ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

Paper ID #44641

Data Driven Methods for Improving Team Culture within Capstone Capstone Design

Morgan Elaine Bartley, West Virginia University
Dr. Andrew C. Nix, West Virginia University
Dr. Brian D. Woerner, West Virginia University

Brian Woerner is Professor in the Lane Department of Computer Science & Electrical Engineering at West Virginia University. He serves as co-advisor to the WVU EcoCAR team, and as a capstone design instructor.

Data-Driven Methods for Improving Team Culture within Capstone Design

Morgan Bartley, Andrew Nix, and Brian Woerner
Benjamin M. Statler College of Engineering and Mineral Resources
West Virginia University
Morgantown, WV
Email: mebartley@mail.wvu.edu, andrew.nix@mail.wvu.edu, brian.woerner@mail.wvu.edu

Abstract

This paper outlines the West Virginia University (WVU) EcoCAR team's strategies for creating a positive and inclusive team culture within the context of the EcoCAR Electric Vehicle Challenge (EV), sponsored by the U.S. Department of Energy, General Motors, and MathWorks. The EcoCAR EV Channels centers on the redesign of 2024 Cadillac Lyriq, and forms the basis of capstone design projects for approximately 70 students per year across the disciplines of Mechanical Engineering, Electrical Engineering, Computer Engineering, and Computer Science. The project requires effective cooperation between diverse design teams, and includes a significant focus on Diversity, Equity and Inclusion (DEI).

The paper outlines four SMART goals: Enhance Internal Education and Team Culture, Fostering Inclusive Sub-Team Integration, Strengthen Cross-Sub-Team Collaboration, and Data Analysis for Continuous Improvement. Baseline data and the impacts on students' attitudes are presented within the framework of capstone design projects.

Key conclusions underscore the role of education, inclusivity, collaboration, and data-driven decision-making in the specific context of capstone design projects. Foreseen challenges provide opportunities for proactive solutions, positioning teams for success in fostering a diverse and inclusive design team culture within the field of sustainable mobility.

Introduction

The EcoCAR Electric Vehicle Challenge (EVC) is a competition between 13 North American university teams, sponsored by the US Department of Energy through Argonne National Laboratories. The challenge focuses on re-designing the drive train and adding autonomous driving functionality to the 2024 Cadillac Lyriq, as serves as a basis for capstone design projects at participating universities [1]. At WVU, approximately 70 students per year in the majors of Mechanical Engineering, Electrical Engineering, Computer Engineering, and Computer Science fulfill their capstone design requirements through the EcoCAR program.

The EcoCAR EVC program includes a significant Equity in Mobility Component, which emphasizes recruitment, inclusion, and collaboration of students from different technical disciplines and diverse backgrounds. Team success depends on developing an inclusive and welcoming team culture, to achieve technical goals. The capstone course aims to realistically

reflect the diverse environment and working conditions of an industry engineering development team.

The flourishing interest in the significance of team culture and inclusivity within design teams underscores the pivotal role they play in the optimal functioning of engineering teams [2]. Moreover, there is a growing body of evidence emphasizing the positive impact of diversity on team performance and student learning outcomes [3]. To provide a more comprehensive understanding of these implications for engineering educators, it is useful to delve deeper into the specific ways in which diversity and inclusion contribute to the enhanced effectiveness of engineering teams. Exploring concrete examples, case studies, or empirical data that highlight the tangible benefits of diverse perspectives and inclusive practices within engineering contexts would serve to fortify the argument and elucidate the broader ramifications for educators in the field.

This paper describes four specific, measurable, achievable, relevant, and time-bound (SMART) goals set to foster the desired team environment by the WVU EcoCAR team: (1) Enhance Internal Education and Team Culture, (2) Fostering Inclusive Sub-Team Integration, (3) Strengthen Cross-Sub-Team Collaboration, (4) Data Analysis for Continuous Improvement [2]. For each goal, baseline data is presented showing the impact of teambuilding efforts on students' attitudes and perceptions, and the attainment of teamwork outcomes.

