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A Survey of the Literature on Co-ops and Cooperative Education in the American Society of Engineering Education

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Abstract

Cooperative education experiences or coops have been promoted as a work integrated learning experience and have been seen as a mechanism way to bridge engineering coursework and practice for engineering students (ASEE NAE, 2018). While there have been several major NSF grants focused on cooperative education and a number of engineering programs with mandatory cooperative education requirements, there is still work to be done to connect research efforts to practice. Through a scoping review, this paper seeks to explore the literature on engineering cooperative education in the United States. More specifically, the purpose of this paper is to synthesize conference proceedings published by ASEE from 2000-2023 to explore trends and identify areas of growth. From the review, we identified three key findings and three areas of opportunity for future work. The first key finding was that 60% of the literature surveyed were descriptive papers and only 40% were research papers. The second key finding was that there was a large focus on learning, particularly the learning and development of professional skills. The third key finding was several time-based trends over time including the prevalence of work that discussed ABET between 2000-2010 as well as a more recent increase in work focused on virtual cooperative education and diversity, equity, and inclusion since 2020. In terms of future work, three key areas emerged including the need to explore the acquisition of technical skills and engineering content knowledge, mental health and student well-being, and equitable design and inclusive practices in cooperative education experiences. This paper contributes to the literature by synthesizing previously conducted research and providing recommendations for future research and practice to improve cooperative education in engineering education.

Introduction

Cooperative education experiences or co-ops have been promoted as a work integrated learning experience and high impact practice in engineering education [1,2]. Co-ops have been promoted as a way to bridge engineering coursework and practice, or in other words bridge theory to practice for engineering students. In alignment with these calls for an increase in cooperative and experiential learning, the American Society of Engineering Education (ASEE), established the Cooperative and Experiential Education Division (CEED).

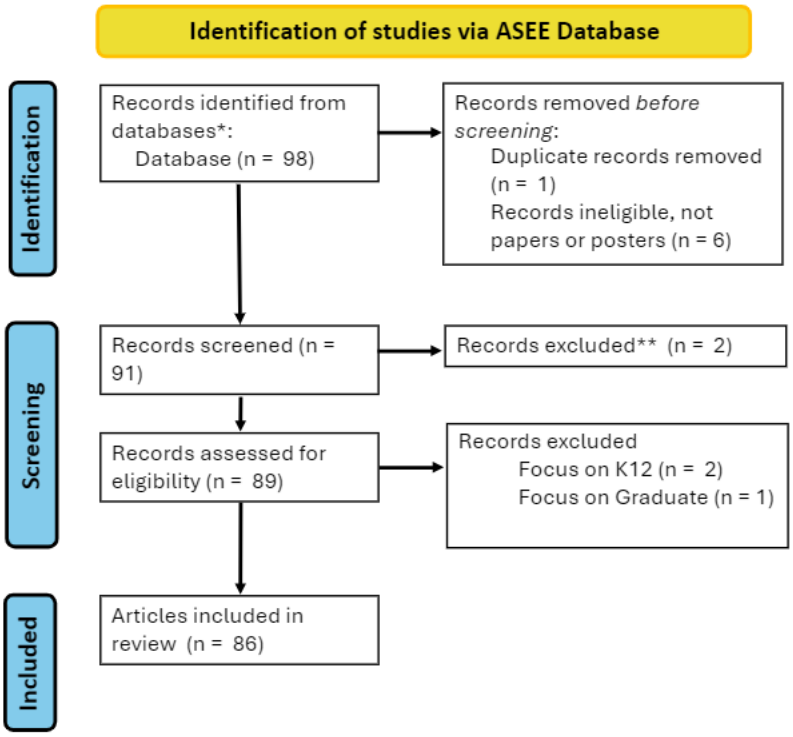
Due to continued calls for co-ops in engineering and their prevalence in engineering education research and practice, through a scoping review, this paper seeks to explore the literature on engineering cooperative education in the United States. More specifically, the purpose of this paper is to synthesize conference proceedings published by ASEE from 2000-2023 to explore trends and identify areas of opportunity for future work. While there have been several major NSF grants focused on cooperative education and a number of engineering programs with mandatory cooperative education requirements there is still work to be done to connect research efforts to practice. This paper contributes to the literature by synthesizing previously conducted research and providing recommendations for future research and practice to improve cooperative education. Specifically, through this literature review we explore two key questions:

1. What major trends exist in the literature published through the American Society of Engineering Education on the topic of co-ops and cooperative education?
2. Based on the published literature, what opportunities exist for further exploration of co-ops and cooperative education?

Methods

To conduct this literature review, we leveraged an evidence-based framework for conducting systematic literature reviews and met with a STEM Librarian at the onset of the project to ensure quality work. To guide the literature search, analysis, and reporting we used the Preferred Reporting Items of Systematic Reviews and Meta-Analyses (PRISMA) method [3]. PRISMA is commonly used in engineering education to guide and report systematic literature reviews and has been cited as a prominent, multidisciplinary tool [4,5]. This method includes identifying and screening records to assess the literature's current state. Figure 1 below displays an overview of how the PRISMA method was used in this study and how articles were identified and screened.

Figure 1. *PRISMA Process Diagram*



In the identification process we used the following search terms: "co-op" or "coop" or "cooperative education" and scoped to the years 2000-2023 to survey the past 20 years of cooperative education. Since our goal was to survey the broader landscape of work published on coops in a specific venue our search terms were broad. Furthermore, our search focused on ASEE Proceedings publicly available through the ASEE PEER document repository [6]. By focusing on the proceedings of ASEE, this review focuses on the largest engineering education professional society for both researchers and practitioners. Additionally, this body of literature was chosen to review because ASEE proceedings are open access articles and are accessible to practitioners in comparison to closed access or paywalled journals. Furthermore, during identification seven records were removed before screen due to duplicates and several abstracts that were for panels and events associated with ASEE that were not refereed paper or poster publications.

