



The Integration of the Humanities and Arts with Sciences, Engineering, and Medicine in Higher Education

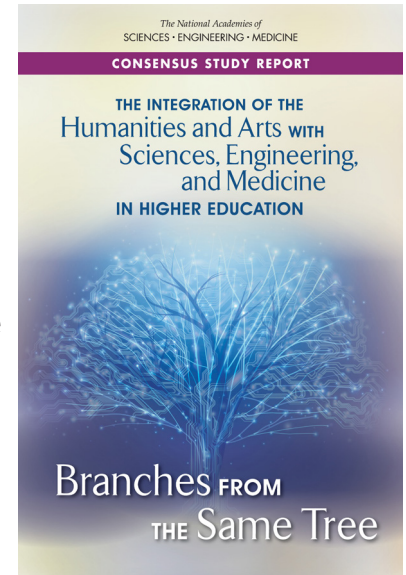
Branches from the Same Tree

This study examined an important trend in higher education: integration of the humanities and arts with sciences, engineering, and medicine at the undergraduate and graduate level—which proponents argue will better prepare students for work, life, and citizenship. Integrative models intentionally seek to bridge the knowledge, modes of inquiry, and pedagogies from multiple disciplines—the humanities, arts, sciences, engineering, technology, mathematics, and medicine—within the context of a single course or program of study. A diverse array of colleges and universities now offer students integrative courses and programs, and many faculty are enthusiastic advocates for this educational approach. This movement in higher education raises an important question: what impact do these curricular approaches have on students?

To address this question, the National Academies of Sciences, Engineering, and Medicine formed a 22-member committee to examine “the evidence behind the assertion that educational programs that mutually integrate learning experiences in the humanities and arts with science, technology, engineering, mathematics, and medicine (STEMM) lead to improved educational and career outcomes for undergraduate and graduate students.” The committee conducted an in-depth review and analysis of the state of knowledge on the impact of integrative approaches on students.

LEARNING AND CAREER OUTCOMES ASSOCIATED WITH INTEGRATIVE APPROACHES

Abundant interest and enthusiasm exist for integration within higher education, as evidenced by the groundswell of programs at colleges and universities in various sectors of American higher education (see Compendium of Programs and Courses That Integrate the Humanities, Arts, and STEMM at <https://www.nap.edu/catalog/24988> for a list of 218 examples that the committee found illustrative). Aggregate evidence indicates that some approaches that integrate the humanities and arts with STEMM are associated with positive learning outcomes. Among the outcomes reported are increased critical thinking abilities, higher-order thinking



and deeper learning, content mastery, problem solving, teamwork and communication skills, improved visuospatial reasoning, and general engagement and enjoyment of learning.

An important observation was that the kinds of outcomes associated with certain integrative approaches in higher education are the educational outcomes that many employers presently seek. Employer surveys consistently show that employers want well-rounded individuals with a holistic education who can take on complex problems and understand the needs, desires, and motivations of others. Importantly, these learning goals and competences are similarly valued by institutions of higher education. The committee considered multiple forms of evidence as it developed the following recommendations for institutions, faculty, administrators, scholars of higher education, and federal and private funders. The recommendations fall under four main areas:

Support for Integrative Approaches

Institutions should work to develop and implement new models and programs that integrate the STEM fields, the arts, and the humanities, and sustain existing efforts that have shown promise.

Faculty, administrators, and scholars of higher education should consider new designs for general education that incorporate integrative approaches that help students make meaningful connections between their general education and specialized courses.

Federal and private funders should recognize the significant role they can and do play in driving integrative teaching, learning, and research. They should lead in supporting integration by prioritizing and dedicating funding for novel, experimental, and expanded efforts to integrate the arts, humanities, and STEM disciplines and for the evaluation of such efforts.

Evaluating Integrative Courses and Programs

Institutions and employers should collaborate to better understand how graduates who participated in courses and programs that integrate the humanities, arts, and STEM fields fare in the workplace throughout their careers.

Faculty and administrators should work with scholars of higher education and experts in the humanities, arts, and STEM fields to establish agreement on the expected learning outcomes of an integrative educational experience and work to design approaches to assessment.

Faculty, administrators, and scholars of higher education should employ multiple forms of inquiry and evaluation when assessing courses and programs that integrate the humanities, arts, and STEM fields, including qualitative, quantitative, narrative, expert opinion, and portfolio-based evidence.

Enhancing Inclusivity Through Integrative Courses and Programs

Scholars of higher education should focus future research on how integrative educational models can promote the representation of women and underrepresented minorities in specific areas of STEM fields, the arts, and the humanities, and all research efforts should account for whether the benefits of an integrative approach are realized equitably.

Removing the Barriers to Integrative Approaches

Faculty, administrators, and accrediting bodies need to identify and mitigate constraints (e.g., tenure and promotion criteria, institutional budget models, workloads, accreditation, and funding sources) that hinder integrative efforts in higher education.

