The Future of Engineering Education
2024 Annual Conference & Exposition
Oregon Convention Center
Portland, OR . June 23 - 26, 2024
Paper ID #42969

Examining the Effectiveness of Industrial Partnerships in Capstone Courses: A Qualitative Study through the Lens of Engineering Undergraduates

Dr. Eileen Fong, Nanyang Technological University

Eileen Fong, PhD, is a Senior Lecturer at School of Materials Science and Engineering (MSE) at Nanyang Technological University (NTU) in Singapore. She is also currently the Associate Chair (Students) at MSE, responsible for student matters and admissions. She teaches third-year MSE undergraduates, and have received several teaching awards including the prestigious Nanyang Education Award for School (2019) and College (2021).

Dr. Ibrahim H. Yeter, Nanyang Technological University

Ibrahim H. Yeter, Ph.D., is an Assistant Professor at the National Institute of Education (NIE) at Nanyang Technological University (NTU) in Singapore. He is an affiliated faculty member of the NTU Centre for Research and Development in Learning (CRADLE) and the NTU Institute for Science and Technology for Humanity (NISTH). He serves as the Director of the World MOON Project and holds editorial roles as Associate Editor of the IEEE Transactions on Education and Editorial Board Member for the Journal of Research and Practice in Technology Enhanced Learning. He is also the upcoming Program Chair-Elect of the PCEE Division at ASEE. His current research interests include STEM+C education, specifically artificial intelligence literacy, computational thinking, and engineering.

Shamita Venkatesh, Nanyang Technological University

Shamita Venkatesh is a senior undergraduate student, majoring in the Philosophy department and minoring in the Economics department at Nanyang Technological University (NTU) in Singapore. She is working on various projects in Dr. Yeter's Research Team at Nanyang Technological University in Singapore, including STEM education, engineering education, artificial intelligence literacy, and computational thinking. Shamita is passionate about contributing to society and finding ways to make things better.

Examining the Effectiveness of Industrial Partnerships in Capstone Courses: A Qualitative Study through the Lens of Engineering Undergraduates

Abstract

Rapid changes in the global economy have necessitated the development of a workforce equipped with the skills to adapt and evolve to meet the demands of the modern workplace. In this context, universities are tasked with preparing and training students to be job-ready upon graduation. Yet, adequately preparing students for engineering careers beyond graduation remains challenging for all engineering institutions. Problem-solving skills are often regarded as one of the key characteristics of successful engineering graduates. Most engineering undergraduates are formally exposed to problem-solving during their senior capstone courses, where students learn how to tackle complex problems while applying their technical knowledge, alongside mastering other essential soft skills such as teamwork, critical thinking, and communication. However, there has been a shift to adopt a more authentic and experiential approach to implementing capstone courses in engineering education of late. Industrial partnerships effectively provide context-specific challenges that are not easily duplicated within an academic environment. Through collaborating with industry and encountering real-world challenges, students can put their theoretical knowledge into practice outside of classroom settings. Moreover, besides translating their technical skill sets, students are exposed to other non-technical aspects of engineering, such as how engineering decisions might be influenced by other factors such as business, ethics, and socioeconomics. A third-year engineering capstone course was recently transformed to incorporate real-world problem statements and industrial mentorship. For the 13-week semester, students worked in teams of six or seven people to solve a problem statement that a company had provided. This study explored how students viewed industrial partnerships in this capstone course. It specifically examined how it influenced their perception of problem-solving, consideration for ethics, and overall confidence as engineers. We used the stratified random sampling technique to select 16 participants, eight females and eight males, for this study. We employed an inductive qualitative analysis to identify important themes related to industrial partnerships that students perceived were critical in the capstone course. These findings may be insightful and imperative for educators when designing capstone courses for engineering undergraduates. Educational and theoretical implications were also further discussed in this study.

Keywords: Industrial engineering partnership, undergraduate, problem-solving, ethics, capstone

Introduction

Employability skills are pertinent in the current context, adding to the need for universities to integrate the learning of such skills into curricula to ensure that the needs of external industries and stakeholders are satisfied (Holt, Mackay, & Smith, 2004). Additionally, the knowledge universities provide is insufficient to help them tackle real-world problems and provide potential solutions to societal issues with innovative yet feasible products (Venkatesh et al., 2022). Moreover, given the multitude of changes in an increasingly globalized world, traditional forms of education based on purely theoretical learning are no longer sufficient to equip students with the ability to work effectively in industry (Powell, 2005).