For the first goal is a baseline participation rate of 90% in the Implicit Bias training conducted near the outside of the project [3]. The pre-and post-survey results demonstrate an improved understanding of implicit bias among team members. Additionally, strategies and tactics, including comprehensive training materials and open dialogues, align with the goal and contribute to a positive cultural shift.

For enhancing internal education and team culture, a baseline comfortability assessment indicates a generally comfortable environment but highlights areas for improvement [4]. Additionally, implementing DEI "Champions" and targeted strategies creates a more inclusive and diverse sub-team culture. The foreseen challenges for enhancing internal education and team culture include balancing training frequency to ensure continued engagement without overwhelming team members may be a challenge and sustaining open dialogues may require ongoing effort to encourage participation and create a culture of continuous learning.

For strengthening cross-sub team collaboration, strategies such as implementing collaboration tools and recognition programs align with the goal and promote diversity and innovation [4]. The challenges for strengthening cross-sub-team collaboration include encouraging consistent and meaningful collaboration may face resistance or time constraints and balancing recognition and incentives to maintain motivation without fostering unhealthy competition.

For continuous improvement with data analysis, using data collection through Qualtrics, including post-survey on implicit bias and comfortability, lays the foundation for a comprehensive data analysis system. It was also concluded that strategies such as creating a DEI dashboard demonstrate the team's commitment to utilizing data for ongoing improvement in DEI initiatives.

Summary and Analysis of Data

Goal 1: Enhance Internal Education and Team Culture

Goal one focuses on enhancing education and team cultures. The SMART objective for this goal is to develop effective methods, procedures, and training to present in one-hour sessions to all EcoCAR Team members. It will ensure that at least 80% of team members have attended the DEI training sessions provided. A baseline measurement for this objective is established through completing the training provided. The WVU EcoCAR Team participated in Implicit Bias training. In the initial training sessions, 62 out of 69 students participated, providing a baseline participation rate of 90%. This measurement meets the SMART objective goal of 80% of team members attending DEI training. Figure 1 below shows the pre- and post- results for what was learned during the training.

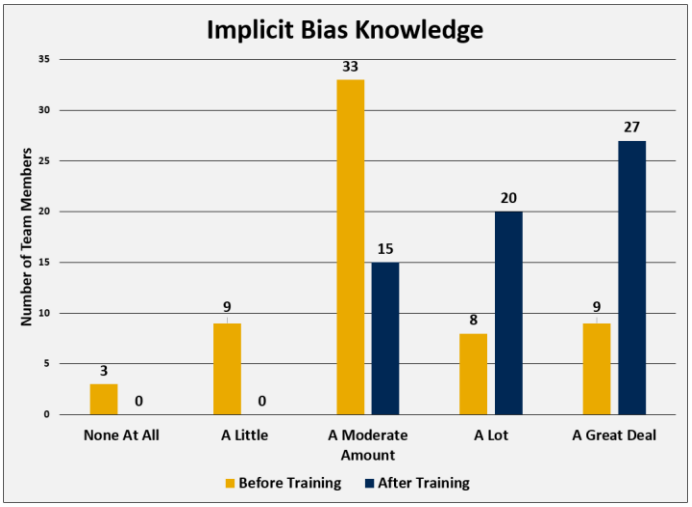

Figure 1. Pre- and Post-Survey Results from Implicit Bias Training.

The baseline participation rate of 90% indicates a strong initial commitment to DEI training. It is also seen from the pre-and post-survey results that team members did gain a better understanding of implicit bias from the training. Figure 2 shows additional results to show this.