Faculty and scholars of higher education working to facilitate integrative curricular models should initiate conversations with the key accrediting organizations for STEM, the arts, and higher education to ensure that the disciplinary structures and mandates imposed by the accreditation process do not thwart efforts to move toward more integrative program offerings.

TOWARDS A MORE INTEGRATED FUTURE

Given that today's challenges and opportunities are at once technical and human, addressing them calls for the full range of human knowledge and creativity. The committee views the integration of the arts, humanities, and STEM fields in higher education as a promising avenue to help create a society prepared to face 21st century challenges. The evidence examined thus far suggests potential benefits to students that warrant further research. The outcomes associated with various approaches to integration—improved written and oral communications skills, teamwork skills, ethical decision making, critical thinking and deeper learning, content mastery, general engagement and enjoyment of learning, empathy, resilience, the ability to apply knowledge in real-world settings, and indicators of improved science literacy—are skills that will prepare students for work, life, and civic engagement in the 21st century.

Higher education should strive to offer all students—regardless of degree or area of concentration—an education that exposes them to diverse forms of human knowledge and inquiry and that impresses upon them the fact that all disciplines are “branches of the same tree.” Such an education should empower students to understand the fundamental connections among the diverse branches of human inquiry—the arts, humanities, sciences, social sciences, mathematics, engineering, technology, and medicine.



Limbitless Solutions

Annika Emmert using Limbitless Solutions' flower arm.

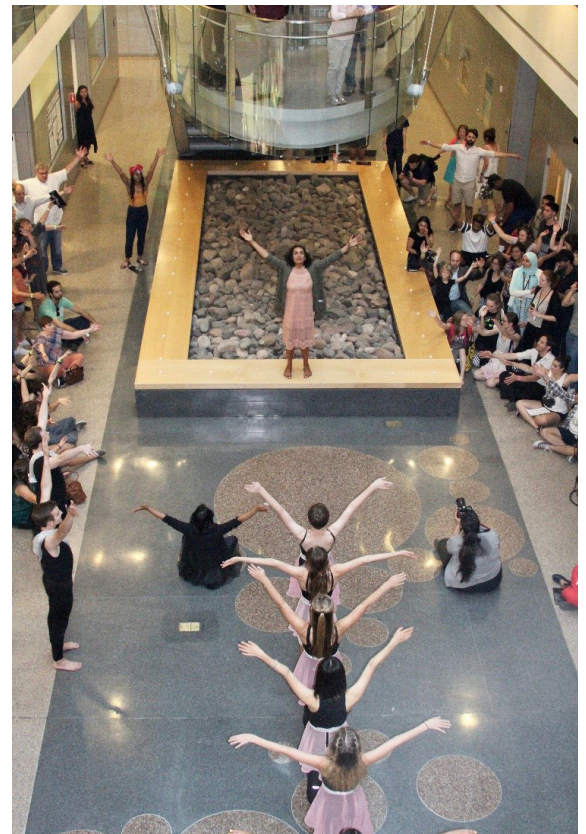
Limbitless Solutions is a nonprofit organization that uses 3D printing to create personalized bionics and affordable prosthetics. The organization grew out of work that the founding team members did as students at the University of Central Florida.

Animating Research and Activating Spaces of Knowledge Production

As part of Liz Lerman's Animating Research class, students lead a participatory moment during a performance at the Biodesign Institute at Arizona State University (2017)

Credit: Deanna Dent/ASU Now

Choreographer, MacArthur Fellow, and Institute Professor at Arizona State University (ASU), Liz Lerman created her “Animating Research” course to combine contemporary movement, dance, theater, and science into multimedia, immersive experiences for audiences and performers: a dozen artists were paired with molecular virologists, evolutionary biologists, and engineers to create mini-performances using and exploring ASU's biodesign building space.





Ghost Food

Miriam Simun (MIT Media Lab) and Miriam Songster (Artist)

Image: courtesy of the artists

Ghost Food is a mobile food truck that puts together sense and food pairings using a wearable device that helps engage smell. Scents of foods threatened by climate change are paired with foods made from climate change-resilient foodstuffs, to provide the taste illusions of foods that may soon no longer be available.

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For More Information . . . This Consensus Study Report Highlights was prepared by the Board on Higher Education and Workforce based on the Consensus Study Report *The Integration of the Humanities and Arts with Sciences, Engineering, and Medicine in Higher Education: Branches from the Same Tree* (2018). The study was sponsored by Andrew W. Mellon Foundation, the National Endowment for the Humanities, the National Endowment for the Arts, and the National Academy of Sciences Scientists and Engineers for the Future Fund. Any opinions, findings, conclusions, or recommendations expressed in this publication do not necessarily reflect the views of any organization or agency that provided support for the project. Copies of the Consensus Study Report are available from the National Academies Press, (800) 624-6242; <http://www.nap.edu> or via the Board on Higher Education and Workforce web page at <http://www.nationalacademies.org/PGA/BHEW>.

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