SUPPLEMENTAL RESOURCES

As part of the development of the collection of Conversation Modules, members of the Roundtable on Systemic Change in Undergraduate STEM Education compiled a list of articles, books, programs, case studies, and other pre-existing evidence and resources related to fostering systemic change in undergraduate STEM education that may be referenced in addition to the resources explicitly cited in the individual modules. This is not meant to be an exhaustive list, but instead an opening salvo to the rich body of resources available in this space. *Please note that all links were accurate and active as of January 2026.*

ARTICLES AND BOOKS

- ***Creating Change***
  - ***Core principles for creating conditions for culture change*** (module 3): Quan, G. M., Corbo, J. C., Finkelstein, N. D., Pawlak, A., Falkenberg, K., Geanious, C., Ngai, C., Smith, C., Wise, S., Pilgrim, M. E., & Reinholz, D. L. (2019). Designing for institutional transformation: Six principles for department-level interventions. *Physical Review Physics Education Research*, *15*(1), 010141. https://doi.org/10.1103/PhysRevPhysEducRes.15.010141
  - Ngai, C., Corbo, J. C., Falbenberg, K. L., Geanious, C., Pawlak, A., Pilgrim, M. E., Quan, G. M., Reinholz, D. L., Smith, C., Wise, S. B. (2020). *Facilitating change in higher education: The departmental action team mode*l. Glitter Cannon Press. Available at: https://www.dat-project.org/resources/facilitating-change/
  - ***Systemic Change in Community Colleges*** (module 5): Leal-Carrillo, N., Gonzales, D., & Lewis, J. (2023). Systemic change: Developing an organizational strategy to increase faculty and staff diversity in California Community Colleges. *New Directions for Community Colleges*, *2023*(201), 29–41. https://doi.org/https://doi.org/10.1002/cc.20558
  - **Faculty Development for Cultural Change:** Sousa, B. J., & Clark, A. M. (2025). Growth mindsets in academics and academia: a review of influence and interventions. *Journal of Higher Education Policy and Management*, *47*(1), 38–56. https://doi.org/10.1080/1360080X.2024.2384003
    - *This review examines how growth mindset affects behavior in academic settings and documents interventions that can help cultivate growth mindset, supporting faculty development efforts to shift departmental culture from deficit- to asset-based thinking and foster the mindset changes necessary for sustained transformation. (module 6)*
  - **Curricular and Course Improvements:** National Academies of Sciences, Engineering, & Medicine. (2025). *Transforming undergraduate STEM education: Supporting equitable and effective teaching*. The National Academies Press. https://doi.org/doi:10.17226/28268
    - *This consensus study documents evidence-based effective and equitable educational practices that can guide curricular modifications and course improvements to better align with student needs and aspirations. (module 6)*
- ***STEM Instruction***
  - ***Anti-Deficit Framework for DEI Practices in STEM Programs*** (module 4): Duncan, D. A. S., Jackson, J. L., Collins, S., & Teherani, A. (2023). Enabling success through transformative practices in STEM: The effects of applying an anti-deficit framework to diversity and equity programming. *bioRxiv*, 2023.2006.2022.546152. https://doi.org/10.1101/2023.06.22.546152