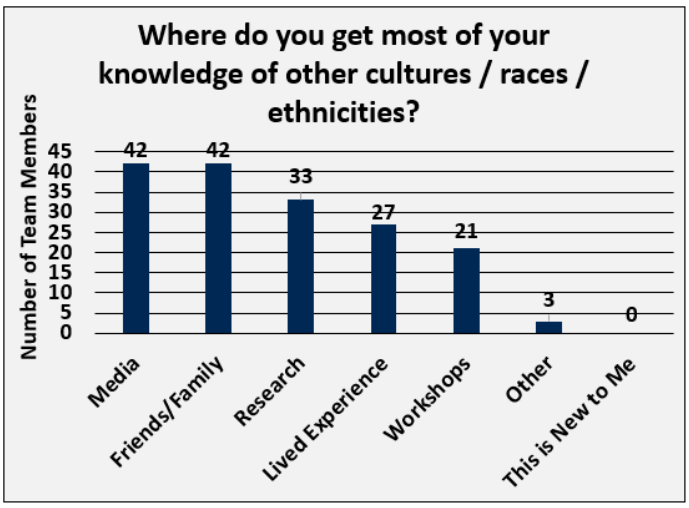

Figure 2. Knowledge Information from Implicit Bias Training.

To achieve the SMART objective, strategies and tactics have been created and were carried out in working towards this goal. These strategies and tactics include the creation of comprehensive training material based on input from the West Virginia University Diversity and Inclusion Office. This material is integrated into hour-long sessions, ensuring alignment with the team's educational needs. This training is given every two months for one hour and will focus on providing tools for understanding DEI initiatives, implicit bias, and allyship. We have also required graduate research assistants to be Safe Zone Trained. Additionally, open dialogue is encouraged by fostering small group discussions during team meetings and events.

The intended impact of these efforts is to elevate team members' understanding of DEI topics, fostering a sense of belonging and inclusivity. The data-driven techniques provide tangible evidence of team members' engagement and the impact of training on their perceptions. This builds a foundation for team members to develop a shared understanding, contributing to a positive team culture. Ultimately, this initiative seeks to contribute to a positive cultural shift within the EcoCAR team.

Goal 2: Fostering Inclusive Sub-Team Collaboration

Goal 2 focuses on fostering inclusive sub-team integration. The SMART objective for this goal is to foster inclusive sub-team integration by appointing a DEI "Champion" for each sub-team. The objective is to work collaboratively with these champions to ensure that DEI practices increase team comfortability by 75%. The baseline measurement involves assessing team members' comfortability through pre- and post-semester surveys. In the initial assessment, 58 out of 69 team members participated. Figure 3-8show the results of the comfortability assessment.

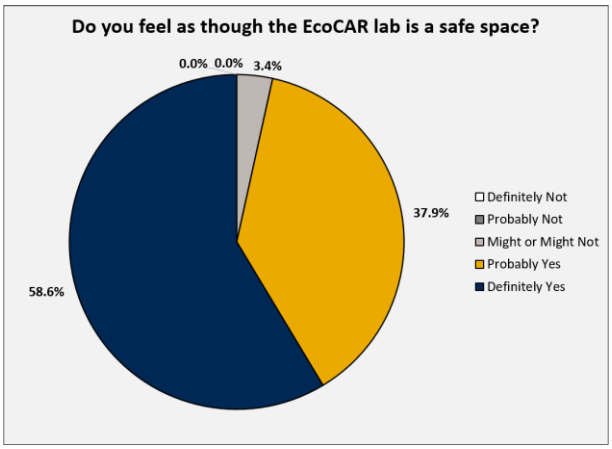

Figure 3. Safe Space Results.

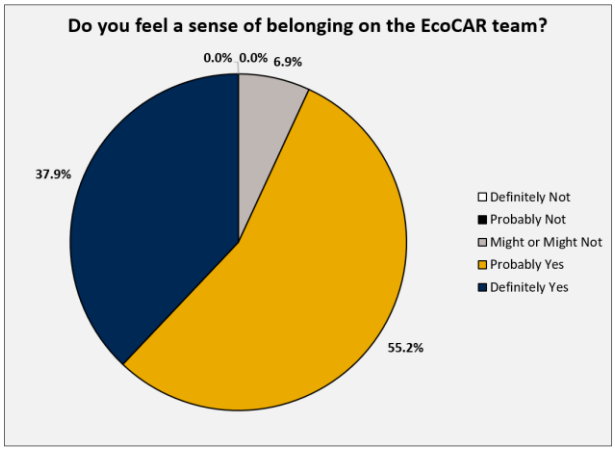

Figure 4. Belonging Results.