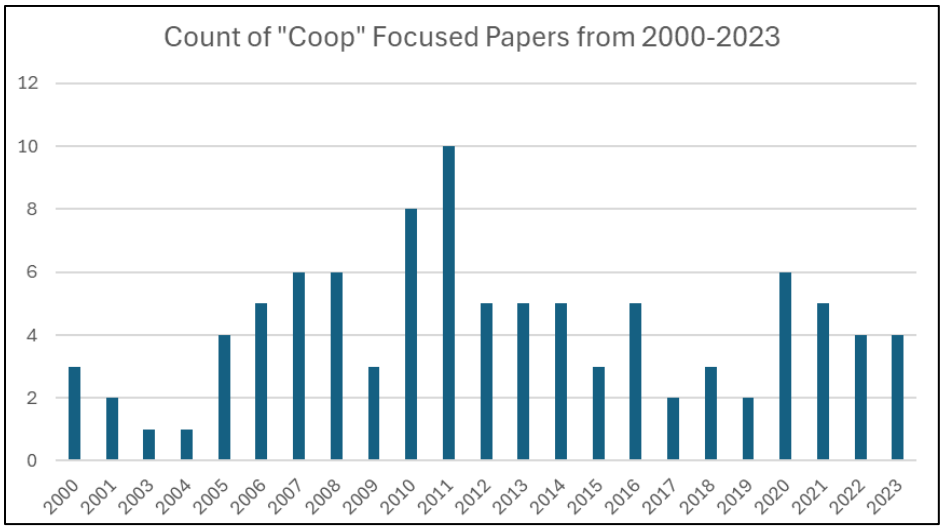
In the screening process we read the abstracts for the 91 remaining records and removed two records for not being relevant to co-ops or cooperative education. After reviewing abstracts, we read through 89 records to assess for eligibility and removed three additional records due to a focus outside of the undergraduate population of interest. The final 86 articles included in this literature review were analyzed for trends and gaps as discussed in the remainder of this paper.

Overview of the Literature

Overall, there has been a significant amount of work published by the American Society of Engineering Education on the topic of co-ops for undergraduate students. This section provides an overview of the work conducted between 2000-2023. A full list of articles can be found in Table 3 in the Appendix.

First, this literature review included 86 records [7-92] which were primarily published in ASEE's Annual Conference Proceedings hosted by the organization each June or the Conference for Industry and Education Collaboration hosted in February by ASEE's Cooperative and Experiential Education Division (CEED), the College Industry Partnership Division (CIPD), the Continuing, Professional, and Online Education Division (CPOED), and the Engineering Technology Division (ETD) specifically. Below is a diagram of the count of papers published over time and while there has been some consistency, there was also a significant increase in literature focused on coops published by ASEE in 2010 and 2011.

Figure 2.



Second, among the records we found that several institutions were heavily involved in publishing work related to coops (seen below in Table 1). Specifically, six institutions were responsible for almost 40% of the papers published focused on coops and cooperative education in ASEE. The institutions with the most papers included several institutions with mandatory co-op programs (i.e., Northeastern, University of Cincinnati). Additionally, across the records the institutions that published work on coops included a range of both public, private, and military institutions, however, there were notably less publications from Minority Serving Institutions (MSIs) such as Historically Black College and Universities (HBCUs), Hispanic-Serving Institutions (HSIs), and Tribal colleges and universities.

Table 1. Most Frequent Institutions and Count

Institution	**Records Published with ASEE**
Northeastern University	9
University of Cincinnati	6
Minnesota State System *(Minnesota State Mankato, Iron Range Engineering)*	5
University of Rochester	4
Kettering University	4
Grand Valley State	4

Key Findings

After an initial analysis of the records, we reviewed the records for trends and identified three key findings detailed below.

Finding 1: Descriptive Papers versus Research Studies

Our first major finding was that there were two major types of published works: research studies and descriptive papers (Figure 3.). More specifically, of the records reviewed 47, or approximately 55%, of the papers were descriptive and 37, or 44%, were research papers. An overview of the descriptive and research paper categories and counts can be seen below in Table 2.

Figure 3.

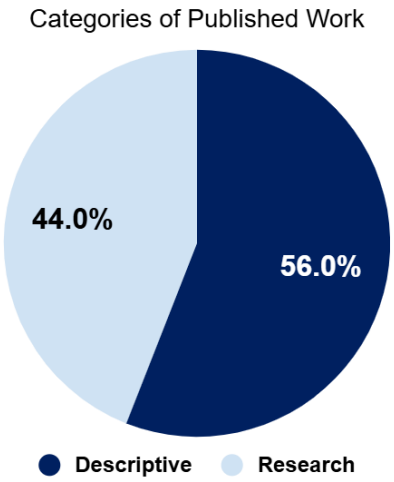


Table 2. Summary of Paper Categories and Counts

Paper Categories	Count
Descriptive	**47**
Co-op Course	6
Co-op Assignment	10
Co-op Program Design	20
Co-op Program Evaluation	14
Research	**39**
Quantitative	22
Qualitative	8
Mixed Methods	3
Design-Based Research	3
Grounded Theory	1
Literature Review	2

Records were categorized as descriptive if they discussed or described the practices or programs used at one of the author's institutions. These papers were explanatory and often focused on describing effective practices and lessons learned. In cases where data was collected, the authors often employed descriptive statistics, and the paper did not include guiding research methods and/or a theoretical grounding (i.e., theoretical or conceptual framework). In terms of topics, we found that descriptive papers often focus on

1. Co-op program design
2. Co-op course design
3. A specific co-op course assignment
4. and/or Program evaluation

Records were categorized as being research papers if they had a chosen method and theoretical grounding (i.e., theoretical or conceptual framework). While some descriptive papers used statistics or interviews their focus was on evaluating a specific program, course, or assignment without theoretical underpinning or reference to previous literature. Within these research papers approximately 56% used quantitative methods such as surveys and approximately 20% used qualitative methods such as phenomenology and thematic analysis. A smaller percentage of papers used a mixed methods research or design-based research approach, and two papers were literature reviews. Furthermore, research frameworks utilized by research papers focused on coops or cooperative education included:

1. Engineering identity
2. Motivation theory
3. Self-efficacy
4. Mental Health

Finding 2: Learning and Skill Development

The second major finding from our review is that there were many descriptive and research papers focused on learning, most of which focused on students' learning and skill development of professional skills. The most common professional skills discussed included: communication, leadership, engineering ethics, time management, and general workplace knowledge.

In contrast, there was only one record by Peters and colleagues [71] that explored technical learning of engineering concepts. Specifically, the authors explored students' perceptions of the connections between a statics course and co-op work experience and found that their participants were able to successfully connect the statics course with their co-op work assignments and other authentic experiences [71]. They also noted that the connections varied tremendously in their form and scope, which supported the need for future research. While there were several other papers that discussed students' increase in GPA post-co-op experience [73], [75], [90] the work by Peters and colleagues [71] is the only record that explored the mechanism that supports connections between academic coursework and co-op experience. This finding will be discussed further in the gaps section.