To address evolving learning needs, educators seek industrial partnerships to expose students to real-world issues (Ford & Lasher, 2004), allowing students to conceptualize, construct, and evaluate solutions to industrial problems (Fong et al., 2023; Yeter et al., 2023). Such partnerships simulate issues in the real world and expose learners to the environment in the industry (Waryoba et al., 2009; Pembridge & Paretti, 2010). An appropriate avenue for fostering industrial-university partnerships is through engineering capstone courses, where students are expected to apply their theoretical knowledge in real-world contexts. By engaging with the industries, students experience first-hand how products are developed, work with design constraints, and learn communication and project management skill sets crucial for transitioning into the workplace after graduation (Goldberg et al., 2014; Holt et al., 2004; Taraban et al., 2017).

To adequately prepare engineering students to apply their skills in the industry and be well-equipped according to the Engineering Accreditation Board (EAB) requirements, it is pertinent for capstone courses in universities to incorporate industry partnerships. Through this, educators can also alter the curriculum to fit current industry needs and better prepare learners for the ever-evolving world. Moreover, employers expect fresh graduates not only to have sufficient engineering know-how but also to possess soft skills such as organization, management, and budgeting (Gilbert & Wingrove, 2019). By working with teams and simulating industry settings, students will be able to acquire the needed skill sets and increase their employability. Hence, industry partnerships are important in engineering capstone courses to ensure that learners have and can apply relevant skills, remain competitive in the industry, and provide educators with a view of what is currently required in the industry.

While educators recognize the tremendous benefits of including industries in capstone courses (Holdsworth et al., 2009), it is possible that learners themselves may not realize their intended value (Gilbert & Wingrove, 2019). Hence, this research aims to analyze how learners perceive their own employability and how they view the transferability and application of what they learn in class in real-world settings (Gilbert & Wingrove, 2019). Besides informing potential curricula changes, findings from this study can also provide a better understanding of how students perceive the industrial experience. Given the limited literature on students' perceptions of industrial partnerships in capstones (van Acker & Bailey, 2011), this study can address this research gap and highlight important aspects of industrial partnerships that are considered valuable to student learners.

In this work, students enrolled in a third-year engineering capstone course were invited to participate in the research study. Course activities were conducted both online and offline while students worked in teams, alongside industry partners to tackle real-world problems. During the course, students not only demonstrate their engineering knowledge but also hone their communication and project management skills to meet the EAB requirements (Venkatesh et al., 2022).

The Significance of the Study

This research study aims to study how participants view industrial partnerships in the course. Specifically, we will identify emerging conceptualizations related to industrial involvement and explore if these perceptions change across genders. Findings from this study add to further understanding of the role of industrial involvement in student learning outcomes in engineering capstone courses. In addition to enhancing the relevance of foreign research frameworks to local practice contexts, our findings will also highlight salient aspects of course design that might be critical for developing effective engineering capstone courses. In line with this aim, our overarching research question is: How do undergraduate students perceive industrial partnerships in engineering capstone courses?

Methodology

Context of study

The study was conducted on students enrolled in a third-year capstone engineering course focusing on industrial design at a university. At the start of the course, the students were randomly grouped into teams of 6 – 7 and tasked to solve a problem provided by a company. The problem statements were randomly assigned. Each team was guided by an industry mentor and a faculty member for the duration of 13 weeks as they tackled the problem statement. The teams met both faculty and industry mentors weekly to gather feedback on their projects. At the end of the course, the teams were assessed by both supervisors.

Participants and Data Collection

We used a stratified random sampling technique to select one female and one male from each team. A total of 16 students (8 females, 8 males) were invited to respond to several open-ended questions as part of a self-reflection assignment at the end of the course. Specifically, the participants were asked the question, “How has industrial collaboration impacted you in this course? Please discuss how the industrial collaboration (a) influenced your perception towards problem-solving, (b) influenced your opinion on ethics, and (c) affected your confidence as an engineer, i.e., self-efficacy.”

Data Analysis

We employed a qualitative inductive approach to analyze the data. Using an open-coding technique, two coders created descriptive codes to ascertain emerging themes. Both sets of codes were compared, and similar codes were grouped and re-titled based on coding themes. Inter-rater agreement was reached during the analysis.