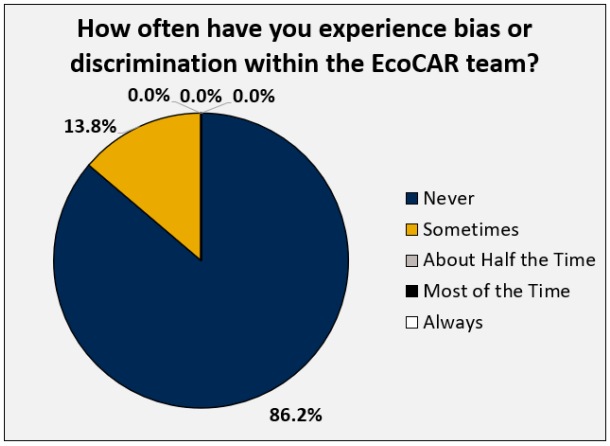

Figure 5. Discrimination Results.

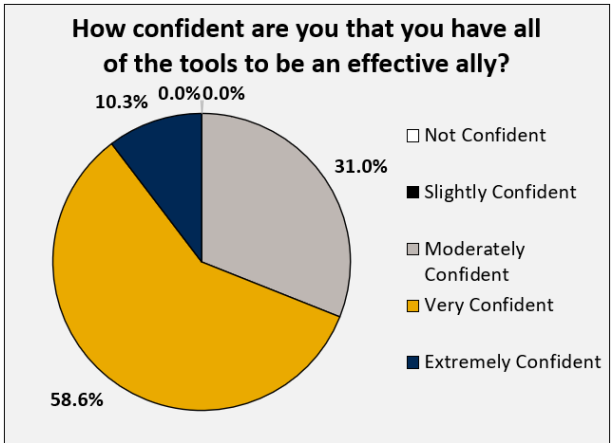

Figure 6. Effective Ally Results.

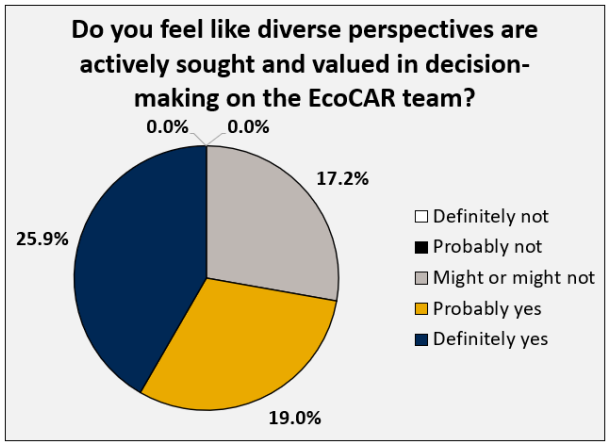

Figure 7. Diverse Perspective Results.

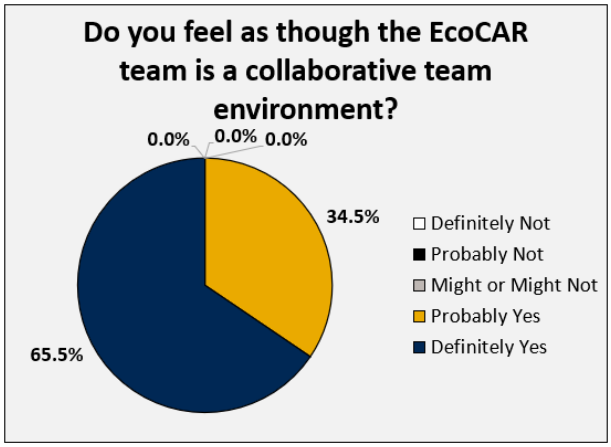

Figure 8. Collaboration Results.

