and sustainability of college-industry partnerships (CIPs) with wastewater treatment plants (WWTPs). With over 16,000 WWTPs across the United States, the wastewater industry represents a largely untapped opportunity for engineering education partnerships. CIPs with WWTPs offer authentic learning environments that enhance student motivation, professional skill development, and real-world relevance. However, many faculty members lack the tools and frameworks to initiate and sustain such collaborations and pedagogical practices in their classrooms. This work aims to support faculty development by investigating best practices for forming and maintaining WWTP-based CIPs through the lens of stakeholder engagement.

The study employs a multi-case qualitative approach, focusing on semi-structured interviews with engineering faculty and WWTP collaborators. Interview protocol development is guided by Donaldson and Preston's Stakeholder Theory Framework, which categorizes stakeholder interactions as descriptive, instrumental, or normative. Descriptive questions explore initial contact and communication methods; instrumental questions examine alignment of educational goals with industry needs; and normative questions address long-term sustainability, unexpected benefits, and stakeholder expectations. Thematic coding and comparative analysis will be conducted across cases, beginning with a pilot study involving faculty engaged in WWTP and public utilities partnerships.

By examining these aspects, this study seeks to equip faculty with the skills and insights needed to engage industry partners effectively. Ultimately, this work seeks to foster an environment of experiential learning and stakeholder collaboration in engineering curricula by leveraging the accessibility and relevance of the wastewater industry.

Keywords:

College-Industry Partnerships, Wastewater Treatment Plants, Faculty Development

I. Introduction

Leveraging industrial partners to supplement undergraduate engineering education can provide authentic, experiential learning contexts that enhance student technical and professional learning, benefit industry partners, and increase engagement within the engineering community [1], [2], [3]. However, there are significant barriers and challenges engineering programs face when trying to form and maintain collaboration with industry despite the overwhelming benefits of forming said partnerships. Barriers including ownership of intellectual property [4], misalignment of goals [5], lack of motivation and experience [6], access and engagement of local industries [7], and limited university resources [6], [7] can hinder engineering programs from establishing and sustaining their own partnerships. Smaller and underserved colleges and universities face unique challenges when finding the time, funding, and support to develop bridges with industry partners. Additionally, these universities may often have to compete with large, well-funded and supported programs to partner with local industries. Wastewater treatment plants (WWTPs), however, represent a widely accessible yet underutilized industry capable of serving as authentic learning environments across multiple engineering disciplines due to their broad applicability and locality to many U.S. colleges and universities.

In this paper, we present initial interview development and piloting of collaborating faculty and industry professionals. The primary focus of this overall work is to better identify and understand processes, successes, and challenges of forming college-industry partnerships (CIPs) answering using WWTP as a model industry.

II. Background and Theoretical Framework

A. College Industry Partnerships

Engineering departments have utilized a wide range of CIPs involving various industries and serving diverse purposes such as enhancing coursework [1], [3], [8] and supporting research efforts [9], [10], [11]. Often seen as an advantageous approach for universities to train future engineers in real-world contexts [1], [10], [12] while allowing industry organizations to influence education and address their specific needs [2], [13], CIPs have a long history delivering mutual benefits aligning well with U.S. workforce development goals and overall efforts to broaden participation in science, technology, engineering, and mathematics (STEM) [5], [10]. Some resulting benefits have included innovative and low-cost solutions for complex industry projects [2], [10], development of real-world problem-solving skills [12], internship and workforce opportunities for students [2], [10], and formation of long-lasting engineering communities between universities and local industrial partners [14], [15].

B. Wastewater Treatment Plants

With over 16,000 WWTPs nationwide [16], the wastewater industry has the potential to be an accessible industry partner to colleges and universities, especially to smaller schools in more rural areas. Although underutilized, WWTPs have been used in numerous educational settings such as internship or co-op programs, sponsoring senior capstone projects, independent study courses, and laboratory courses [14]. Additionally, WWTP may have analytical equipment used to monitor and examine various treatment processes that may be unavailable to smaller engineering programs who either do not have the funds and/or space for expensive equipment [14]. WWTPs are also rich in diverse educational topics and environments that can span multiple engineering disciplines in addition to common coursework in Civil and Environmental Engineering curricula as illustrated in Figure 1.