- ***College Experiences of STEM Students*** (module 4): Xu, Y.J. (2016). Attention to retention: Exploring and addressing the needs of college students in STEM majors. *Journal of Education and Training Studies*, *4*(2), 67-76. https://doi.org/10.11114/jets.v4i2.1147
- ***Common Student Questions in Introductory STEM Courses*** (module 4): Meaders, C. L., Smith, M. K., Boester, T., Bracy, A., Couch, B. A., Drake, A. G., Farooq, S., Khoda, B., Kinsland, C., Lane, A. K., Lindahl, S. E., Livingston, W. H., Bundy, A. M., McCormick, A., Morozov, A. I., Newell-Caito, J. L., Ruskin, K. J., Sarvary, M. A., Stains, M.,...Stetzer, M. R. (2021). What questions are on the minds of STEM undergraduate students and how can they be addressed? [Perspective]. *Frontiers in Education*, Volume 6 - 2021. https://doi.org/10.3389/feduc.2021.639338
- ***Deficit Discourses in Mathematics Education*** (module 4): Adiredja, A.P., & Louie, N. (2020). Untangling the web of deficit discourses in mathematics education. *For Learning of Mathematics*, 40(1), 42-46. Available at: https://flm-journal.org/index.php?do=details&lang=en&vol=40&num=1&pages=42-46&ArtID=1264
- ***Deficit Discourses in STEM Recruitment and Retention Programming*** (module 4): Castro, E. L. (2014). "Underprepared" and "at-risk": Disrupting deficit discourses in undergraduate STEM recruitment and retention programming. *Journal of Student Affairs Research and Practice*, *51*(4), 407–419. https://doi.org/doi:10.1515/jsarp-2014-0041
- ***Deficit Perspectives in Undergraduate Mathematics Education*** (module 4): Peck, F. (2021). Towards anti-deficit education in undergraduate mathematics education: How deficit perspectives work to structure inequality and what can be done about it. *PRIMUS*, *31*(9), 940–961. https://doi.org/10.1080/10511970.2020.1781721
- ***Diverse Approaches to Learning Mathematics*** (module 4): Frade, C., Acioly-Régnier, N., & Jun, L. (2013). Beyond Deficit Models of Learning Mathematics: Socio-cultural Directions for Change and Research. In M. A. Clements, A. J. Bishop, C. Keitel, J. Kilpatrick, & F. K. S. Leung (Eds.), *Third International Handbook of Mathematics Education* (pp. 101–144). Springer New York. https://doi.org/10.1007/978-1-4614-4684-2_4
- ***Framework for Conceptualizing Mathematics Teacher Noticing*** (module 4): Louie, N., Adiredja, A. P., & Jessup, N. (2021). Teacher noticing from a sociopolitical perspective: the FAIR framework for anti-deficit noticing. *ZDM – Mathematics Education*, *53*(1), 95–107. https://doi.org/10.1007/s11858-021-01229-2
- ***Learning Experiences and Degree Completion of STEM Students*** (module 4): Xu, Y. J. (2016). The Experience and Persistence of College Students in STEM Majors. *Journal of College Student Retention: Research, Theory & Practice*, *19*(4), 413-432. https://doi.org/10.1177/1521025116638344 (Original work published 2018)
- ***Pedagogy to Support Academic Success of Students from Historically Excluded Groups*** (module 4): Collins-Warfield, A. E., Niewoehner-Green, J. E., Scheer, S. D., & Mills, K. J. (2025). Student-ready critical care pedagogy: a student-centred instructional approach for struggling students. *Teaching in Higher Education*, *30*(2), 375–395. https://doi.org/10.1080/13562517.2023.2249401
- ***Professional Development Program for Mathematics Instructors*** (module 4): Adiredja, A., Civil, M., & Jarnutowski, B. (2024). Project Adelante: An anti-deficit professional development program for university mathematics instructors. Retrieved from https://par.nsf.gov/biblio/10545655.
- ***Role of Instructional Workforce*** (module 4): Lee, M., Volpe Horii, C., E. Austin, A., Avery, L., DeSanctis, M., Finkelstein, N., ... Schaal, B. (2023). An Instructional-Workforce Framework for Coordinated Change in Undergraduate Education. *Change: The Magazine of Higher Learning*, *55*(1), 54–63. https://doi.org/10.1080/00091383.2023.2151809