Results and Discussion

Preliminary analysis suggested eight emergent themes: (1) problem-solving, (2) transferability of knowledge, (3) ethical consciousness, (4) sustainability, (5) self-efficacy, (6) knowledge, information, and literacy, (7) gaps and improvements, and (8) misconceptions. Table 1 shows the themes and examples of participant responses for each theme. The frequencies of codes related to each theme are also provided. Of the total number of codes generated for each theme, the number of codes generated by males (M) and females (F) are also shown.

Table 1. *Themes and examples of participant responses to the open-ended question*

Theme		Frequency of code	Examples of participant responses
(1)	Problem-Solving	51/235 (21.7%) M (27) F (24)	*“It made me realise that everything that is thought of and carried out must be practical. Resources and time constraints may also affect the process and as such everyone must be efficient.”* *“All stages are essential to a successful product, but I think given the time and the product nature, its hard for us to brush up on our prototype and test it.”*
(2)	Transferability of Knowledge	52/235 (22.1%) M (28) F (24)	*“To improve the process, I might emphasize a stronger feedback loop between stages. This could involve more frequent user testing, even in the early stages, to validate assumptions and iterate on solutions quickly.”*

Theme		Frequency of code	Examples of participant responses
(3)	Knowledge, Information, and Literacy	40/235 (17.0%) M (18) F (22)	*"Understanding NanoFilm Industries' challenges and requirements on the high cost and low resource of Pt was essential in defining a precise problem statement related to Pt catalyst replacement."*
(4)	Self-Efficacy	32/235 (13.5%) M (16) F (16)	"*This collaboration has significantly boosted my confidence as an engineer."* *"All stages are essential to a successful product, but I think given the time and the product nature, it's hard for us to brush up on our prototype and test it."*
(5)	Ethical Consciousness	21/235 (8.4%) M (14) F (7)	*"Secondly, the industrial collaboration made me understand the importance of ethical responsibility. Although there will be positive and negative impacts, one should be made known the importance of ethical responsibility in the industry."*
(6)	Sustainability	18/235 (7.7%) M (13) F (5)	*"Can the increase in cost be justified by consumer satisfaction; if the new bottle design is more convenient for consumers to use and hence more attractive to consumers, the increase in demand can cover for the increase in cost."*
(7)	Gaps and Improvements	15/235 (6.4%) M (9) F (6)	"*However, since sustainability is a concern these days, I suggest adding a sustainability stage which allows users to stop and think if their solution is sustainable."*
(8)	Misconceptions	4/235 (1.7%) M (0) F (4)	"*I think we had the mindset that we should come up with all possible ideas first before eliminating them then prototyping. We spent quite a lot of time on finding different ways to discharge batteries, then deciding which methods to proceed with. We did our first prototype during recess week but could only finish our second prototype in week 9 and 10 due to waiting for parts to come. As a result, TESTING prototype 2 and creating prototype 3 were squeezed into week 11 which was a little rushed."*

The themes illustrated the students' perceptions of industrial partnerships in the course at the end of the semester. (1) *Problem-solving.* This theme includes codes that define and recognize skills required by the industry, application of knowledge in practice, and the ability to acquire knowledge whenever there is an identified gap. (2) *Transferability.* This theme refers to codes pertaining to the application of knowledge across various contexts in and outside of engineering. (3) *Knowledge, information, and literacy.* This is a theme that includes codes that relate to understanding the needs of stakeholders and the definition of technical terms. Examples of codes in this theme are "knowledge definition" and "empathy and relation". (4) *Self-efficacy.* This theme includes codes relating to self-confidence and self-awareness as engineers. (5) *Ethical consciousness*. This theme includes codes related to ethical awareness and focuses on the core of ethics. (6) *Sustainability.* This theme includes codes pertaining to overarching concerns with sustainability in areas like "environmental" and "financial" contexts. (7) *Gaps and improvements.* This theme contains codes that highlight suggestions for further improvement of the course or alternative methods to approach problems. Finally, (8) *Misconceptions.* This theme includes codes that discuss students' misunderstandings of existing beliefs pertaining to industrial practices or processes.

Of the eight themes discovered, themes 1 and 2, *problem-solving* and *transferability,* respectively, were the most prominent, and both were with similar frequencies of codes (~20%). The emergence of both themes could be directly attributed to the incorporation of real-world problem statements and industrial mentorship in the course. While working on their projects, students were exposed to many practical considerations unique to the industries. Given that the projects are real-world problems, students were expected to apply their engineering knowledge beyond their major, often in non-engineering contexts such as business and other socio-economic settings.