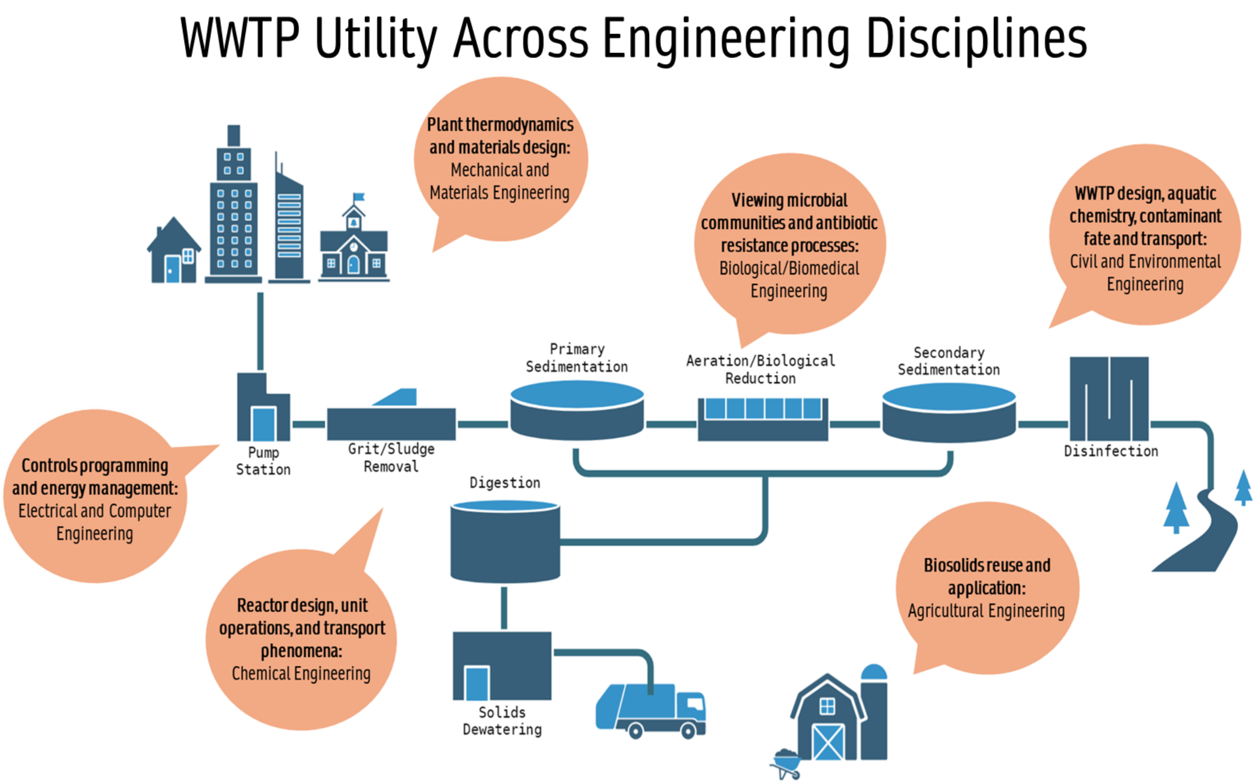

Figure 1. Wastewater treatment plant opportunities across multiple engineering disciplines

Courses and/or course topics related to the treatment plant thermodynamics and choice of materials related to Mechanical and Materials Engineering; controls programing and energy management/efficiency pertaining Electrical and Computer Engineering; reactor design, unit operations, and transport phenomena common to Chemical Engineering [17]; microbial community prevalence and horizontal gene transfer in antibiotic resistance bacteria processes of interest in Biological/Biomedical Engineering [18]; and applicability of dewatered biosolids for agriculture and land applications in Agricultural Engineering [19] are just a few learning opportunities that could benefit from WWTP collaboration. Additionally, there are recent developments of college campuses utilizing wastewater and wastewater treatment as a means of SARS-CoV-2 monitoring during the COVID-19 pandemic [20].

C. Stakeholder Theory

Faculty and industry professional interviews are grounded in organizational management theories to frame how CIPs are developed and can be leveraged in the classroom. Stakeholder Theory or Stakeholder Thinking as explained by Gilbert and Rasche (2007) describes, "…serving the interest of those groups and individuals identified as 'stakeholders' the primary purpose of an organization" [21]. While there are many iterations of stakeholder theory, Donaldson and Preston's (1995) framework will be utilized to guide methodologies due to its establishment in its field and applicability to CIPs [21], [22], [23]. Herein three main aspects of stakeholder theory are made distinct as depicted in Figure 2.