- ***Student Success***
  - ***Eight Indicators for Measuring Equitable Student Success in STEM***: Redd, K., Estrada, M., Nembhard, H. B., & Ngai, C. (2024). Eight Indicators for Measuring Equitable Student Success in STEM. *Change: The Magazine of Higher Learning*, *56*(3), 4–14. https://doi.org/10.1080/00091383.2024.2348425
    - *The paper provides metrics, indicators, and evidence that institutions can examine in pursuing a more equitable and inclusive STEM education (module 5). These can help give a starting point for what data to gather from your institutional research office. The paper has a distinct focus on equitable success outcomes to ensure that all students are achieving the same level of success. (module 6)*
  - ***Humanizing STEM Education*** (module 4): Yao, C., Follmer Greenhoot, A., Mack, K., Myrick, C., Poolaw, J., Powell, L., & Yarger, L. (2023). Humanizing STEM education: An ecological systems framework for educating the whole student [Perspective]. *Frontiers in Education*, *Volume 8 - 2023*. https://doi.org/10.3389/feduc.2023.1175871
    - *This paper outlines the components of an ecosystem that can contribute to a student ready institution. It outlines how to take into account the entire ecosystem to ensure that students are supported in every aspect so they can really focus on learning. There are specific resources related to faculty and how to engage them in this work as well as a substantial list of references for further reading. (module 6)*
  - ***Indicators of STEM Equity***: National Academies of Sciences, Engineering, and Medicine. (2018). *Indicators for Monitoring Undergraduate STEM Education*. Washington, DC: The National Academies Press. https://doi.org/10.17226/24943.
    - *This report provides concrete indicators and metrics that departments can use when conducting baseline self-assessments and monitoring their progress in undergraduate STEM education transformation efforts. (module 6)*
  - ***Pathways to Become a Student-Ready Institution:*** McNair, T.B., Albertine, S., McDonald, N., Major Jr., T., & Cooper, M.A. (2022). *Becoming a student-ready college: A new culture of leadership for student success*. John Wiley & Sons.
    - *This is a comprehensive resource for creating a student ready institution. There are specific sections that address the change effort that may be required. There are also several case studies that outline institutions that are successfully implementing these student ready practices. (modules 4 and 6)*
  - ***Perceptions of Hispanic STEM Students*** (module 4): Bravo, E. I., & Stephens, D. P. (2023). *RESISTIR*: Hispanic undergraduate STEM majors' perceptions of barriers and supports toward degree persistence. *Journal of Latinx Psychology*, *11*(2), 104–118. https://doi.org/10.1037/lat0000223
  - **Student-Faculty Partnerships:** Cook-Sather, A., Bovill, C., & Felten, P. (2014). *Engaging students as partners in learning and teaching: A guide for faculty*. Jossey-Bass. See also this this resource on the Elon University Center for Engaged Learning website: https://www.centerforengagedlearning.org/resources/students-as-partners/.
    - *These resources offer practical guidance for creating opportunities for student input and for meaningfully engaging students as partners in transforming the learning environment. (module 6)*

CASE STUDIES AND EXAMPLES

- **Amarillo College**: example of intentionally building institutional culture around caring for students and then grounding all practices in that culture.
  - Lowery-Hart, R. (2022). Leading culture change: Moving from transformational initiatives to a transformational institution. *Change: The Magazine of Higher Learning*, *54*(3), 5–10. https://doi.org/10.1080/00091383.2022.2054172