In terms of learning and skill development, we also found that most papers, both descriptive and research, included discussions of learning that had practical implications for engineering educators and industry practitioners. Two common implications were (1) The

importance of general reflection and goal setting during the co-op experience and (2) the role that pre-co-op professional development courses can play in uncovering the "hidden curriculum." While most authors were from academic institutions, this finding shows that work published at ASEE still has implications and useful recommendations for practitioners and industry.

Finding 3: Time-Based Trends

Over the 23-year time span that we reviewed, from 2000-2023, we noticed several time-based trends that are useful for engineering education researchers and practitioners to note.

Firstly, we noticed a trend in the number of publications that focused on ABET and evaluating students' co-op experiences through the lens of accreditation. Upon further research, we found that there was an increase in work incorporating ABET primarily between 2000-2010 and that this change was likely due to the implementation of Engineering Criteria 2000 or EC 2000 by ABET which emphasized experiential learning and professional skills [93]. Since 2010, there has been little work that includes mention of ABET, however, it is useful to note that the published work is influenced by broader trends in accreditation.

Secondly, we noticed a trend related to the COVID-19 pandemic in 2020-2023. In this timeframe, papers focused on exploring remote and hybrid co-op experiences increased. This trend is consistent with the broader field of engineering education and higher education due to the need for increased flexibility in 2020 and 2021. Moving forward it will be useful to explore if these trends continue.

Lastly, we noted a recent trend incorporating principles of diversity, equity, and inclusion in co-ops. In recent years there has been a slight increase in work focusing on the co-op experiences of students who have been historically marginalized in engineering. Although there is work focused on women [73] in this sample as well as work focused on racially minoritized experiences [77], there is a larger amount of work in focused on marginalized and historically underrepresented students in engineering in the broader ASEE experiential learning literature experiential learning literature (e.g. disability, low-income, first-generation) [94], [95]. As Schearer and colleagues state [94], there is still significant room for work to be done in this space to promote equity and inclusion.

Opportunities and Questions for Future Exploration

Opportunity 1: Technical Skills and Content Knowledge

The first area of opportunity we identified was research and exploration of technical skills and content knowledge learned during co-ops. While there were several papers that discussed learning professional skills (e.g., communication) only one paper focused on the acquisition of technical knowledge and skills. In their research study, Peters and Arbor [71] explored the connection between students' work experiences and a Statics course. This work demonstrates the possibility to connect co-op work assignments to other engineering courses and the opportunity to explore technical learning during co-ops.

Questions for consideration include:

- What connections are students making between their technical coursework and co-op experiences?
- What technical skills are students learning during their co-op experiences?
- What can faculty and academic professionals do to facilitate the connection between the classroom and co-op experiences?
- What can employers do to facilitate the connection between the classroom and co-op experiences?
- How do we measure students' learning of technical knowledge while on co-op?

Opportunity 2: Mental Health and Student Wellbeing

The second area of opportunity we identified was mental health and student wellbeing during co-ops. In the review of the literature, we found one paper focused on health and wellbeing during co-op experiences. Spence and colleagues [89] identified the types of coping strategies used by students, explored students' perceptions of the connection between wellbeing and belongingness, and the use of reflection as a coping strategy. The authors further recommended that institutions provide students with a wide variety of resources and coping strategies to help support students in identifying health and wellness strategies that work best for them [53]. This work, the growing research on mental health in engineering [96], and the well-documented mental health crises for college students [97] demonstrate the opportunity to deeper explore mental health and student wellbeing during co-ops.

Questions for consideration include:

- How do co-ops affect students' mental health?
- What coping strategies do students employ to support health and wellbeing on co-op?
- What practices support students' mental health while on co-op?
- What support, programming, and resources can faculty and academic professionals provide to prepare students for wellbeing on co-ops?
- What can employers do to support students' mental health while on co-op?

Opportunity 3: Equitable Co-op Design and Inclusive Practices

The third area of opportunity we identified was equitable co-op design and inclusive practices. In recent years there has been a slight increase in work focusing on the co-op experiences of students who have been historically marginalized in engineering. In our review, there was a paper focused on women that compared women's and men's self-efficacy as a result of participating in a co-op experience [73]. There was also a paper focused on racially minoritized students' experiences in internships and co-ops [77]. Furthermore, there are other publications in the ASEE literature more broadly focused on supporting disabled students, first-generation and low-income during work-based learning experiences (e.g. [94], [95]), however, given the few papers that explore co-ops from an equity lens, there is still more work to be done to further our understanding and promote positive experiences in cooperative education for all students.

Questions for consideration include:

- How do we design inclusive and equitable co-ops from the job acquisition stage to the workplace?

- What are effective practices that promote an inclusive workplace and environment for engineering students?
- What can employers do to support an inclusive environment?
- What can faculty and academic professionals do to support an inclusive environment?

Opportunity 4: Global & International Coops

The fourth area of opportunity is global and international co-op experiences. There is a significant amount of literature published by ASEE and in engineering education focused on global experiences and study abroad experiences for engineers. Scholars have called for the need for engineering students to "possess cross-cultural communication skills, team management skills, and the ability to perform on geographically distributed teams" [98]. Furthermore, study abroad programs and internships have been promoted as a way to "engineer global competencies" [99].

In our review of the literature, we found five descriptive papers that discussed international or global co-op programs [9], [13], [18], [26], [47]. These five papers included the word "global" or "international" in their title and for the purposes of this review we determined an international co-op was defined as any program where the students leave the country of their home institution for a co-op experience. In addition to these five papers there was an additional proceeding that was screened from the review because it was not a paper or poster but a panel at the 2006 ASEE Annual Conference titled: "Developing Globally Minded Engineers Through Education and Experience: A Panel Discussion On International Co Op/Internship Program Models" [100]. This panel and four of the five papers focused on international co-ops were published prior to 2010 and it is surprising that only one paper focused on global co-ops between 2010-2020. In the aftermath of the COVID-19 pandemic and with the resurgence of study abroad programs, there is an opportunity to support and research international co-ops.

Questions for consideration include:

- What are the similarities and differences in student experiences during a domestic co-op compared to an international co-op?
- What considerations and practices effectively support students at work in international countries?
- What barriers and support exist in coordinating international co-ops?
- How can faculty and academic professionals create global partnerships to support international co-ops?