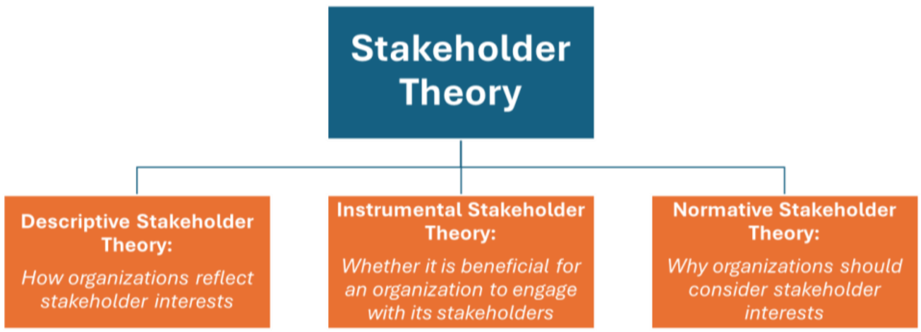

Figure 2. Donaldson and Preston's Stakeholder Theory Framework [22]

The three distinctions of stakeholder theory, descriptive, instrumental, and normative, have been utilized to identify and explain problems and opportunities in partnerships, as well as ethical concerns in collaborations [21], [22]. Descriptive stakeholder theory examines how organizations actually behave in relation to their stakeholders; how roles, relationships, and patterns of interaction unfold in practice [24], [25]. Instrumental stakeholder theory, by contrast, focuses on how managing these relationships and aligning with stakeholder goals can lead to more effective and successful outcomes [24], [25]. Normative stakeholder theory adds an ethical dimension, asking why the interests of stakeholders should matter in the first place [24], [26]. This ethical lens is especially important for understanding the long-term sustainability of partnerships. These three perspectives are not isolated but instead work together, offering a more comprehensive understanding of how stakeholder relationships are formed, maintained, and evaluated.

In this work, these distinctions will serve as the foundation for exploring how the interests of colleges and industries can be represented, assessing the benefits of engagement, and understanding why each party should consider these interests during the development of partnerships through stakeholder interviews and model developments.

III. **Methods**

Five institutions with known WWTP CIPs were recruited for this study. In this paper, we explore preliminary, sixty-minute, semi-structured interviews with two faculty members and one local wastewater treatment plant (WWTP) professional from one of these institutions. These participants were selected for their direct experience with university–industry collaborations: Faculty Member 1 and the WWTP professional are long-standing collaborators, and Faculty Member 2 has extensive experience partnering with multiple industries for both educational and research purposes. All interviews were audio-recorded, transcribed, and subsequently de-identified to ensure participant anonymity. Utilizing Donaldson and Preston's Stakeholder Theory Framework (Figure 2) [22], interviews were framed in descriptive, instrumental, and normative stakeholder theory to explore the complexities of formed CIPs as shown in Table 1.

Table 1. Descriptive, Instrumental, and Normative Stakeholder Theory Question Examples

Descriptive	Instrumental	Normative
"How did you connect with your collaborator (e.g., email, phone call, research event)?"	*"When forming this partnership, what were your specific course/project objectives?"*	*"What benefits have you and your partner received throughout this collaboration that you did not expect?"*
"How were your intentions for a partnership communicated (e.g., focus group, interview, formalized statements of intents)?"	*"How did these objectives align with the proposed partner?"*	*"What would have made developing or implementing this partnership run more smoothly for you and your partner?"*
"What forms of communication worked better than others to initially reach out?"	*"Did these goals change or iterate while developing or implementing this partnership?"*	*"What are the specific expectations and contributions are needed from you and your partner to continue working together?"*

IV. Preliminary Results

Early interview data point to two interconnected themes shaping the formation and sustainability of university–industry partnerships (1), the importance of positionality, preparation, and clear communication when initiating collaborations (reflecting descriptive and instrumental dimensions of stakeholder theory); and (2) the role of identifying a committed "heroic agent" within industry who champions and sustains the partnership (reflecting normative stakeholder theory).

