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The Curriculum Puzzle: Developing and Integrating Materials to Localize a Curriculum

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Introduction

Engineering and engineering education (EE) have played a significant role in the development of countries before, during, and since colonization [1]. Lucena & Schneider [1] remind us that while economic and political conditions may have differed across countries, engineers' primary goal during colonization was to transform nature into infrastructure to be controlled, get a return on investments, and demonstrate superiority over indigenous technology. Across different colonizing powers, engineers filled a role in service to the colonial project. Over time, as colonies became independent countries, engineering was - and still is - considered an essential tool for helping these “traditional” societies on the path to development [1]. In addition to engineering, formal education emerged as a venerated tool for advancing and emancipating marginalized communities [2], [3].

International organizations like the World Bank, UNESCO, and countries in the Global North have proffered education, engineering skills like problem-solving and critical thinking, and specifically EE, as a tool for social mobility, individual agency, or economic development in the Global South [2], [4]–[7]. However, engineering and EE initiatives for the “development” of countries in the Global South take a deficit-oriented approach [6] where engineers - and engineering students - from the Global North are seen as experts, and the community is merely considered a beneficiary [8], [9]. Questioning who the actual beneficiaries are, Nieusema and Riley [10] illustrate how such initiatives reinforce structures of marginalization where the communities have to pay the price for the development interventions, and development workers are the beneficiaries. ‘Engineering & EE for development’ initiatives rarely include a framework for social justice [8], [9] and may end up doing more harm than good for already marginalized communities [8], [9], [11].

We (the authors) are a team of engineering education researchers at a predominantly white American university: a professor, a research scientist, a graduate student, and undergraduate students. As part of the DeBoer Lab, we offer an engineering education curriculum for displaced learners in Kenya, Senegal, Zimbabwe, and the U.S. As engineering and education in international development often reinforce structures of marginalization, we are vigilant and critical in implementing this curriculum and seek to minimize the imposition of hegemonic ways of knowing, doing, and being. Our pedagogical framework of Localized Engineering in Displacement is grounded in principles of social justice and critical pedagogy [8]. The framework centers the local knowledge of the community and empowers displaced students to be learners, leaders, and citizens [8]. In DeBoer et al. [8], we describe this framework, its outcomes for students, and its impact on the community.

In this paper, we explore the drivers of relevant curricular design and share how the LED curriculum has evolved over the past seven years through reflection and action. We focus on five recent developments that have emerged at different times as discrete components of the curriculum: 1) EngStarter - a toolkit for tinkering and prototyping with electronic components 2) a design notebook for students 3) spatial visualization assessments 4) a teacher guide, and 5) co-design workshops to localize with teachers. Using the metaphor of a puzzle, we illustrate our curriculum design and redesign process. In each section, we add details about reflections on our philosophy and actions for implementation. This fluctuation between critiques of philosophy and details about practicality may be disorienting. Still, we intend to highlight the iterative process between reflecting critically on the curriculum and making practical changes. The iteration aims to ground our work in praxis [12] and transform the curriculum through reflective action.

Conceptualizing the engineering curriculum

We would like to start by clarifying what we mean by a curriculum because the definitions of a curriculum range from everything that happens in a course [13] to a plan for learning [14] to the materials used for teaching [15], [16]. The word curriculum is often not even defined in the literature, assuming a shared understanding of this word. However, it is crucial to define curricula since they are not ahistorical or apolitical. Like knowledge, curricula are socially constructed and reflect the ideologies of those in power [15]–[18]. Dei [18] insists that the curriculum is "a social construction of what skills, talents, knowledge, and capabilities" we want to foster in students. It is not merely the mandated text given to the teacher to work with [18]. Since the curriculum is socially constructed, it can become a site for resistance, a space for creating change [18]. Kovack [17] emphasizes that a curriculum makes space like nothing else in education; it can be a powerful tool of social justice for the marginalized. However, this is only possible if a curriculum empowers learners to ask questions about what the curriculum includes as well as what it omits or devalues [18]–[20].

Given the interdependence between curriculum and instruction, we define the curriculum as the collection of content, pedagogy, and assessment used to foster a particular set of skills and knowledge in students. Implicit in this definition are the power dynamics, negotiations, and decisions between the various stakeholders involved in the teaching and learning environment, such as students, teachers, curriculum designers, funding agencies, etc. We define the curriculum so broadly - beyond the technical content - to acknowledge that there are multiple ways in which dominant values are promoted through the educational ecosystem.