Conclusion

Through the review of 86 ASEE conference publications from 2000-20223, this paper explored three major trends and identified four areas of opportunity for future work. The first major trend focused on the types of papers published and their methods. We found that 56% of the papers published on co-ops or cooperative education were descriptive in nature compared to approximately 44% which were focused on research. Descriptive papers most commonly focused on describing a co-op course, a specific assignment in a co-op course, co-op program design, or an evaluation of a co-op program. Amongst research papers, we found that the majority of research studies reported used quantitative methods such as surveys and around 20% used qualitative methods. The second major trend focused on shifts over time. Specifically, the rise in papers incorporating ABET during 2000-2010, likely due to the Engineer of 2020 Criteria and

since 2020 both an increase in hybrid and remote work and focus on exploring the experiences of minoritized students. In addition to the trends discussed, this work uncovered areas of opportunities for both practitioners and researchers supporting and/or exploring technical skills and content knowledge gained co-ops, mental health and wellbeing, equitable co-op design and inclusive practices, and international co-ops.

This literature review provides insight into the trends from 2000-2023 as well as opportunities for the field of engineering education to continue to improve our co-ops and cooperative education. Over the past twenty-three years there has been a significant amount of publications, both descriptive and research focused, that have advanced our practices and understanding. As work-integrated and experiential learning continue to evolve it is crucial for practitioners and researchers to continue to share their knowledge for the shared and continued progress of our community of practice.

References

[1] NAE. (2018). Understanding the educational and career pathways of engineers. In The National Academy of Engineering (Vols. 2018-June). The National Academies Press. https://doi.org/10.17226/25284

[2] ASEE. (2024). Cooperative and Experiential Education Division. Retrieved from: https://ceed.asee.org/

[3] Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009) Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. https://doi.org/10.1371/journal.pmed.1000097

[4] Power, J. (2021). Systematic reviews in engineering education: a catalyst for change. *European Journal of Engineering Education*, *46*(6), 1163–1174. https://doi.org/10.1080/03043797.2021.1980770

[5] Phillips, M., Reed, J. B., Zwicky, D., & Van Epps, A. S. (2024). A scoping review of engineering education systematic reviews. Journal of Engineering Education, 113(4), 818–837. https://doi.org/10.1002/jee.20549

[6] ASEE (2024). https://peer.asee.org/

[7] Gunn, C. (2000, June), Utilizing Co Op To Further Liberal Education Within Engineering Paper presented at 2000 Annual Conference, St. Louis, Missouri. 10.18260/1-2--8828

[8] Anderson, A., & Lee-Thomas, G. (2000, June), Assessing Cooperative Education Through The Lens Of Abet Outcomes Paper presented at 2000 Annual Conference, St. Louis, Missouri. 10.18260/1-2--8172

[9] Wilding, K., & Grossman, C., & Hundley, S., & Fox, P. (2001, June), An International Cooperative Education Experience For Engineering And Technology Students Paper presented at 2001 Annual Conference, Albuquerque, New Mexico. 10.18260/1-2--9457

[10] Sathyamoorthy, M. (2003, June), An Innovative Co Op Program At WVU Tech Paper presented at 2003 Annual Conference, Nashville, Tennessee. 10.18260/1-2--12406

[11] Cala, M., & Patel, J., & Kudav, G., & Davis, B. (2004, June), Industry University Partnership A Model For Faculty Continuing Development And Student Co Op Opportunities Paper presented at 2004 Annual Conference, Salt Lake City, Utah. 10.18260/1-2--12858

[12] Bankes, W., & Eastman, M., & Trippe, A., & Lillie, J., & Zion, G. (2005, June), Students Sharing Their Co Op Experiences Paper presented at 2005 Annual Conference, Portland, Oregon. 10.18260/1-2--15243
[13] Powell, R., & Kwinn, M. (2005, June), Enhancing Engineering Education Through Global Co Ops Paper presented at 2005 Annual Conference, Portland, Oregon. 10.18260/1-2--15115
[14] Cote, M. (2005, June), The Development Of A Cooperative Education Project As An Assessment Tool For An Engineering Technology Program Paper presented at 2005 Annual Conference, Portland, Oregon. 10.18260/1-2--15600
[15] Gunn, C. (2006, June), Co Op, Communication, And Engineering Disciplines Paper presented at 2006 Annual Conference & Exposition, Chicago, Illinois. 10.18260/1-2--397
[16] Griffin, R., & McMahon, D., & Marberry, M. (2006, June), Using Cooperative Education Data For Abet Reviews Paper presented at 2006 Annual Conference & Exposition, Chicago, Illinois. 10.18260/1-2--1417
[17] Stwalley, R. (2006, June), Definition, Mission, And Revitalization Of Cooperative Education Programs Paper presented at 2006 Annual Conference & Exposition, Chicago, Illinois. 10.18260/1-2--975
[18] Guidera, S. (2006, June), Integrating Study Abroad And Cooperative Education: A Case Study Paper presented at 2006 Annual Conference & Exposition, Chicago, Illinois. 10.18260/1-2--566
[19] Cates, C., & Todd, A. (2007, June), Online Assessment And Learning Instruments For Cooperative Education Students: The Importance Of Co Op Data To Abet Paper presented at 2007 Annual Conference & Exposition, Honolulu, Hawaii. 10.18260/1-2--1764
[20] Mathews, J., & Reese, D. (2007, June), Using Co Op Employer Surveys To Assess Abet Outcomes Paper presented at 2007 Annual Conference & Exposition, Honolulu, Hawaii. 10.18260/1-2--1591
[21] Walsh, D., & Whited, J., & Crockett, R. (2007, June), Cooperative Education As A Prime Mover And Key Constant In Industry ? University Relationships Paper presented at 2007 Annual Conference & Exposition, Honolulu, Hawaii. 10.18260/1-2--2261
[22] Godbey, J., & Marbut, T., & Broyles, D. (2007, June), Expanding A Successful Industry Based Partnership Beyond The Traditional Cooperative Education Experience Paper presented at 2007 Annual Conference & Exposition, Honolulu, Hawaii. 10.18260/1-2--1627
[23] Cates, C., & Cedercreutz, K. (2007, June), The Use Of Cooperative Education In Curricular Reform: The Abet Feedback Cycle Realized Paper presented at 2007 Annual Conference & Exposition, Honolulu, Hawaii. 10.18260/1-2--1572
[24] Johnson, J., & Crisanti, E., & Collet, J., & Grood, E., & Moeller, L. (2008, June), Undergraduate Research Co Op In Biomedical Engineering Paper presented at 2008 Annual Conference & Exposition, Pittsburgh, Pennsylvania. 10.18260/1-2--4251
[25] El-Sayed, J. (2008, June), The Role Of Co Op Experience In Achieving Engineering Educational Outcomes Paper presented at 2008 Annual Conference & Exposition, Pittsburgh, Pennsylvania. 10.18260/1-2--3169
[26] Akins, T., & Gulick, D. D., & Lohmann, J. (2008, June), Models On Industry And University Global Collaboration Through Co Op And Internships Paper presented at 2008 Annual Conference & Exposition, Pittsburgh, Pennsylvania. 10.18260/1-2--4438