The results from the comfortability assessment show there is general comfortability, but some work can still be done to make it better. To achieve the SMART objective, strategies and tactics have been implemented. These strategies and tactics include encouraging sub-teams to prioritize diversity and inclusion by appointing DEI "Champions" who engage with members,

collaborating with sub-team DEI "Champions" to develop recruitment strategies for each sub-team, and providing diversity training and resources to sub-team DEI "Champions" to cultivate more inclusive sub-team cultures. Four team members from different teams have been elected as DEI "Champions" for the entirety of the EcoCAR Team. Training and resources were provided to the selected "DEI" champions through Linked-In Learning. The specific pieces of training provided to the DEI "Champions" were "Leading Inclusive Teams" and "Communicating Through Disagreement". Pre-semester and post-semester surveys were also administered to gauge changes needed within each sub-team for increased inclusivity, diversity, and safety.

The intended impact of these efforts is to create an environment where all team members, regardless of background, feel valued, engaged, and have equal growth opportunities. The data-driven techniques allow the team to measure the effectiveness of strategies in enhancing sub-team comfortability. It provides insights into specific areas requiring attention and guides adjustments to foster inclusivity within sub-teams. Ultimately, this initiative seeks to establish a model of inclusive integration within sub-teams that can be sustained and replicated in future team endeavors.

Goal 3: Strengthening Cross-Sub-Team Collaboration

Goal 3 focuses on strengthening sub-team collaboration. The SMART objective of this goal is to establish a robust system of cross-sub-team collaboration. This objective includes achieving at least three successful cross-sub-team projects, enhancing overall team cohesion, and promoting diversity and inclusion within the team. The baseline measurement involves the implementation of Microsoft Teams for cross-sub-team collaboration, the initiation of a "Student of the Week" incentive program, and the achievement of at least three successful cross-sub-team projects. The team has effectively collaborated on both the DEI training presented as several other technical reports. The team used Microsoft Teams to log these cross-sub-team collaborations. Figure 4 shows the collaboration work done and implemented into Microsoft Teams.

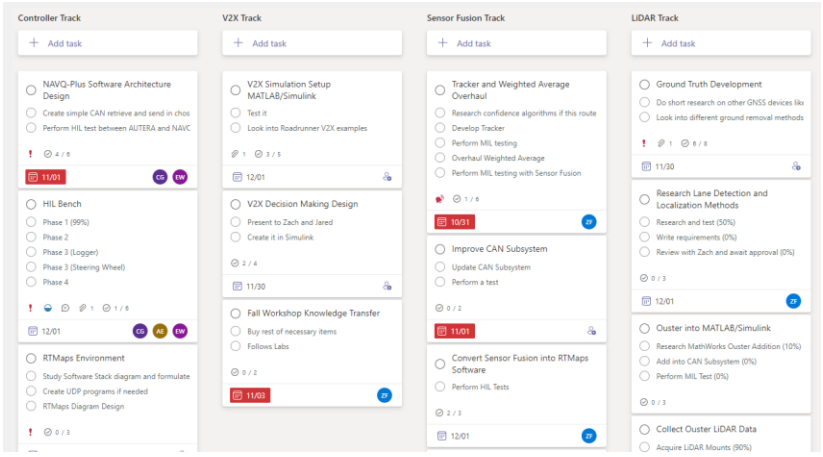

Figure 4. Tasks Within Microsoft Teams That Are Linked to Other Sub-Team Tasks.

The Kanban board shows the success of the collaboration between different sub-teams on the technical report. To achieve the SMART objective, strategies and tactics have been implemented. These strategies and tactics include cultivating a collaborative environment where cross-sub-team collaboration becomes ingrained in the team's culture, implementing and promoting the use of collaboration tools and platforms like Microsoft Teams to facilitate communication and project management across sub-teams, and implementing a recognition and incentives program that rewards successful cross-sub-team projects. To achieve this goal, it is important to recognize the value of collaboration, innovation, and diversity in these projects.

