



Introduction to this Special Issue on Impact-Focused Education

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INTRODUCTION

As the lead instigator for three academic programs, the Global Social Impact Fellowship, the Lehigh Valley Social Impact Fellowship, and the Campus Sustainable Impact Fellowship at Lehigh University, and in my previous avatar as the Founding Director of the Humanitarian Engineering and Social Entrepreneurship (HESE) Program at Penn State, I have witnessed firsthand the transformation that occurs in students when they work on challenges they deeply care about and where they believe they can make a real difference in the lives of others. At that point, grades don't matter, the number of hours spent on a project are not counted, and social life takes a backseat, for the students are laser-focused on the mission of the project. Students find themselves and define themselves when they lose themselves in the quest for building a world that works for everyone. Students truly come alive, realize that engineers can be artists and anthropologists and entrepreneurs at the same time, and accomplish things neither they nor their faculty advisors thought possible.

Through engaging in meaningful, authentic, and incredibly real projects, students develop 21st century skill sets and mindsets and expand their portfolios of accomplishment. More importantly, this combination of skill sets, mindsets, and externally-calibrated portfolios helps students develop their agency and self-efficacy, reach a higher level of consciousness, and, most importantly, find their sense of purpose and belonging in the world. In programs that I have led and others I have learned from, students develop these competencies through building sustainable technology-based enterprises, publishing their works in peer-reviewed journals, integrating their insights into national policies, and championing social movements that directly influence and improve the lives of millions of people.

The quest for sustainable impact and preparing students to lead lives of impact drives the philosophy, pedagogy, and operations of such programs. For my faculty collaborators, my students, and me, there are three incredibly clear goals - impact, impact, and impact. Learning is a wonderful byproduct on this long-winded journey to sustainable social impact. What matters more is learning how to learn, how to ask the right questions, how to engage with others, how to create value, how to find your



place in the world, how to build organizations and systems, and how to get stuff done – to deliver sustainable impact.

Over the last two decades, a large number of academic programs and co-curricular student organizations have emerged to engage engineering and other students in addressing the needs of low-resource communities and markets in the U.S. and around the world. Constructs such as Humanitarian Engineering, Development Engineering, Sustainable Development, and Engineering for Developing Communities are often employed to describe such programs. An increasing number of impact-oriented educational endeavors incorporate a significant entrepreneurial component to ensure the sustainability of these emergent ventures. The rigorous integration of an entrepreneurial approach has helped transform engineering design and service-learning programs focused on service activities into vibrant ecosystems and incubators for high-impact social enterprises that lead to sustainable and scalable impact. While relatively few universities offer formal academic programs of this nature, extra-curricular student clubs and professional organizations such as Engineers without Borders, Engineers for a Sustainable World, and Bridges to Prosperity can be found at almost every university.

Irrespective of the framing and degree of academic integration, impact-focused academic programs emphasize developing solutions for people, communities, countries, and societies that might be classified as underserved due to the marginalization or disenfranchisement of certain groups. These programs also share a focus on the implementation of sustainable solutions that can benefit individuals, their communities, and larger markets and systems within which they live. While such endeavors are usually well-meaning, creatively designed, and enthusiastically deployed, they do not necessarily result in positive long-term impact. This is due, in part, to the tendency to prioritize immediate educational experiences for students over long-term sustainable impacts for the partnering communities and target markets.

For this Impact-Focused Education special issue, we invited articles from faculty who have developed or offer courses and programs that 1) engage students in real-world technology projects related to social innovation and global sustainable development, and 2) prioritize (or at least give equal importance to) long-term project outcomes rather than focusing on and designing programs around student learning outcomes.

The objective of this special issue is to curate proven practices and initiate larger conversations emerging from the work of engineering programs that engage students and faculty in the rigorous research, design, field-testing, and dissemination of technology-based solutions that address global development challenges. Whether partnering with departments on campus or communities in Appalachia, or striving to transform markets in Angola, we wanted to learn from, and celebrate, programs that espouse diverse academic models, philosophies of engagement, and funding mechanisms to deliver practical solutions to complex challenges, including those related to food, energy, water, and health. Sustainability, in this context, is the notion that real solutions must be technologically



appropriate, culturally and socially acceptable, environmentally benign, and economically sustainable. There is a recognition that ideas, presentations, and prototypes by themselves don't address problems; only implementation, assessment, and fast-paced pivoting can help reach a higher sustainable equilibrium. The challenge is in the execution - getting the job done in partnership with diverse actors in an ethical, harmonious, and self-determined manner.