[27] Johrendt, J., & Hector, S., & Watters, M., & Northwood, D., & Salinitri, G., & Jaekel, A., & Benzinger, K. (2009, June), A Learning Outcomes Survey Of Engineering Cooperative Education Students: Preliminary Findings Paper presented at 2009 Annual Conference & Exposition, Austin, Texas. 10.18260/1-2--4993
[28] Schreck, R. M., & Cline, A. (2010, June), Enhancing The Co Op Learning Process Paper presented at 2010 Annual Conference & Exposition, Louisville, Kentucky. 10.18260/1-2--16155
[29] Coolen, A. M. (2011, June), Implementing a CEAB Graduate Attributes Based Co-op Work Term Curriculum Paper presented at 2011 ASEE Annual Conference & Exposition, Vancouver, BC. 10.18260/1-2--18096
[30] Andreeva-Moschen, E., & Millward-Sadler, A. J. (2011, June), Designing a New Evenly Balanced Curriculum for a Co-op Automotive Engineering Bachelor's Degree Program Paper presented at 2011 ASEE Annual Conference & Exposition, Vancouver, BC. 10.18260/1-2--17720
[31] Gygi, K. F., & Turns, J. A. (2011, June), "I Just Thought I Did Insignificant Tasks": Using e-Portfolios to Understand Co-Op and Undergraduate Research Experiences Paper presented at 2011 ASEE Annual Conference & Exposition, Vancouver, BC. 10.18260/1-2--17289
[32] Jeffryes, J. N. (2011, June), Gauging Workplace Readiness: Information Behavior and Preparedness of Engineering Students in Cooperative Education Programs Paper presented at 2011 ASEE Annual Conference & Exposition, Vancouver, BC. 10.18260/1-2--18017
[33] Joseph, A., & Payne, M. (2011, June), Computing Students Relative Use of Cooperative Education Services within an Urban University Paper presented at 2011 ASEE Annual Conference & Exposition, Vancouver, BC. 10.18260/1-2--17646
[34] Rutz, E. (2011, June), Lessons Learned Offering a Combined B.S. Engineering (with Cooperative Education) and M.B.A. Paper presented at 2011 ASEE Annual Conference & Exposition, Vancouver, BC. 10.18260/1-2--18276
[35] Gunn, C. J. (2012, June), Co-ops and Their Communication Needs Paper presented at 2012 ASEE Annual Conference & Exposition, San Antonio, Texas. 10.18260/1-2--21077
[36] Pearson, E. P., & Boyd, T. (2012, June), Aligning Internship, Co-op, and New Graduate Engineering Rotation Programs to Improve Experiential Learning Paper presented at 2012 ASEE Annual Conference & Exposition, San Antonio, Texas. 10.18260/1-2--20903
[37] Younis, N. (2012, June), Cooperative Education Impact on Enhancing Mechanical Engineering Curriculum Paper presented at 2012 ASEE Annual Conference & Exposition, San Antonio, Texas. 10.18260/1-2--21105
[38] Kelley, K. P., & McGonagle, S. T. (2013, June), "Leveraging Co-op Experiences to Enhance Engineering Students' Leadership Skills" Paper presented at 2013 ASEE Annual Conference & Exposition, Atlanta, Georgia. 10.18260/1-2--19025
[39] Gunn, C. J. (2013, June), Co-ops and Interns-What Do They See as Their Communication Needs Paper presented at 2013 ASEE Annual Conference & Exposition, Atlanta, Georgia. 10.18260/1-2--19305
[40] Plouff, C. (2013, June), Cooperative Education as the Catalyst for Effective and Efficient Assessment of ABET Student Learning Outcomes for an Engineering Program Paper presented at 2013 ASEE Annual Conference & Exposition, Atlanta, Georgia. 10.18260/1-2--19354

[41] Plouff, C., & Barakat, N. (2014, June), A Model for Engineering Ethics Education through a Co-op Program Paper presented at 2014 ASEE Annual Conference & Exposition, Indianapolis, Indiana. 10.18260/1-2--19961
[42] Watson, J., & Schomaker, M. G. (2014, June), Introduction to Cooperative Education-The Course Paper presented at 2014 ASEE Annual Conference & Exposition, Indianapolis, Indiana. 10.18260/1-2--20708
[43] Pung, C. P., & Plotkowski, P. D., & Plouff, C. (2015, June), Leveraging Cooperative Education Experiences to Enhance and Develop the Capstone Design Course Paper presented at 2015 ASEE Annual Conference & Exposition, Seattle, Washington. 10.18260/p.24428
[44] Hamilton, S. R., & Fitzmaurice, J., & Wolff, P. J. (2016, June), Building Future Careers: A Co-op Course Reimagined Paper presented at 2016 ASEE Annual Conference & Exposition, New Orleans, Louisiana. 10.18260/p.26411
[45] Sadat-Hossieny, M., & Torres, M. (2016, June), How Co-op in Engineering Technology Proves to Strengthen Student Learning and Fulfill Student Learning Outcomes Paper presented at 2016 ASEE Annual Conference & Exposition, New Orleans, Louisiana. 10.18260/p.25470
[46] Davis, R. A. (2016, June), An Online Course for Professional Development of Chemical Engineering COOPs and Interns Paper presented at 2016 ASEE Annual Conference & Exposition, New Orleans, Louisiana. 10.18260/p.26232
[47] Schwarz, S. (2018, August), Eurotech - Preparing Engineering Students for International Co-ops in Germany and Beynond Paper presented at 2018 ASEE Conferences - Conference for Industry and Education Collaboration / San Antonio proceedings, San Antonio. 10.18260/1-2-370-31375
[48] Corneal, L., & Reffeor, W. S., & Pung, C. P. (2020, June), Linking Co-op and Senior Project: Technical Proposal Requirement Embedded in Second Co-op Rotation Paper presented at 2020 ASEE Virtual Annual Conference Content Access, Virtual Online. 10.18260/1-2--34929
[49] Rayess, N. E., & Pistrui, D., & Bonnstetter, R., & Gehrig, E. T. (2020, June), Co-op Education and the Impact on the Behaviors and Competencies of Undergraduate Engineering Students Paper presented at 2020 ASEE Virtual Annual Conference Content Access, Virtual Online . 10.18260/1-2--34294
[50] Ackerman, P., & Arcieri, K. (2022, August), Co-ops are Great! But What are the Numbers Telling Us? Paper presented at 2022 ASEE Annual Conference & Exposition, Minneapolis, MN. 10.18260/1-2--40896
[51] Hochgraf, C., & Christman, J., & Shackelford, L., & Nation-Knapper, S., & Brown, D. (2022, August), Vertically Integrating E-portfolios and Cooperative Educational Experiences to Develop Students' Entrepreneurial Mindset Paper presented at 2022 ASEE Annual Conference & Exposition, Minneapolis, MN. 10.18260/1-2--41573
[52] Ackerman (2023, June), Board 69: Co-ops are Great! But What Are the Final Numbers Telling Us? Paper presented at 2023 ASEE Annual Conference & Exposition, Baltimore , Maryland. 10.18260/1-2--42906\
[53] Spence, C. M., & Siverling, E. A., & Soledad, M. (2023, June), Board 330: Iron Range Engineering Academic Scholarships for Co-Op Based Engineering Education Paper presented at 2023 ASEE Annual Conference & Exposition, Baltimore , Maryland. 10.18260/1-2--42930