- **American Talent Initiative Resources**: These resources explain research and institutional initiative outcomes focused on expanding access and opportunity for talented low- and moderate-income students. (module 5)
    - See: https://americantalentinitiative.org/academic-equity-research-2023/ and https://americantalentinitiative.org/what-we-do/
- **California State University, Long Beach (CSULB):** Increased retention and graduation rates of underrepresented students in STEM fields with (1) Research Opportunities: Provides underrepresented students with research experience and faculty mentorship, (2) Professional Development: Workshops on academic writing, presentation skills, and career planning, and (3) Support Networks: Peer mentoring and support groups for students. (module 6)
    - **See:** BUILD Program (Building Infrastructure Leading to Diversity
- **EP3 Guide** is a collection of resources to implement best practices specifically related to physics, but many of the resources can be adapted to other STEM fields. Some particular modules from the EP3 that be helpful to department leaders include: Departmental Culture and Climate, How to Create and Use a Strategic Plan, How to Create and Use Foundational Documents, or How to Undertake an Undergraduate Program Review (module 6)
- **Georgia Institute of Technology (Georgia Tech):** Excel Program increased accessibility and success for students with disabilities in STEM fields with (1) Support for Students with Disabilities: Comprehensive support system for students with intellectual and developmental disabilities, (2) Tailored Curriculum: Customized STEM curriculum to meet diverse learning needs, and (3) Career Readiness: Emphasis on preparing students for careers through internships and job placement services. (module 6)
- **Illinois Tech Empowerment, Leadership, and Mentorship Program**: a program that used student leadership and community partnerships to enhance retention and graduation rates. (module 2).
    - Mowreader, 2024 describes a mentorship and support program for student leaders that boosted student success. The program is run by the Office of the Vice Provost for Academic Affairs, including undergraduate and graduate academic affairs and the academic resource center, while supported by other offices (campus life, student health and wellness, career services, residence life, and alumni and student organizations). (module 5)
- **National Association of College and University Business Officers (NACUBO**) provides tool kits useful for leaders at any institutions interested in analytical resources to prioritize student learning through dashboards and metrics (module 5).
- **University of California, Davis (UC Davis) ADVANCE Program:** Improved climate for diversity and inclusion within STEM departments with (1) Inclusive Practices: Workshops and training for faculty on inclusive teaching practices and cultural competence, (2) Diversity Initiatives: Efforts to increase the diversity of the faculty and student body in STEM disciplines, and (3) Support for Women: Specific initiatives aimed at supporting women in STEM through mentoring and networking opportunities. (module 6)
- **University of California, Davis** used SEA Change principles to restructure its STEM departments and integrate them into faculty hiring and curriculum design, improving student retention rates. (module 2)
- **University of Illinois at Urbana-Champaign Illinois Scholars Program:** Improved first-year retention and academic performance in STEM disciplines with (1) Early Exposure: Summer bridge programs for incoming STEM students to acclimate to college-level coursework, (2) Peer Mentoring: Peer-led study groups and mentoring for first-year students, and (3) Academic Support: Comprehensive academic support services, including tutoring and supplemental instruction. (module 6)
- **University of Maryland, Baltimore County (UMBC)** Meyerhoff Scholars Program**:** High retention and graduation rates, with many graduates continuing to advanced degrees in STEM with (1) Holistic

Support: Comprehensive academic, financial, and social support for students, (2) Community Building: Cohort-based model to foster a sense of community and belonging, and (3) Faculty Engagement: Strong faculty involvement in mentoring and advising. (module 6)

- **University of Texas at El Paso (UTEP) Model Institutions for Excellence (MIE)**: Saw significant increases in STEM graduation rates, particularly among Hispanic students with (1) Inclusive Curriculum: Curriculum redesign to incorporate active learning and culturally relevant pedagogy, (2) Support Services: Extensive tutoring and mentoring programs, and (3) Community Engagement: Partnerships with local high schools and community colleges to create pathways for STEM students. (module 6)
    - Merisotis, J. P., & Kee, A. M. (2006). A Model of Success: The Model Institutions for Excellence Program's Decade of Leadership in STEM Education. *Journal of Hispanic Higher Education*, *5*(3), 288–308. https://doi.org/10.1177/1538192706288422