PAPERS IN THE SPECIAL ISSUE

We received a large number of submissions from around the world. The majority of these articles described courses and programs that focused on student learning without much concern (or data) about the outcomes beyond the learning outcomes. The abstracts, and then the manuscripts, were reviewed by at least three reviewers, one of whom was a practitioner from academia or from the non-profit or (social) enterprise sector. Eventually, seven articles made it through two, and sometimes three, rounds of rigorous reviews.

Deboer and colleagues describe the Localized Engineering in Displacement framework that engages refugee learners and former street youth in developing their self-image as engineers. They partner with in-country nonprofits that serve as implementation partners and provide the structures, spaces, and continuity necessary to develop the learners' knowledge, practical skills, and agency. Safari and Asadi describe an innovative program with a competency-based curriculum and a work process to engage students in energy assessment of small commercial buildings in their community. This program facilitated energy assessment for 45 commercial buildings and supported the development of a retrofit plan with financing in place for nearly 30 of these projects.

MacCarty and Walkin discuss how their program in humanitarian engineering at Oregon State University offers a two-part faculty-led study abroad course in which student project teams prepare and plan for summer fieldwork in Guatemala. Students in this course learn to appropriately frame research questions and then how to execute their projects, emphasizing an equitable exchange of learning, and doing, alongside and with community and NGO partners. Through the design of this course, the authors learned key lessons about the value of long-term partnerships and a fair trade model of learning and communicating. Brubaker and colleagues conducted a meta-analysis of community-engaged engineering courses and, in interviews with nearly two dozen campus and community stakeholders, created a new rubric for effectively guiding partnerships. The questions contained in their "Partnerships Compass" address the dual needs of being impactful and equitable when campus-based practitioners (particularly students) work with community partners, and also the need to minimize harm on both sides, but particularly on the side of the partner communities.



Reynolds et. al. draw upon the Fair Trade Learning framework and interrogate its role in a broad range of engineering education projects with global sustainable development goals (SDGs). Overall, they conclude that the FTL framework is sound and applicable if engineers keep a focus on its first two core principles – community voice/direction and dual purposes – and the framework can be adapted to incorporate many different kinds of off-campus partners, including for-profit enterprises. Moreno-Serna and colleagues describe the interrelatedness of two sustainability-focused programs at the Universidad Politécnica de Madrid. They use this case study as a means to recommend ways that institutions of higher education must go beyond new academic programs to deeper, structural innovations if they wish to have truly “transformational sustainability” in their outcomes. Research outcomes and learning outcomes, they conclude, must be supported by proper institutional structures if they are to be truly meaningful and impactful in their contributions to the SDGs.

Finally, Dodson et. al. discuss the work of the Peugeot Center for Engineering Service in Developing Communities, housed at Lipscomb University. They describe the model of this center, which in its 17-year existence has achieved lasting impacts for students, communities, and engineering professionals alike, working in a symbiotic system that supports strong mentorship, student and professional desire to improve the world’s conditions, and trust-based community relationships.

We applaud these authors for their untiring efforts. Their commitment to equanimity, innovative pedagogy, and, yes, impact, means that their programs stand out as models of not only globally-focused higher education, but truly meaningful project-based engagement where ambitious students, appropriately guided and mentored by academic and non-academic experts, self-determine and deliver practical and lasting solutions in collaboration with diverse partners.

Doing this kind of work is incredibly difficult and involves years of learning how to engage with different cultures, build relationships, build professional networks, etc., none of which count towards promotion and tenure. This is truly a labor of love; the pragmatic kind of gentle long-lasting love, for it can take years and decades for programs to develop, mature, and bear fruit.

Getting busy faculty to commit to writing a paper that might go through three review cycles is difficult. There were at least 20+ other faculty that I regard as leaders in the impact-focused education space who I invited, sometimes pleaded with, to capture aspects of their brilliant work and submit manuscripts. Only a few of them actually did. A common thread in their response during candid follow-up conversations was that they were busy changing the world. Some of them did not see a direct connection between publishing their work as academic papers and advancing their impact agenda. At the same time, they unequivocally expressed their support for this special issue and their willingness to share their experiences and expertise with other passionate faculty through less formal channels.