[54] Canale, R. L., & Duwart, E. J., & Cates, C. (2000, June), Co Op And Abet 2000: The Added Learning Dimension! Paper presented at 2000 Annual Conference, St. Louis, Missouri. 10.18260/1-2--8242
[55] Ohland, M., & Finelli, C. (2001, June), Peer Evaluation In A Mandatory Cooperative Education Environment Paper presented at 2001 Annual Conference, Albuquerque, New Mexico. 10.18260/1-2--9643
[56] Baber, T., & Fortenberry, N. (2008, June), The Academic Value Of Cooperative Education: A Literature Review Paper presented at 2008 Annual Conference & Exposition, Pittsburgh, Pennsylvania. 10.18260/1-2--3148
[57] Pierrakos, O., & Borrego, M., & Lo, J. (2008, June), Preliminary Findings From A Quantitative Study: What Are Students Learning During Cooperative Education Experiences? Paper presented at 2008 Annual Conference & Exposition, Pittsburgh, Pennsylvania. 10.18260/1-2--3517
[58] Raelin, J., & Hamann, J., & Whitman, D., & Reisberg, R. (2008, June), The Effect Of Cooperative Education On Self Efficacy Among Undergraduate Engineering Students Paper presented at 2008 Annual Conference & Exposition, Pittsburgh, Pennsylvania. 10.18260/1-2--3748
[59] El-Sayed, J., & Stodola, D. (2009, June), Integrating Co Op And Classroom Learning Experiences Paper presented at 2009 Annual Conference & Exposition, Austin, Texas. 10.18260/1-2--5197
[60] Joseph, A., & Payne, M. (2009, June), The Impact Of Cooperative Education Internships On Full Time Employment Salaries Of Students In Computing Sciences Paper presented at 2009 Annual Conference & Exposition, Austin, Texas. 10.18260/1-2--5854
[61] Johrendt, J., & Hector, S., & Benzinger, K., & Salinitri, G., & Jaekel, A., & Northwood, D., & Watters, M. (2010, June), Learning Outcomes Achievement In Cooperative Education: A Survey Of Engineering Students Paper presented at 2010 Annual Conference & Exposition, Louisville, Kentucky. 10.18260/1-2--16581
[62] Yin, A. (2010, June), Understanding Cooperative Education And Internships: The Influence On Engineering Students' Problem Solving Skills Paper presented at 2010 Annual Conference & Exposition, Louisville, Kentucky. 10.18260/1-2--15670
[63] Joseph, A., & Payne, M. (2011, June), Computing Students Relative Use of Cooperative Education Services within an Urban University Paper presented at 2011 ASEE Annual Conference & Exposition, Vancouver, BC. 10.18260/1-2--17646
[64] Castro-Cedeno, M., & Mazumder, Q. (2010, June), Motivation And Maturity Of Engineering And Engineering Technology Students With And Without Coop Experience Paper presented at 2010 Annual Conference & Exposition, Louisville, Kentucky. 10.18260/1-2--15686
[65] Smyser, B. M., & Kowalski, G. J. (2011, June), Assessing the Effect of Co-Op Sequence on Capstone Design Performance Paper presented at 2011 ASEE Annual Conference & Exposition, Vancouver, BC. 10.18260/1-2--17523
[66] Ingram, S., & Ens, A. H., & Friesen, M. R. (2011, June), Academic Preparation in a Co-Op Program as a Career Enhancement Tool for International Engineering Graduates Paper presented at 2011 ASEE Annual Conference & Exposition, Vancouver, BC. 10.18260/1-2--17413
[67] Anderson, K., & Prem, K. J., & Wirsbinski, S., & Courter, S. S. (2011, June), Comparing the Learning Experiences of Male and Female Engineering Students in Internship and