PROGRAMS AND OTHER RESOURCES

- AAAS SEA Change Framework: A guide for systemic transformation to remove structural barriers and increase opportunities for all scholars in STEMM (module 2). SEA Change led by the American Association for the Advancement of Science (AAAS) aims to help higher education institutions advance institutional transformation that supports success for all learners in STEMM. SEA Change provides resources and opportunities for institutions to collaborate as they engage in their individual institutional change efforts (module 5).
- Achieving the Dream: Initiatives to improve outcomes for community college students, with a focus on equity and systemic change (module 2).
    - Achieving the Dream Strategy Hub focuses on whole-college transformation ". . . to put students at the center so that all students can access life-changing learning that propels them into community-changing careers." ATD offers institutional coaching in the transformation process, practical tools for change, and access to a large cohort of approximately 300 community colleges (module 5).
- American Indian Higher Education Consortium (AIHEC) STEM Initiative: Supporting tribal colleges and universities in advancing STEM education and research (module 2).
- Change Leadership Toolkit 2.0: A Guide for Advancing Systemic Change in Higher Education: a set of tools and resources to help campus leaders and teams develop strategies and leadership competencies that contribute to implementing, scaling and sustaining campus systemic change and transformation initiatives (module 2).
    - The **Change Leadership Toolkit** (Elrod, Kezar, and Gonzalez, 2023) recognizes the importance of a systemic approach to change while providing a step-by-step guide for working with other campus leaders and stakeholders to advance that change. A good place to start is with this podcast (Kezar et al., 2024) (module 5).
- Community College President's Initiative in STEM (CCPI-STEM) & Advanced Technological Education (ATE): Advances workforce education through regional networks that foster academic and business partnerships, along with greater awareness of NSF's ATE funding opportunities (module 2).
- Community College Research Center (CCRC): Insights on student transfer outcomes and systemic barriers (module 2).
- The Student Experience Project examples of survey and focus group methodology (module 6).
- Excelencia in Education: Promoting Latino student success in higher education, including STEM disciplines (module 2).
- Intentional Futures 2020 Guide for designing strategies for systemic change, including key questions for any design (module 5).

- **Increasing Student Success in STEM: Summary of a Guide to Systemic Institutional Change** describes a summary of 20 years of work in this area, including how to implement relevant models, examples and campus case studies (module 5).
    - Elrod, S., & Kezar, A. (2017). Increasing student success in STEM: Summary of A guide to systemic institutional change. *Change: The Magazine of Higher Learning*, *49*(4), 26–34. https://doi.org/10.1080/00091383.2017.1357097
- **National Institute on Scientific Teaching**: Workshops and toolkits for evidence-based STEM education practices (module 2).
- **NSF Regional Innovation Engines**: Resources for building regional STEM ecosystems (module 2).
- **Partnerships for Undergraduate Life Science Education (PULSE)**: Resources and programs to promote excellence in undergraduate life sciences education (module 2).
    - The PULSE **rubrics** are a comprehensive suite of tools, guides, and rubrics for leading departmental change. This resource includes the **PULSE DEI Rubric** (Brancaccio-Taras et al., 2022) and **Effective Practices for Physics Programs** (EP3), and the **Departmental Action Team (DAT) model**. While the focus is on the department as the unit for change, these resources offer strategies that target multiple levels of the institution for catalyzing change and have been implemented by many change efforts across the country. (module 5).
    - PULSE Rubrics are a series of criteria to help with departmental self-assessment specifically related to life sciences but can be adapted for many STEM Disciplines. They cover topics such as DEI, departmental climate, assessment and curriculum alignment (module 6).
- **Pedagogical Partnerships:** This resource offers a series of practical steps to develop these sorts of programs in your department or institution. (module 6)
- **STEMM Opportunity Alliance (SOA)**: Advancing national strategies to create an equitable and inclusive STEMM ecosystem. (module 2)
- **Accelerating Systemic Change Network (ASCN)** is a network of individuals and institutions whose goal is to more quickly advance STEM education programs. ASCN brings together those who are researching systemic change at higher education institutions with those who are making systemic change happen at their institutions. This is a curated set of resources on organizational change. (module 5)
- **Equity-Minded Leadership**: The American Council on Education, in collaboration with the Pullias Center at the University of Southern California, hosts a set of resources under the umbrella of Equity-Minded Leadership (ACE, 2024). These resources provide practical guidance on creating a campus leadership approach that involves a wide commitment to equity and inclusion, involving people from throughout the institution. The first publication within the series, *Shared Equity Leadership: Making Equity Everyone's Work*, is a good starting point to learn about practical, research-based recommendations about how leaders can create a shared approach to embedding equity in their institutional change goals and processes and *Capacity Building for Shared Equity Leadership* also provides information on ways to build capacity. (module 5)
- **Sloan Foundation Equitable Pathways Program**: A cross-institutional collaboration designed seamless transfer pathways for STEM students from community colleges to research universities. (module 2)

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