Theme 3, *knowledge, information, and literacy,* also garnered a considerably large number of codes (17.0%). This theme mainly relates to students' understanding of technical terms and demonstration of empathy where they attempt to understand the pain points of the stakeholders. This theme also highlights the ability of students to engage with the stakeholders, and to consider their viewpoints in their proposed design. Moreover, this theme emphasizes the importance of considering stakeholders and their needs in their design and the practicality of a product besides its theoretical uses. It is interesting to note that there were comparable numbers of codes generated by both males and females for themes 1 - 3, suggesting that both genders viewed these themes with similar importance.

Theme 4, *self-efficacy* is an important consideration for senior-year engineering undergraduates, with 13.5% of the total codes contributing to this theme. Examples of codes in this theme include "self-awareness" and "self-confidence". From the data, it was clear that participants were aware of their capabilities and limitations when asked to perform certain engineering tasks. These findings were, in part, consistent with a reportedly positive perception of students' employability following a capstone course (Gilbert & Wingrove, 2019). Both females and males generated the same number of codes under this theme, which suggests both genders were equally conscious of their own competencies throughout their experiences.

Themes 5, *ethical consciousness*, and 6, *sustainability*, have also emerged from our analysis, though they are not as prominent as the other themes (<10%). This result was not surprising, given the increasing awareness of ethics and sustainability globally, especially when engineering practical designs (Venkatesh et al., 2022). It was interesting to note, however, that there were almost twice as many codes generated by the males compared to the females for these two themes. This suggested that male participants place greater emphasis on issues related to ethics and sustainability. These findings add to mixed literature findings on how gender views ethics and sustainability in existing studies (McCright, 2010; Wang & Juslin, 2010; Haski-Leventhal et al., 2015; Rucks et al., 2016). Given that only a small number of participants were analyzed in this work, further studies are necessary to determine if other factors, such as personal values, backgrounds, outcome expectations, interests, and experiences, played a role in influencing their perception of these aspects (McDonald & Kanske, 2023; Gupta et al., 2023).

Lastly, themes 7 and 8, *gaps and improvement*s, and *misconceptions*, may not directly correlate to industrial partnership. However, they do suggest that interacting with the industries could have prompted students to question or change their beliefs, engage in self-reflection, and identify potential gaps, such as practical tinkering skills, that may be lacking in the existing curricula. For example, one participant wrote, "*Soldering is something that we seldom get to do, through this project we get to try out soldering which is an important skill to have.*"

This reflects the need for more such hands-on experiences for students in their curriculum and highlights how industry partnerships can act as a supplementary learning opportunity and bridge for students to step into the working world.

Limitations

The main limitation of this study is its small sample size. Hence, the viewpoints of the participants may not be representative or generalizable of the engineering undergraduate population. Furthermore, given that the sample is from one university in Singapore, there may be certain limitations to generalizability due to differences in culture and environment. In addition, there is the possibility of participants exhibiting social desirability bias and answering the open-ended questions in a manner that aligns with social norms to portray themselves in a positive light, which may affect the overall accuracy of the data collected. As with all qualitative studies, a limitation of this study is the possibility of preexisting biases amongst the coders, which may impact how they categorize the data gathered from the participants. However, it should be noted that coders were not made aware of the gender of the participants while coding. Lastly, the lack of quantitative data limits the study's findings as it does not conclusively show how student learning is correlated to the presence of industrial partnerships in the course.

Conclusion, Educational Implications, and Recommendations

Industrial partnerships in undergraduate capstone courses allow students to experience and learn responsibility at a professional level, broaden their perspectives on the applications of engineering, and equip them with the capabilities required for jobs (Onal et al., 2017). As educators continue to partner with industries as co-instructors in the classroom, it is important to identify key aspects of industrial collaborations that students view as critical for their learning and training as engineers.

In this work, we identified three emerging themes: *problem-solving*, *transferability of knowledge* and *knowledge, information, and literacy*. All of these themes could be directly attributed to industrial involvement within the capstone course. *Self-efficacy* was also a theme that was identified to be important amongst both male and female participants. This also indicates an opportunity for educators to address some of these identified gaps in knowledge or skill sets through curriculum changes. *Ethical consciousness* and *sustainability* are themes that have emerged from our analysis. This also implies the increasing need to expose undergraduates to real-world issues, such as introducing ethics courses or using engineering case studies to highlight the importance of ethics, safety, and sustainability. Finally, regarding whether gender differences have any correlation to issues such as ethics and sustainability, further studies with a more deliberate focus and a larger sample population are necessary.