Similar thoughts were expressed by practitioners who politely turned down my requests to serve as reviewers. In expressing their disenchantment with academia, they shared examples of academic



collaborations, where they had invested significant time and effort, that fell apart when a grant didn't come through or when the project direction organically pivoted in a direction that no longer interested the faculty. Relationships built over years and decades were compromised and precious time and efforts were squandered. While community relationships would be eventually mended, their larger concern was the lack of seriousness, persistence, and continuity amongst academics who prioritize what they are told will count towards their promotion and tenure dossiers.

The lesson here is certainly not that all academics are dilettantes, but rather that mainstream academic models and systemic institutional barriers continue to limit investments in impact-focused work. Academia, as has often been pointed out, evolved into an extremely well-developed factory for monolithic ideas, often pursued and claimed individually and reiterated internally, whereas collective, outward-facing work is discouraged and shunted to the margins of acceptability. We need to do better. Developing and delivering real-world solutions is not just service but responsibility to the world that, by its very nature, bolsters faculty members' engaged research and transformative teaching and learning accomplishments.

Legitimate questions have been raised concerning the relevance of higher education in the 21st century. Impact-focused education provides a philosophy and framework that addresses these questions and the evolving demands of students, prospective employers, and the world at-large. A university is an institution where you find your place in the universe. Higher education has always been about expanding opportunities and transforming lives. The singular focus on social impact provides a gateway for students' personal and professional development as productive scholars, pro-active innovators, and engaged citizens. The contributors to this special issue demonstrate how engineering is as much of a caregiving profession. Engineering education, as it often has, can and should lead the way for higher education to articulate its rightful place as the epicenter of knowledge creation and societal transformation in the 21st century.

REFLECTION ON KEY DIFFERENTIATORS BETWEEN PROGRAMS

As I embarked on this journey, with Larry Shuman helping every step of the way, I surveyed the various kinds of programs that might contribute articles to this special issue. Based on my informal analysis, I offer here a reflection on the key questions that drive the design and operation of impact-focused academic programs. This is most certainly not a comprehensive list and almost none of the questions posed have simple either-or answers. The activities and impacts of EWB-type efforts ebb and flow with student (and advisor) passion and engagement. While these questions might be relevant to co-curricular endeavors, the focus in this special issue is on formal credit-bearing courses



and programs that integrate learning, research, and entrepreneurial engagement. I hope that, as readers learn from all the articles, these questions will help them imagine the kinds of programs they might design and the kinds of impacts they might strive for.

Programmatic Design

1. How will the program balance student learning with sustainable impact? While they are certainly not mutually exclusive, the priorities need to be very clearly defined to design appropriate program structures, partnerships, success metrics, and evaluation strategies.
2. Is the program a single course, a set of courses focused on diverse sectors (e.g. health, human rights, food-water-energy nexus) or a set of courses focused on venture process (e.g. project validation, hypothesis testing, grassroots diplomacy, and execution strategy)?
3. What is the program's core philosophy of engagement? For example, programs might focus on educating others, implementing design-build projects, launching independent self-sustaining enterprises, or conducting original research and publishing it in refereed journals and conference proceedings.
4. What kinds of outcomes define program success? Will project accomplishments be valued more than student enrollment numbers, number of projects, project diversity, or geographical diversity of projects? How will peer-reviewed journal articles and conference proceedings with students as lead authors be valued? Will project impacts on communities or markets be audited by an independent third-party?

Student and Faculty Demographics

1. What disciplines might students and faculty come from? Will the program engage individuals from only engineering, STEM fields, engineering and business backgrounds, or will students and faculty from every discipline across campus participate?
2. What is the role of faculty members from the liberal arts and humanities? Will they be engaged as core collaborators involved in every project decision or might it be more realistic to engage them as advisors? The real question here is about finding the balance between deconstruction and construction, analysis and action, ideation and execution.
3. Will the program focus on lower-division students, upper-division students, graduate students or enable integration across different levels? How relevant are these levels when Coursera, Udemy, and YouTube make learning accessible in a just-in-time manner and subject matter experts are an email or LinkedIn connection away?
4. Will students be expected to have completed certain prerequisite courses? Will those requirements emphasize specific technical knowledge and skills (e.g. fluid mechanics,



thermodynamics), mindsets (e.g. bias for action, willingness to learn quickly) or passion for a cause as demonstrated by prior action (e.g. leading a green energy student movement)?