Cooperative Educational Opportunities Paper presented at 2011 ASEE Annual Conference & Exposition, Vancouver, BC. 10.18260/1-2--17629
[68] Reisberg, R., & Raelin, J. A., & Bailey, M. B., & Whitman, D. L., & Hamann, J. C., & Pendleton, L. K. (2012, June), The Effect of Cooperative Education on the Self-efficacy of Students in Undergraduate Engineering Paper presented at 2012 ASEE Annual Conference & Exposition, San Antonio, Texas. 10.18260/1-2--22050
[69] Wanless, D. (2013, June), Perspectives from internships and co-ops with industry Paper presented at 2013 ASEE Annual Conference & Exposition, Atlanta, Georgia. 10.18260/1-2--22349
[70] Raelin, J. A., & Bailey, M. B., & Hamann, J. C., & Whitman, D. L., & Reisberg, R., & Pendleton, L. K. (2013, June), The Effect of Cooperative Education and Contextual Support on the Retention of Undergraduate Engineering Students Paper presented at 2013 ASEE Annual Conference & Exposition, Atlanta, Georgia. 10.18260/1-2--22575
[71] Peters, D. L., & Arbor, J. (2014, June), Student Perceptions of Connections between Statics Class and Co-op Work Experience Paper presented at 2014 ASEE Annual Conference & Exposition, Indianapolis, Indiana. 10.18260/1-2--23051
[72] Main, J. B., & Ohland, M. W., & Ramirez, N. M., & Fletcher, T. L. (2014, June), Access to Cooperative Education Programs and the Academic and Employment Returns by Race, Gender, and Discipline Paper presented at 2014 ASEE Annual Conference & Exposition, Indianapolis, Indiana. 10.18260/1-2--20020
[73] Raelin, J. A., & Bailey, M. B., & Hamann, J. C., & Reisberg, R., & Whitman, D. L., & Pendleton, L. K. (2014, June), The Effect of Cooperative Education, Contextual Support, and Self-Efficacy on Male and Female Student Retention Paper presented at 2014 ASEE Annual Conference & Exposition, Indianapolis, Indiana. 10.18260/1-2--23135
[74] Main, J. B., & Ohland, M. W., & Ramirez, N., & Fletcher, T. L., & Davis, J. (2015, June), Factors Associated with Student Participation in Cooperative Education Programs (Co-Ops) Paper presented at 2015 ASEE Annual Conference & Exposition, Seattle, Washington. 10.18260/p.24094
[75] Ramirez, N., & Main, J. B., & Ohland, M. W. (2015, June), Academic Outcomes of Cooperative Education Participation Paper presented at 2015 ASEE Annual Conference & Exposition, Seattle, Washington. 10.18260/p.23479
[76] Gunderson, K. E., & Bailey, M. B., & Raelin, J. A., & Ladge, J., & Garrick, R. (2016, June), The Effect of Cooperative Education on Retention of Engineering Students & the Transition to Full-Time Employment Paper presented at 2016 ASEE Annual Conference & Exposition, New Orleans, Louisiana. 10.18260/p.26131
[77] Strayhorn, T. L., & Johnson, R. M. (2016, June), What Underrepresented Minority Engineering Majors Learn from Co-Ops & Internships Paper presented at 2016 ASEE International Forum, New Orleans, Louisiana. 10.18260/1-2--27273
[78] McNeil, J. C., & Andrade, M., & Beebe, A. D. (2017, June), The Students' Experience Coming Back After Cooperative Education Experiences Paper presented at 2017 ASEE Annual Conference & Exposition, Columbus, Ohio. 10.18260/1-2--29014
[79] Ehlert, K. M., & Orr, M. K. (2019, June), Board 132: Documenting Student Perspectives of Learning While on Co-op Paper presented at 2019 ASEE Annual Conference & Exposition , Tampa, Florida. 10.18260/1-2--32237
[80] Johnson, B., & Main, J. B. (2019, June), Underrepresented Minority Engineering Students' Professional Experiences with Cooperative Education: Perceived Benefits, Drawbacks, and

Pathways to Participation Paper presented at 2019 ASEE Annual Conference & Exposition , Tampa, Florida. 10.18260/1-2--33474
[81] Ehlert, K. M., & Orr, M. K. (2020, June), Understanding How Co-op Students View their Learning Paper presented at 2020 ASEE Virtual Annual Conference Content Access, Virtual On line . 10.18260/1-2--35421
[82] Rogalsky, D., & Johnson, B. M., & Ulseth, R. R. (2020, June), Design-Based Research: Students Seeking Co-op in New Educational Model Paper presented at 2020 ASEE Virtual Annual Conference Content Access, Virtual On line . 10.18260/1-2--34398
[83] Ali, H., & Harris, J. (2020, June), Development of Employability Skills in Engineering Disciplines through Co-op Paper presented at 2020 ASEE Virtual Annual Conference Content Access, Virtual On line . 10.18260/1-2--34458
[84] Maki, B., & Mann, C. (2020, June), Guiding Student Engineers in the Co-op Obtainment Process: Exploring Methods of Motivation Paper presented at 2020 ASEE Virtual Annual Conference Content Access, Virtual On line . 10.18260/1-2--34718
[85] Rogalsky, D., & Ulseth, R. (2021, July), Design-Based Research: Students Seeking Co-Op in Refined Educational Model Paper presented at 2021 ASEE Virtual Annual Conference Content Access, Virtual Conference. 10.18260/1-2--36925
[86] Peters, D. L. (2021, July), Student Perceptions of Connections Between an Introductory Dynamic Systems Class and Co-Op Work Experience Paper presented at 2021 ASEE Virtual Annual Conference Content Access, Virtual Conference. 10.18260/1-2--37753
[87] Dietz, G. A., & Wishah, L., & Douglas, E. P., & McCray, E. D. (2021, July), WIP: Assessing Community Cultural Wealth and Funds of Knowledge for Students Attending a Co-Op-Based Engineering Program Paper presented at 2021 ASEE Virtual Annual Conference Content Access, Virtual Conference. 10.18260/1-2--38070
[88] Rogalsky, D., & Johnson, B., & Ulseth, R. (2022, August), Design-Based Research: Multiple cohorts of students seeking co-ops in a co-op-centric educational model Paper presented at 2022 ASEE Annual Conference & Exposition, Minneapolis, MN. 10.18260/1-2--40815
[89] Spence, C., & Nyberg, L., & Chasmar, J., & Nelson, J., & Tsugawa, M. (2022, August), Working Full Time and Earning an Engineering Degree: Wellbeing in a Co-Op-Based Engineering Program Paper presented at 2022 ASEE Annual Conference & Exposition, Minneapolis, MN. 10.18260/1-2--41119
[90] Imbrie, P., & Ranjbar, F., & Agarwal, J. (2023, June), Board 70: Impact of First Co-op Experience on Student Retention and Learning: A Work in Progress Paper presented at 2023 ASEE Annual Conference & Exposition, Baltimore , Maryland. 10.18260/1-2--42910
[91] Hanna, G., & Ibegbu, N., & Sherman, A., & Boyar, N., & Garay, N., & Rayess, N. E. (2023, March), An Evaluation of Remote Co-op Assignments on Engineering Students Paper presented at 2023 ASEE North Central Section Conference, Morgantown, West Virginia. 10.18260/1-2--44926
[92] Noyes, C. R., & Gordon, J., & Ludlum, J. (2011, June), The Academic Effects of Cooperative Education Experiences: Does Co-op Make a Difference in Engineering Coursework? Paper presented at 2011 ASEE Annual Conference & Exposition, Vancouver, BC. 10.18260/1-2--18449
[93] ABET. (2024). About ABET - History. Retrieved from: https://www.abet.org/about-abet/history/
[94] Schearer, E. M., & Reinthal, M. A., & Jackson, D. K. (2019, June), Supporting Students with Mobility and Dexterity Disabilities in a Research Experiences for Undergraduates Summer