Acknowledgment

This material is based upon work supported by the EdeX Teaching and Learning Grant at Nanyang Technological University (NTU) in Singapore. This work was approved by NTU Institutional Review Board (reference number IRB-2021-483). Any opinions, findings, conclusions, or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the EdeX program. We would like to acknowledge all the researchers, data collectors, and students who participated in the study.

References

Bailey, Thomas R. (1995). *Learning to work: Employer involvement in school-to-work transition programs.* Washington, D.C.: The Brookings Institution.

Berry, J., M. (2009). *An examination of partnership development between community service agencies and an institution of higher education: Implications for service-learning*. Ohio State University, Columbus, OH.

Christov-Moore, L., Simpson, E. A., Coudé, G., Grigaityte, K., Iacoboni, M., & Ferrari, P. F. (2014). Empathy: gender effects in brain and behavior. *Neuroscience and Biobehavioral Reviews, 46*(4), 604–627. https://doi.org/10.1016/j.neubiorev.2014.09.001

Farr, M., Lee, R. Metro, R., &Sutton, J. (2001). Using a systematic engineering design process to conduct undergraduate engineering management capstone projects. *Journal of Engineering Education,* 193–197.

Fink, F. K. (2001). Integration of work based learning in engineering education. *31st Annual Frontiers in Education Conference.* Impact on Engineering and Science Education. Conference Proceedings (Cat. No.01CH37193). https://doi.org/10.1109/fie.2001.963747

Fong, E., Yeter, I. H., Venkatesh, S., Kim, M. S., & Liu, J. (2023). Studying the development of design thinking of undergraduate engineering students in Singapore: Qualitative reflection analysis (Research). *2023 ASEE Annual Conference & Exposition Proceedings*, 44350. https://doi.org/10.18260/1-2--44350

Ford, R. M. and Lasher, W. C. (2004). Processes for ensuring quality capstone design projects. *In Proceedings of 34th Annual Frontiers in Education*, Savannah, GA, 2(12), 2-17.

Gilbert, G., & Wingrove, D. (2019). Students' perceptions of employability following a capstone course. *Higher Education, Skills and Work-Based Learning*, *9*(4), 650–661. https://doi.org/10.1108/heswbl-11-2018-0121

Goldberg, J., Vikram, Corliss, G., & Kaiser, K. (2014). *The benefits of industry involvement in the multidisciplinary capstone design course at Marquette University, 30*(1). 6-13.

Gupta, T., Yeter, I. H., & Khoo, M. J. (2023, June). Linking Undergraduate Engineering Students' Outcome Expectations, Interests, Career Goals, Self-Efficacy, Social Support, and Barriers in Singapore: A Social Cognitive Career Theory Study. In *2023 ASEE Annual Conference & Exposition*.

Haski-Leventhal, D., Pournader, M.; McKinnon, A. (2015). The role of gender and age in business students' values, CSR attitudes, and Responsible Management Education: Learnings from the PRME International Survey. *Journal of Business Ethics, 146*(1), 219–239. https://doi.org/10.1007/s10551-015-2936-2

Holdsworth, A, Watty, K & Davies, M. (2009). Developing capstone experiences. *Centre for the Study of Higher Education.* The University of Melbourne.

Holt, D., Mackay, D., & Smith, R. (2004). Developing professional expertise in the knowledge economy: integrating industry-based learning with the academic curriculum in the field of information technology. *AsiaPacific Journal of Cooperative Education, 5*(2), 1–8.