5. What kind of professional pathways for students does the program hope to create or strengthen? Is the objective to develop well-rounded students with stronger communication, teamwork, creativity etc. skills for traditional industry jobs? Is the goal to prepare students for non-traditional careers in social innovation and global sustainable development?
6. Will the program attract students looking for job opportunities right after graduation or those who intend to pursue graduate, medical, or professional schools or those interested in pursuing (social) entrepreneurial careers?
7. Will the program attract students who have completed or are interested in pursuing service opportunities such as the Peace Corps, Teach for America, and AmeriCorps or prestigious awards and fellowships such as Fulbright, Rhodes, and Marshall Scholarships?
8. What kind of academic pipelines (e.g. mini projects in large survey courses, new first-year seminars) and partnerships (e.g. freshmen orientation program, pre-med student club) need to be created to identify the right students and faculty who will contribute the most to the program and truly benefit through their engagement?

Curriculum Design

1. Will the courses in the program focus on learning technical content (e.g. water, energy, health) or learning process (e.g. project validation, securing funding, etc)?
2. Will faculty serve as subject matter experts, mentors, or collaborators (to the students)? How vested will the faculty be in the project outcomes? Will the faculty mentor(s) detach themselves from project outcomes or will they be fully immersed and integrated into the team?
3. Will one lead faculty member mentor each team, or will each team be advised by a group of faculty with diverse experiences and expertise? How will difficult decisions on project trajectory be made?
4. Will the learning outcomes focus on verticals (e.g. thermodynamics, coding) or horizontals (e.g. systems thinking and strategy, ethical decision-making, execution)?
5. Will students be expected to do all the work themselves or are they allowed, maybe even encouraged, and ultimately judged on what they get done? For example, can students win a grant and outsource App development to an expert in Poland so that they can focus their efforts on the design and beta-testing of the App in Zambia? Can a sub-team charged with the design of an urban farming system for inner cities challenge a lighting design course with 30 students to design and prototype the lighting system and then incorporate the best design in the larger urban farming system?



6. Will student evaluation be based on faculty perception of the quality of the project deliverables? Will project partners have a real say in student evaluation? Will externally-calibrated outcomes such as refereed publications, submitted funding proposals, or the success of products in the marketplace be considered when assigning grades? How will noble failures be judged when assigning grades?
7. How will external subject matter experts be engaged in the projects? Will each project team have a formal or informal advisory network reflecting relevant technological, humanistic, business, and geographical expertise?
8. What kind of formal and informal preparation is required for students before they engage in fieldwork? What kind of critical reflection opportunities will they have after fieldwork? Will the critical reflection balance student development with project strategy?
9. How might technologies such as Augmented/Mixed/Virtual Reality be leveraged to optimize the team's time and efforts, both during fieldwork and in everyday work?

Nature of Projects

(Assuming that any impact-focused program involves students working on incredibly real projects that strive to improve the human condition.)

1. Will the projects have a community orientation or a market orientation? In other words, is the aspiration to create value for a specific well-defined community, say a small village or a school, or to introduce a superior (cheaper, durable, effective) product to a larger marketplace (e.g. east Africa, refugee camps across the world) or system (e.g. public health system across Sierra Leone)?
2. Will the projects be conceived by students, faculty, specific communities (e.g. a school in Appalachia), or by communities of practice (e.g. responding to a need for more effective contraception methods in LMICs)?
3. Will faculty take deep ownership in the project and bring it to life, or will they merely serve as advisors and guides to the student teams and detach themselves from the project outcomes?
4. Will the creative control for the project rest with students, faculty, or project partners? How will decisions on project direction and continuity be made?
5. Will projects change from semester to semester, or will the projects be conceptualized as multi-year endeavors from the get-go? This is clearly a leading question for it can often take upwards of 3-5 years of dedicated work to get ventures up and running and turn them over to operational partners.
6. Will these projects be based on campus, in local communities, other high-income countries or in low- and middle-income countries?