A. Positionality, Preparation, and Clear Communication

Participants consistently emphasized that faculty must understand their own positionality and the expectations of potential partners before initiating contact. Faculty Member 1 articulated this clearly when reflecting on how academics should approach industry collaborators:

> *"What's your positionality relative to that person?...I don't have to bribe [WWTP Partner], you know, I think that person had to offer something to that person… if you're already known and respected by the other person, versus you're just wasting their time and driving them crazy. That's quite a different situation..."*

Seen through the lens of instrumental stakeholder theory, this comment illustrates how potential collaborators assess whether a partnership will offer meaningful value. Successful outreach therefore requires faculty to attend not only to what they hope to gain from a collaboration but also to how they are perceived by the stakeholders they seek to engage, their positionality. In this sense, preparing for partnership is as much a relational and perceptual task as it is a technical or logistical one.

Communication style also emerged as a critical factor. Faculty Member 2 described the need to adapt academic norms to industry expectations:

> *"The presentation you would make for an industry audience would be a little different, would be pretty different from the presentation you would make for an academic audience…so it's more high level, more concise, more to the point…I think as academics, we have a tendency…we try to show everything that we have, you know? With, like, all the details, but, you know, that sort of gets a little trickier when you're conversing with industrial audience."*

Industry partners echoed this need for alignment and preparation. The WWTP partner emphasized that faculty should conduct basic research, such as potential tour offerings, and clearly articulate their goals (e.g., learning outcomes for students) before reaching out:

> *"…if they're interested in that enough, they should know some basics, and they should know what they want to have their students learn, and…they can just ask, you know, will you be able to cover these things?…If it has to do with wastewater, I can't imagine them getting a no."*

Taken together, these interviews suggest that effective partnership initiation requires faculty to understand their own position as stakeholders, assess the potential partner's interests, and communicate objectives in ways that resonate with industry norms and constraints.

B. *Finding Your "Heroic Agent"*

Sustaining partnerships, participants noted, depends heavily on identifying individuals within industry who are intrinsically motivated to support educational collaborations. Faculty Member 1 described this as finding a "heroic agent":

> *"But I do think that's a potentially really important thing of seeing not just a functionary, but, like, a real heroic agent in these people, you know, and pick out, you know, therefore you shouldn't hit people you don't know, because they might not be a heroic agent.*

They continue to describe a colleague who exemplified this idea; someone with a distinctive ability to champion others' work:

> *"…because he had this fairly notable capability of discovering what was cool about what you were doing, and appreciating it more than you did. So…he could do that to talk to*

anybody and…then frame it in this really sparkly frame, and then make the subject feel great. So if you're trying to do certain things in your class, chances are you need a person that you can frame like that.”

The WWTP partner, identified by this faculty member as one such “heroic agent,” described why they continue to engage enthusiastically with educators:

“I do know that my tour is almost always seemed very valuable to the teacher, whatever level, you know, high school or university, and once I get them in the door and do it they often want…to every year…I'm still excited after over 20 years about what I do, and I love sharing it with people. Makes me feel good, I think… it's been suggested to me more than once that maybe I should have been a teacher rather than a wastewater operator.”

They went on to describe the wide range of specialized tours and educational experiences they can offer, highlighting the richness of the WWTP environment as a learning space. Across interviews, participants agreed that while identifying such individuals can be challenging, these “heroes” are central to initiating sustaining long-term, mutually beneficial partnerships. However, the literature suggests that relying on a single “heroic agent” to continue a collaboration is difficult to sustain over time, particularly when that individual departs [27]. Sustainable collaborations instead require multiple committed participants who share responsibility and investment in the relationship [27], [28].

V. Future Work

The next phase of this project will expand the current interview set by engaging a larger group of faculty and industry collaborators involved in established college–WWTP partnerships across the United States. These additional interviews will deepen understanding of how partnerships are initiated, negotiated, and sustained across diverse institutional and regional contexts. Following this phase, the study will incorporate interviews with students who have participated in course-integrated partnership (CIP) activities. Guided by Activity Theory, the student phase will examine how learners perceive the authenticity, relevance, and educational value of these experiences.