The intended impact of these efforts is to build a stronger connection among sub-teams, creating a sense of shared purpose and fostering more innovative solutions to complex problems. The encouragement of cross-sub-team collaboration also aims to promote diversity and inclusion within the team by providing opportunities for members of various backgrounds to interact and share experiences. The measurement through the completion of at least three successful cross-sub-team projects serves as a tangible indicator of the team's progress in achieving this goal. The ongoing "Student of the Week" incentive program reinforces the value of effective collaboration within the team.

Goal 4: Data Analysis for Continuous improvement

Goal 4 focuses on utilizing data analysis for continuous improvement. The SMART objective of this goal is to develop and deploy a comprehensive data collection and analysis system. This system will track DEI-related metrics, providing real-time insights to guide ongoing DEI initiatives. Data collection is established through Qualtrics. This semester, data from a post-survey on implicit bias training and a comfortability survey was collected, analyzed, and used to inform the next steps for internal diversity, equity, and inclusion efforts. The baseline measurement for this goal and objective is the collection and analysis of the data being collected.

To achieve the SMART objective, strategies and tactics have been implemented. These strategies and tactics include implementing data collection and analysis processes to track DEI-related metrics through Qualtrics, creating a DEI dashboard within Microsoft Teams to track and report progress on DEI goals throughout the year, and utilizing feedback and data insights to make informed decisions and adjustments to DEI strategies and tactics as the year progresses.

The intended impact of this initiative is to establish a robust and proactive approach to DEI measurement and improvement. The team aims to utilize the comprehensive data collection and analysis system to assess the team's DEI climate, understand progress, and identify areas for improvement. By developing a DEI dashboard within Microsoft Teams, the team aims to foster transparency and accountability, allowing members to track and report on progress regularly. The continuous feedback loop, informed by data insights, will enable the team to make informed decisions, ensuring that DEI efforts are responsive, effective, and aligned with the evolving needs of the team. Ultimately, the goal is to create a data-driven culture that supports ongoing DEI initiatives and fosters a more inclusive and diverse team environment.

Conclusion

In conclusion, this DEI plan is a strategic and comprehensive initiative aimed at fostering a diverse and inclusive community. Through this data analysis the four key goals, paired with SMART objectives, showcase the team's commitment to education, inclusivity, collaboration, and data-driven decision-making.

Key conclusions were made from the data for the first goal. The baseline participation rate of 90% in the Implicit Bias training indicates a strong commitment to DEI training. The pre-and post-survey results demonstrate an improved understanding of implicit bias among team members. Additionally, strategies and tactics, including comprehensive training materials and open dialogues, align with the goal and contribute to a positive cultural shift. The foreseen challenges for enhancing internal education and team culture include balancing training frequency to ensure continued engagement without overwhelming team members may be a challenge and sustaining open dialogues may require ongoing effort to encourage participation and create a culture of continuous learning.

Several key conclusions were additionally made for the second goal. The baseline comfortability assessment indicates a generally comfortable environment but highlights areas for improvement. Additionally, the implementation of DEI "Champions" and targeted strategies contributes to creating a more inclusive and diverse sub-team culture. The foreseen challenges for enhancing internal education and team culture include balancing training frequency to ensure continued engagement without overwhelming team members may be a challenge and sustaining open dialogues may require ongoing effort to encourage participation and create a culture of continuous learning. For fostering inclusive sub-team integration, goal 2, the foreseen challenges include ensuring sustained commitment from DEI "Champions" and sub-teams to prioritize diversity may pose a challenge, and addressing specific areas for improvement identified in comfortability assessments may require targeted interventions.