Jackson, H., Tarhini, K., Zapalska, A., & Zelmanowitz, S. (2010). Strategies to infuse global perspectives and industrial collaboration in engineering education. *40th ASEE/IEEE Frontiers in Education Conference.* https://doi.org/10.1109/fie.2010.5673322

Jestrab, E. M., Jahren, C. T., & Walters, R. C. (2009). Integrating industry experts into engineering education: Case study. *Journal of Professional Issues in Engineering Education and Practice, 135*(1), 4–10. https://doi.org/10.1061/(asce)1052-3928(2009)135:1(4)

McCright, A. M. (2010). The effects of gender on climate change, knowledge and concern in the American public. *Population and Environment, 32*(1), 66–87. https://doi.org/10.1007/s11111-010-0113-1

McDonald, B. & Kanske, P. (2023). Gender differences in empathy, compassion, and prosocial donations, but not theory of mind in a naturalistic social task. *Sci Rep,* 13. https://doi.org/10.1038/s41598-023-47747-9

National Research Council. (1986). Engineering education and practice in the United States: Engineering undergraduate education. Washington, D.C.: *National Academy Press.*

Onal, S., Nadler, J., & O'Loughlin, M. (2017). Applying theory to real-world problems: Integrating service-learning into the industrial engineering capstone design course. *International Journal for Service Learning in Engineering, Humanitarian Engineering and Social Entrepreneurship, 12*(2), 57–80. https://doi.org/10.24908/ijsle.v12i2.6659

Pang, C., Li, W., Zhou, Y., Gao, T., & Han, S. (2023). Are women more empathetic than men? questionnaire and EEG estimations of sex/gender differences in empathic ability. *Social Cognitive and Affective Neuroscience, 18(1). https://doi.org/10.1093/scan/nsad008*

Pembridge, J. & Paretti, M. (2010). *The current state of capstone design pedagogy. Proceedings of the American Society for Engineering Education.*

Powell, R. (2005). Integrating practice into Engineering Education. *2005 Annual Conference Proceedings*. https://doi.org/10.18260/1-2--14209

Rucks, M., Orr, M.; Hall, D. Social Consciousness in engineering students: An analysis of freshmen design project abstracts. *2016 ASEE Annual Conference; Exposition Proceedings*. https://doi.org/10.18260/p.25820

Salah, B., Khan, S., Ramadan, M., & Gjeldum, N. (2020). Integrating the concept of Industry 4.0 by teaching methodology in Industrial Engineering Curriculum. Processes. *MDPI, 8*(9). https://doi.org/10.3390/pr8091007

Shamita, V., Yeter, I. H., & Fong, E. (2022, August). An initial investigation of funds of knowledge for first-generation and continuing-generation engineering students in Singapore. In *2022 ASEE Annual Conference & Exposition*.

Shepard, Sheri D. (2003). Design as cornerstone and capstone. *Mechanical Engineering Magazine.*

Shin, Y.-S., Lee, K.-W., Ahn, J.-S., & Jung, J.-W. (2013). Development of internship & capstone design integrated program for university-industry collaboration. *Procedia - Social and Behavioral Sciences, 102*, 386–391. https://doi.org/10.1016/j.sbspro.2013.10.753

Taraban, R., Reible, D., Mesple, D., Donato, F., Yeter, I., Campbell, R., ... & Hoffman, J. (2017, June). Using a Museum Exhibit as a Pedagogical Tool for Developing Reflective Engineers. In *ASEE Annual Conference and Exposition, Conference Proceedings* (Vol. 2017).

van Acker, L., & Bailey, J. M. (2011). Embedding graduate skills in capstone courses. *Asian Social Science, 7*(4). https://doi.org/10.5539/ass.v7n4p69

Venkatesh, S., Fong, E. W., & Yeter, I. H. (2022). Investigating ethics in an undergraduate design thinking project: The Stanford EDIPT framework Approach in Southeast Asia. *2022 IEEE Frontiers in Education Conference (FIE)*, 1–5. https://doi.org/10.1109/FIE56618.2022.9962748

Wang, L. & Juslin, H. (2012). Values and corporate social responsibility perceptions of Chinese university students. *Journal of Academic Ethics, 10*(1), 57–82. https://doi.org/10.1007/s10805-012-9148-5

Waryoba, R., Luongo, C. A., & Shih, C. (2009). Integration of industrial-sponsored and design competition projects in the capstone design course. *ASEE 2009 Conference Proceedings*.

Yeter, I. H., Tan, V. S. Q., & Le Ferrand, H. (2023). Conceptualization of Biomimicry in Engineering Context among Undergraduate and High School Students: An International Interdisciplinary Exploration. *Biomimetics*, *8*(1), 125. https://doi.org/10.3390/biomimetics8010125

Zhu, N. (2018). Effectiveness of involving the industrial and business professions into Mechanical Engineering Capstone Course. *International Journal of Mechanical Engineering Education, 46*(1), 31–40. https://doi.org/10.1177/0306419017718920