Together, these expanded data sources will support a more comprehensive investigation of the following research questions:

RQ1: What are the current successes, challenges, and necessary stakeholder contributions (from engineering programs and WWTPs) required to form and sustain mutually beneficial partnerships?

RQ2: What unifying features and key differences characterize university collaborations with WWTPs across diverse institutional and regional contexts?

RQ3: How do industry needs and expectations shape the formation, evolution, and long-term sustainability of partnerships with academic institutions?

RQ4: What best practices support the effective integration of wastewater treatment plants into undergraduate engineering curricula?

By systematically examining both stakeholder and student perspectives, this work aims to generate actionable insights for designing, implementing, and sustaining high-impact educational partnerships that benefit all parties involved.

References

[1] D. Peters and A. Lucietto, "A Survey of Types of Industry-Academia Collaboration," in *2016 ASEE Annual Conference & Exposition Proceedings*, New Orleans, Louisiana: ASEE Conferences, June 2016, p. 26455. doi: 10.18260/p.26455.

[2] C. E. Vergara *et al.*, "Leveraging workforce needs to inform curricular change in computing education for engineering: The cpace project," *Comput. Educ. J.*, vol. 19, no. 4, pp. 84–98, 2009.

[3] A. N. Washington, L. Burge, M. Mejias, K. Jean-Pierre, and Q. Knox, "Improving undergraduate student performance in computer science at historically black colleges and Universities (HBCUs) through industry partnerships," in *SIGCSE - Proc. ACM Tech. Symp. Comput. Sci. Educ.*, Decker A., Eiselt K., Tims J., and Alphonce C., Eds., Association for Computing Machinery, 2015, pp. 203–206. doi: 10.1145/2676723.2677277.

[4] J. Bruneel, P. D'Este, and A. Salter, "Investigating the factors that diminish the barriers to university–industry collaboration," *Res. Policy*, vol. 39, no. 7, pp. 858–868, Sept. 2010, doi: 10.1016/j.respol.2010.03.006.

[5] S. Bray and K. Scalzo, "Partnerships that perform: It takes more than good intentions," *Contin. High. Educ. Rev.*, vol. 69, p. 97, 2005.

[6] A. L. Rossoni, E. P. G. de Vasconcellos, and R. L. de Castilho Rossoni, "Barriers and facilitators of university-industry collaboration for research, development and innovation: a systematic review," *Manag. Rev. Q.*, vol. 74, no. 3, pp. 1841–1877, Sept. 2024, doi: 10.1007/s11301-023-00349-1.

[7] V. Karlsdottir, M. T. Torfason, I. R. Edvardsson, and T. M. Heijstra, "Barriers to academic collaboration with industry and community: Individual and organisational factors," *Ind. High. Educ.*, vol. 37, no. 6, pp. 792–809, Dec. 2023, doi: 10.1177/09504222231173953.

[8] A. Sergeyev, M. Kinney, S. Kuhl, N. Alaraje, M. Highum, and P. Mehandiratta, "University, community college and industry partnership: Revamping robotics education to meet 21st century workforce needs – nsf sponsored project final report," *J. Eng. Technol.*, vol. 36, no. 2, pp. 8–20, 2019.

[9] William Fitzgerald and Lil Rudden, "Use of laboratory-scale wastewater treatment plants for undergraduate research, teaching and learning," presented at the Flexible Learning: Proceedings NAIRTL 4th Annual Conference,

[10] R. Shah and A. L. Gillen, "A systematic literature review of university-industry partnerships in engineering education," *Eur. J. Eng. Educ.*, vol. 49, no. 3, pp. 577–603, May 2024, doi: 10.1080/03043797.2023.2253741.

[11] R. F. Burch, L. Strawderman, G. D. Collins, J. Mohammadi-Aragh, J. Martin, and C. Taylor, "Development of a Collaborative Research Partnership Between Academia and Industry: A Case Study," *Int. J. Eng. Educ.*, vol. 37, no. 6, pp. 1619–1629, 2021.