7. For projects that are off-campus and not in the immediate vicinity of the university, what is the model for fieldwork? How often, and for how long, will faculty and students travel for fieldwork? What kind of partnerships need to be developed to ensure project continuity between fieldwork stints? If the university is the lead intellectual partner, what entity will serve as the lead operational partner?
8. Will there be a mechanism for a few experienced students or new graduates to engage in longer-term fieldwork (say, a semester or a year) to advance projects and serve as liaisons between project partners and academic teams?
9. Will the projects focus on fundamental insight and research-driven innovations (e.g. developing and commercializing a novel \$2 sickle cell diagnostic device) or installation/deployment of existing off-the-shelf products (e.g. installing solar panels at a school)?
10. If the program has a significant innovation component and faculty/students focus on the creation of new products/services/business models, etc. they will most certainly be creating new knowledge. Will there be an explicit expectation for students to publish their work? Will there be necessary programming / resources on sharing the new knowledge through scholarly and practitioner channels? Are 'undergraduate journals' acceptable or will teams be expected to publish in rigorous faculty and practitioner journals where more people will read, cite, build upon, and ultimately, benefit from the work?
11. Will the project team pursue external funding from competitive sources (e.g. VentureWell, NIH, Grand Challenge Explorations, USAID)? Who will develop these proposals and provide leadership and accountability? Will the funds be solicited from the university or through external partners?
12. Who will own the intellectual property generated by the team? Will it be published and thus open-sourced or owned by the students, the university, or the project partners?

Project Partnerships

1. Will faculty lead the way with respect to identifying partners and nurturing relationships across diverse sectors such as universities, non-profits, for-profits, UN and governmental agencies, etc. to bring projects to life? What is the role of students in building partnerships?
2. Will projects emerge first, and partnerships developed to advance projects or will projects emerge from trusted partnerships built over time?
3. Will university partnerships be considered essential at the programmatic level? What if those universities don't really care about project outcomes or don't have academic structures to support projects? Will the students be engaged in virtual teaming with academic partners?
4. Will partnerships with nonprofits be valued more than for-profits and industry?
5. Will the projects be essentially focused on supporting and empowering partners (e.g. helping the Red Cross design more efficient supply chains) or will the projects be focused on specific



challenges (e.g. strengthening vaccine cold chains) with partnerships developed with relevant organizations that can contribute to the larger goal?

6. What kinds of organizations will you not work with? For instance, would you partner with a manufacturer that has questionable labor practices or a nonprofit that discriminates against the LGBTQ+ community?
7. As global migration leads to increasingly multiracial communities, how will you address the complexities of identity, equity, and project mission? For example, would you partner with a Zambian startup with a Chinese immigrant founder to distribute your novel farming implement across the country?

Faculty Incentives

1. Will faculty participate in the program because it counts towards their teaching load or because the project aligns with their research agenda or impact agenda?
2. Faculty time expended while mentoring a team is a function of the degree to which they integrate themselves into the project. How will faculty time be valued? Who will decide the degree of engagement – the faculty members or the program leaders?
3. Will the faculty members be able and willing to engage in fieldwork away from their residence? What might the optimal time away from home be? What about fieldwork in another region or country with the comforts of developed countries (say, a Starbucks)? What about a rural area in a low-income country with few comforts of home? What about a setting with higher than normal personal risk?
4. If multiple projects are focused in one geographical area, will one or two faculty members lead fieldwork for all teams? Will the other faculty mentors trust the fieldwork leader to guide teams and make time-sensitive decisions?
5. How will the tangible works (e.g. grants, publications, awards, invited talks) count towards promotion and tenure? How will the intangible works (e.g. building partnerships, leading intensive fieldwork, advising and empowering partners) count towards promotion and tenure?
6. How will the program recognize and reward teaching/research faculty, professors of practice, and others who are not tenure-eligible but bring tremendous passion and real-world experience to the program?
7. What kind of onboarding and professional development will new faculty mentors need to productively engage with the program? Who is responsible for delivering that?

Academic Infrastructure

1. Do mid-level and senior administrators understand and care enough about the challenges and opportunities of this kind of work? For example, traditional study-away programs, short-term



service trips, and programs focused on developing innovative technology-based social enterprises are all equally important. However, they need very different kinds of resources, lead to different outcomes, and show results over different time scales.