The key conclusions made from the third goal include successful collaboration on the DEI training and Baseline Vehicle Evaluation demonstrating the team's commitment to cross-sub-team projects. Also, strategies, such as implementing collaboration tools and recognition programs, align with the goal and promote diversity and innovation. The foreseen challenges for strengthening cross-sub-team collaboration include encouraging consistent and meaningful cross-sub-team collaboration may face resistance or time constraints and balancing recognition and incentives to maintain motivation without fostering unhealthy competition.
For the fourth goal, the key conclusions made include the use of data collection through Qualtrics, including post-survey on implicit bias and comfortability, which lays the foundation for a comprehensive data analysis system. It was also concluded that strategies such as creating a DEI dashboard demonstrate the team's commitment to utilizing data for ongoing improvement in DEI initiatives. For the fourth goal, data analysis and continuous improvement, the foreseen challenges include developing and deploying a comprehensive data collection and analysis system may face technical and resource challenges as well as ensuring that feedback and data insights translate into effective and timely adjustments to DEI strategies require ongoing attention.

This data-driven approach, coupled with strategic goals and objectives, positions the team for continued progress. Foreseen challenges provide opportunities for proactive solutions to further enhance the impact of DEI initiatives within the team.

Acknowledgement

This work has been supported by the U.S. Department of Energy through Argonne Laboratories, as part of the EcoCAR Electric Vehicle Challenge.

References

[1] Argonne National Laboratory, "About the EcoCAR EV Challenge," *Advanced Vehicle Technology Competitions*, 2022. https://avtcseries.org/about-the-ecocar-ev-challenge/

[2] Dillon, H., & VanDeGrift, T. (2021, July), *Creating an Inclusive Engineering Student Culture Through Diverse Teams: Instructor-led and Student-led Approaches Paper* presented at 2021 ASEE Annual Conference & Exposition Virtual Meeting. https://peer.asee.org/32428

[3] Pucha, R., & Dunbar, T., & Yow, R. (2022, August), *Role of diverse teams and socio-cultural aspects on students learning in freshman design course* Paper presented at 2022 ASEE Annual Conference & Exposition, Minneapolis, MN. https://peer.asee.org/41820

[4] J. Martins, "Write Better SMART Goals - Tips with Examples • Asana," *Asana*, Nov. 01, 2023. https://asana.com/resources/smart-goals

[5] C. Milanesi, "The Business Impact of Diversity, Equity and Inclusion," *Forbes*, 2022. https://www.forbes.com/sites/carolinamilanesi/2023/04/20/the-business-impact-of-diversity-equity-and-inclusion/?sh=5cd0f46a6630 (accessed Jan. 26, 2024).

[6] Indiana University School of Education, "Tips for More Inclusive Data Sharing and Analysis," *Evidence-Based Improvement in Higher Education*. https://nsse.indiana.edu/support-resources/data-results-guides/tips-for-more-inclusive-data-sharing-and-analysis/index.html

[7] D. Meinart, "How Leaders Can Foster Better Collaboration," *www.shrm.org*, May 09, 2019. https://www.shrm.org/topics-tools/news/hr-magazine/how-leaders-can-foster-better-collaboration

[8] A. De Brún, L. Rogers, A. Drury, and B. Gilmore, "Evaluation of a formative peer assessment in research methods teaching using an online platform: A mixed methods pre-post study," *Nurse Education Today*, vol. 108, p. 105166, Jan. 2022, doi: https://doi.org/10.1016/j.nedt.2021.105166.

[9] J. D. Kibble, "Best practices in summative assessment," *Advances in Physiology Education*, vol. 41, no. 1, pp. 110–119, Mar. 2017, doi: https://doi.org/10.1152/advan.00116.2016.

[10] Wilson, Z. S., Holmes, L., deGravelles, K., Sylvain, M. R., Batiste, L., Johnson, M., McGuire, S. Y., Pang, S. S., & Warner, I. M. (2011). Hierarchical Mentoring: A Transformative Strategy for Improving Diversity and Retention in Undergraduate STEM Disciplines. *Journal of Science Education and Technology*, *21*(1), 148–156. https://doi.org/10.1007/s10956-011-9292-5

[9] Premraj, D., Rudi" Thompson, R., Hughes, L., & Adams, J. (2019). Key Factors Influencing Retention Rates Among Historically Underrepresented Students Groups in STEM Fields. *Journal of College Student Retention: Research, Theory & Practice*, *23*(2), 152102511984876. https://doi.org/10.1177/1521025119848763