Program Paper presented at 2019 ASEE Annual Conference & Exposition , Tampa, Florida. 10.18260/1-2--33327
[95] Yang, J., & Towles, J. D., & Sheppard, S., & Atwood, S. (2022, August), Internships' Impact on Recognition for First-Generation and/or Low-Income Students Paper presented at 2022 ASEE Annual Conference & Exposition, Minneapolis, MN. 10.18260/1-2--40755
[96] Jensen KJ, Cross KJ. Engineering stress culture: Relationships among mental health, engineering identity, and sense of inclusion. Journal of Engineering Education. 2021; 110: 371–392. https://doi.org/10.1002/jee.20391
[97] Flannery, M.E. (2023). The Mental Health Crisis on College Campuses. https://www.nea.org/nea-today/all-news-articles/mental-health-crisis-college-campuses
[98] Doerry, E. & Doerry, K. & Bero, B.. (2003). The global engineering college: Exploring a new model for engineering education in a global economy. ASEE Annual Conference Proceedings. 7127-7139.
[99] Tunno, P. (2023, June), Engineering Global Competencies through Study Abroad Paper presented at 2023 ASEE Annual Conference & Exposition, Baltimore , Maryland. 10.18260/1-2--43313
[100] Gulick, D., & Pearson, D., & Elliott, G., & Oliver, J., & Zimmer, K. (2006, June), Developing Globally Minded Engineers Through Education And Experience: A Panel Discussion On International Co Op/Internship Program Models Paper presented at 2006 Annual Conference & Exposition, Chicago, Illinois. 10.18260/1-2--223

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Appendix

Table 3. Summary of Literature

Author(s), Year	Paper Type	Co-op Assignment	Co-op Course	Co-op Program Design	Co-op Program Evaluation	Quant	Qual	Other	External Author to Academia
Anderson & Lee-Thomas, 2001	Descriptive				X				
Gunn, 2000	Descriptive	X							
Wilding et al., 2001	Descriptive			X					
Sathyamoorthy, 2003	Descriptive			X					
Cala et al., 2004	Descriptive			X					
Bankes et al., 2005	Descriptive	X							
Cote, 2005	Descriptive			X	X				
Powell & Kwinn, 2005	Descriptive			X					
Griffin et al., 2006	Descriptive				X				

Guidera, 2006	Descriptive			X					
Gunn, 2006	Descriptive	X							
Stwalley, 2006	Descriptive			X					
Cates & Cedercreutz, 2007	Descriptive			X	X				
Cates & Todd, 2007	Descriptive	X							
Godbey et al., 2007	Descriptive			X					Industry
Mathews & Reese, 2007	Descriptive				X				
Walsh et al., 2007	Descriptive			X					Industry
Akins et al., 2008	Descriptive			X					
El-Sayed, 2008	Descriptive				X				
Johnson et al., 2008	Descriptive			X					
Johrendt et al., 2009	Descriptive				X				
Schreck & Cline, 2010	Descriptive	X							
Andreeva-Moschen & Milward-Sadler, 2011	Descriptive			X					
Coolen, 2011	Descriptive			X					
Gygi & Turns, 2011	Descriptive	X							
Jeffryes, 2011	Descriptive		X						
Joseph & Payne, 2011	Descriptive								
Rutz, 2011	Descriptive			X					
Gunn, 2012	Descriptive	X							
Pearson & Boyd, 2012	Descriptive			X					Industry
Younis, 2011	Descriptive			X					
Gunn, 2012	Descriptive	X							
Kelley & McGonagle, 2013	Descriptive			X	X				
Plouff, 2013	Descriptive			X	X				
Plouff & Barakat, 2014	Descriptive				X				
Watson & Schomaker, 2014	Descriptive		X						
Pung et al., 2015	Descriptive		X						
Davis, 2016	Descriptive		X						
Hamilton et al., 2016	Descriptive		X						
Sadat-Hossieny & Torres, 2016	Descriptive		X						
Schwarz, 2018	Descriptive			X					
Corneal et al., 2020	Descriptive	X							
Rayess et al., 2020	Descriptive				X				Industry

Ackerman & Arcieri, 2022	Descriptive			X	X				
Hochgraf et al., 2022	Descriptive	X							
Ackerman, 2023	Descriptive				X				
Spence et al., 2023	Descriptive			X	X				
Canale & Cates, 2000	Research					X			
Ohland & Purdue, 2001	Research					X			
Baber & Fortenberry, 2008	Research								Non-profit
Pierrakos et al., 2008	Research					X			
Raelin et al., 2008	Research					X			
El-Sayed & Stodola, 2009	Research					X			
Joseph & Payne, 2009	Research					X			Government
Castro-Cedeno & Mazumder, 2010	Research					X			
Johrendt et al., 2010	Research					X			
Joseph & Payne, 2011	Research							Literature Review	
Yin, 2010	Research					X			
Anderson et al., 2011	Research					X			
Ingram et al., 2011	Research						X		
Smyser & Kowalski, 2011	Research							Mixed Methods	
Reisberg et al., 2012	Research					X			
Raelin et al., 2013	Research					X			
Wanless, 2013	Research							Mixed Methods	
Main et al., 2014	Research					X			
Peters & Arbor, 2014	Research						X		
Raelin et al., 2014	Research					X			
Main et al. 2015	Research					X			
Ramirez et al., 2015	Research					X			
Gunderson et al., 2016	Research						X		
Strayhorn & Johnson, 2016	Research							Mixed Methods	
McNeil et al., 2017	Research					X			
Ehlert & Orr, 2019	Research					X			
Johnson & Main, 2019	Research						X		
Ali & Harris, 2020	Research						X		
Ehlert & Orr, 2020	Research					X			
Maki & Mann, 2020	Research						X		

Rogalsky et al., 2020	Research							Design-Based Research	
Dietz et al., 2021	Research						X		
Peters, 2021	Research						X		
Rogalsky & Ulseth, 2021	Research							Design-Based Research	
Rogalsky et al., 2022	Research							Design-Based Research	
Spence et al., 2022	Research						X		
Imbrie et al., 2023	Research					X			
Hanna et al., 2023	Research					X			
Noyes et al., 2011	Research					X			