2. Does your academic culture celebrate noble failure with the goal of creating a vibrant culture of innovation, collaboration, and iterative learning? If not, how will you build a culture that is open to learning from failure and constantly questioning “the way that we have always done things here”?
3. Is the institution supportive of longer-term faculty travel for fieldwork? For example, can a faculty member live in another state or country for a year as they engage in ecosystem mapping and building new partnerships? There are several legal questions besides questions of risk management, compensation, and technological infrastructure to ensure that the faculty member can remotely participate in every aspect of university life.
4. Is the Institutional Review Board (IRB) at the institution familiar with the unique challenges associated with working in low-resource communities? Are they experienced and supportive of working with IRBs as well as less formal and structured pathways for local approvals for research involving human subjects?
5. Will the offices that support sponsored research be supportive of extramural funding proposals led by non-profit organizations (with much lower indirect rates) who then subcontract back to the university or directly cover project expenses on the ground?
6. Will university intellectual property offices support your program in filing regular patents or patents for humanity or publishing your work and open-sourcing it since the freedom to operate is more important when working with low-resource communities where intellectual property protections might not be enforceable anyway?
7. Are the university risk management structures and processes well-developed to support faculty, graduate student, and undergraduate student travel to low-resource communities in the U.S. and to low- and middle-income countries? Will they permit undergraduate students to travel to, say, refugee camps in northern Kenya or parts of Chicago or Mexico City with higher than average crime rates?
8. What kind of resources will be available to the program for supporting faculty and student travel, seed funds for new projects, subsidizing project implementation expenses, travel to conferences, etc.?
9. What kinds of resources will be available to support high-need students who don't have the means to support fieldwork expenses or cannot miss four weeks of paid work because they need to support their families? Will those students be offered wage replacements?
10. How will you ensure that the program is not over-reliant on just one or two leaders? How will you capture tacit knowledge, build multi-stranded partnerships, and create professional



development opportunities for new faculty so that the program flourishes when key leaders step away from the program?

Community Engagement and Equity

1. Once again, will the projects undertaken by faculty-student teams be focused on specific communities or larger markets and systems?
2. If the program will espouse a participatory approach, how will end users and other partners be engaged in the design process? Will the program emphasize design for, design by, or design with stakeholders?
3. How will you ensure that all relevant partners are engaged, and the voices of the most marginalized and disenfranchised stakeholders are heard?
4. What will be the practical mechanism of keeping your partners informed about project progress? Will you or your partners host regular in-person meetings? How might you employ social media such as WhatsApp and Facebook for project communications?
5. How will you ensure reciprocity with your partners? How will you seek, recognize, respect, and incorporate the knowledge, perspectives, and resources that each partner brings to the collaboration?
6. While all stakeholders should have skin in the game, the level of risk that they can assume might vary significantly. How will you ensure equity from and between all stakeholders?
7. When working on ambitious multi-year projects, different stakeholders might be involved at different phases of the project. For example, rural clinics and traditional healers might contribute insights for a new diagnostic device in the early phases, hospitals might be engaged in clinical trials, and for-profit manufacturers and distributors might be engaged in the commercialization phase. How will you manage partner dynamics and phase-in and phase-out partners fairly and respectfully as the venture progresses?
8. How will you ensure that the dignity and self-determination of your partners is never compromised by your team or by other partners?
9. How will you navigate the inevitable unintended consequences of projects? How will you ensure that the possibility of negative consequences is minimized and that unfortunate situations are appropriately dealt with?
10. How will your team and the engaged partners deal with partners who are no longer contributing to project goals?
11. What boundaries exist between your academic program and the on-the-ground operations by your partners to ensure that questions of risk and legal liability are appropriately addressed?
12. When working on market-centric projects, when might you step away from the venture and let the partners and market forces take over?



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engage faculty and students in ambitious, interdisciplinary, multi-year, impact-focused ventures. In a previous avatar, Mehta was the Founding Director of the Humanitarian Engineering and Social Entrepreneurship (HESE) Program at Penn State. His book, [Solving Problems that Matter \(and Getting Paid for It\)](#), takes a deep dive into STEM careers in social innovation and global sustainable development.