[12] E. Scott and M. Tanner, “Using a Partnership in Industry to Link Theory and Practice in Undergraduate Courses,” presented at the InSITE 2015: Informing Science + IT Education Conferences: USA, 2015, pp. 385–399. doi: 10.28945/2187.
[13] M. O’Dwyer, R. Filieri, and L. O’Malley, “Establishing successful university–industry collaborations: barriers and enablers deconstructed,” *J. Technol. Transf.*, vol. 48, no. 3, pp. 900–931, June 2023, doi: 10.1007/s10961-022-09932-2.
[14] M. Brown *et al.*, “University–utility partnerships: Best practices for water innovation and collaboration,” *Water Environ. Res.*, vol. 92, no. 3, pp. 314–319, Mar. 2020, doi: 10.1002/wer.1252.
[15] “Academic Outreach: Pennsylvania college of technology: Innovation in teaching, career awareness, and industry partnerships,” *Plast. Eng.*, vol. 67, no. 10, pp. 30–31, 2011.
[16] “Water and Wastewater Systems | Cybersecurity and Infrastructure Security Agency CISA.” Accessed: Nov. 03, 2024. [Online]. Available: https://www.cisa.gov/topics/critical-infrastructure-security-and-resilience/critical-infrastructure-sectors/water-and-wastewater-sector
[17] A. P. Sincero and G. A. Sincero, *Physical-Chemical Treatment of Water and Wastewater*. Boca Raton: CRC Press, 2002. doi: 10.1201/9781420031904.
[18] C. C. Nguyen, C. N. Hugie, M. L. Kile, and T. Navab-Daneshmand, “Association between heavy metals and antibiotic-resistant human pathogens in environmental reservoirs: A review,” *Front. Environ. Sci. Eng.*, vol. 13, no. 3, p. 46, June 2019, doi: 10.1007/s11783-019-1129-0.
[19] C. A. Kinney *et al.*, “Survey of Organic Wastewater Contaminants in Biosolids Destined for Land Application,” *Environ. Sci. Technol.*, vol. 40, no. 23, pp. 7207–7215, Dec. 2006, doi: 10.1021/es0603406.
[20] W. Q. Betancourt *et al.*, “COVID-19 containment on a college campus via wastewater-based epidemiology, targeted clinical testing and an intervention,” *Sci. Total Environ.*, vol. 779, p. 146408, July 2021, doi: 10.1016/j.scitotenv.2021.146408.
[21] D. U. Gilbert and A. Rasche, “Opportunities and Problems of Standardized Ethics Initiatives – a Stakeholder Theory Perspective,” *J. Bus. Ethics*, vol. 82, no. 3, pp. 755–773, Oct. 2008, doi: 10.1007/s10551-007-9591-1.
[22] T. Donaldson and L. E. Preston, “The Stakeholder Theory of the Corporation: Concepts, Evidence, and Implications,” *Acad. Manage. Rev.*, vol. 20, no. 1, pp. 65–91, 1995, doi: 10.2307/258887.
[23] Y. Fassin, “The Stakeholder Model Refined,” *J. Bus. Ethics*, vol. 84, no. 1, pp. 113–135, Jan. 2009, doi: 10.1007/s10551-008-9677-4.
[24] J. Rose, L. S. Flak, and Ø. Sæbø, “Stakeholder theory for the *E*-government context: Framing a value-oriented normative core,” *Gov. Inf. Q.*, vol. 35, no. 3, pp. 362–374, Sept. 2018, doi: 10.1016/j.giq.2018.06.005.
[25] F. Bridoux and J. Stoelhorst, “Stakeholder theory, strategy, and organization: Past, present, and future,” *Strateg. Organ.*, vol. 20, no. 4, pp. 797–809, Nov. 2022, doi: 10.1177/14761270221127628.
[26] R. Mahajan, W. M. Lim, M. Sareen, S. Kumar, and R. Panwar, “Stakeholder theory,” *J. Bus. Res.*, vol. 166, p. 114104, Nov. 2023, doi: 10.1016/j.jbusres.2023.114104.
[27] S. E. DeChenne-Peters and N. L. Scheuermann, “Faculty Experiences during the Implementation of an Introductory Biology Course-Based Undergraduate Research

Experience (CURE)," *CBE—Life Sci. Educ.*, vol. 21, no. 4, p. ar70, Dec. 2022, doi: 10.1187/cbe.21-06-0154.

[28] L. Christian *et al.*, "Construction of a CURE Community to Empower Faculty and Accelerate Pedagogical Change," *Int. J. Scholarsh. Teach. Learn.*, vol. 19, no. 1, May 2025, doi: 10.20429/ijsotl.2025.190102.