A strategy to combat the hegemony of knowledge from the Global North has emerged in international development over the past few decades: bringing in the local knowledge of the communities. However, such efforts were not always successful. Shizha [16] provides several examples of attempts to localize the curriculum where the knowledge and values of stakeholders from the Global North dominated this curriculum design process.

Examining the complicity between power and knowledge, Briggs and Sharp [21, p. 665] observe how local knowledge of the community is "allowed to offer contained solutions that fit within the current scientific/development worldview but not to challenge the content, structure, or value-system of this view.” Elsewhere, Briggs [22] suggests that it is time to move on from merely focusing on the content of local knowledge and from attempts to legitimize it through academic research. Instead, he advocates for thinking beyond the content of local knowledge to its process and practice. This approach resonates with us as it allows us to center and empower the community, deepen our understanding of local knowledge, and understand the power relations embedded within this local knowledge [22].

In the LED curriculum, we center the local knowledge of the students and teachers to teach engineering skills. These engineering skills include engineering design, critical thinking, problem-solving, professional skills, and knowledge of relevant science and technology concepts. Since the mid-1990s, U.S. scholars have noted a significant shift toward the idea of engineering as design [23]. The centuries-old emphasis on engineering science, science, and mathematics knowledge was critiqued and questioned for relevance in solving everyday problems [1]. With the welcoming and appropriate shift towards design, a common misconception arose amongst scholars and practitioners that design is universally transferable. Since design is not centered on a specific context, culture, or definition, there is some truth to the idea that design is universal. Design is defined as what engineers “do” [24], and there are notable differences in the design process based on the context, knowledge, and resources where it is applied. Though it is agreed that there is no one design process, the essence of design is considered “the creative application of scientific principles” [25], [26]. As a result, the idea that design is transferable is limited by what is recognized as “scientific principles” [21], [22]. The rise of Western science, concurrently with the histories of colonialism and globalization, has influenced the forging of a universalized notion of Western science as the dominant practice [27]. Therefore, as EE scholars designing programs for international settings, we are responsible for critically examining our work, eliminating the impositions of dominant science, and engaging in meaningful ways to recognize and center local beliefs, knowledge, and skills.

The puzzle of localizing an engineering curriculum

Curriculum design requires a multi-dimensional approach to resist dominant ways of knowing, doing, and being in engineering. Localizing is often limited to surface-level changes, like providing local or cultural examples such as Egyptian pyramids or Mayan hieroglyphics [28]. Even if problems or activities are contextualized, these are often tokenistic changes without reflection on whether the activity is relevant for students [29], [30]. Local or cultural examples are merely plugged in without a consideration of epistemologies or engagement with the community [30]–[32]. Our approach is that a localized curriculum requires more than adding context-specific examples; it requires a holistic set of materials, tools, relationships, and structural support for teachers and students.

The LED curriculum's germination began with the lab's introduction to its first significant collaborator, the Tumaini Innovation Center. Leaders in both spaces first discussed their goals in research and instruction. There was a clear alignment in their shared interest in student-initiated and student-led change and building learners’ self-determination. The center was re-scoping and constructing new facilities based on the direction of students, who knew their needs best. The researcher was developing an agenda to understand how learners outside of formally credentialed engineering settings could best develop solutions to their community's problems. Given this alignment, the two groups were well-placed for a small internal university-funded seed grant, which led to their co-design of the first version of the curriculum. We built the first curriculum based on student interviews about their interests, goals, and aspirations. Early pilot testing focused on students and teachers, especially on how students learned best (e.g., storytelling) and the most relevant project focus areas (e.g., kitchen garden irrigation).

Translating the idea of centering local knowledge in practice required us to break down the curriculum into several modular components. During the initial curriculum design, we worked with teachers and students and divided the curriculum into three major components: Content, Assessment, and Pedagogy [33]. The content covered the learning objectives, learning outcomes, class topics, and class content. The assessment covered both the formative and summative assessments throughout the entire course. The pedagogy covered the technology tools used for course delivery (e.g., mobile tablets) [33], [34], and teaching techniques (e.g., Active, Blended, Collaborative, and Democratic (ABCD)) [8]. Through our initial tests of the curriculum with our first collaborators at Tumaini Innovation Center, we realized that it was important for the learners to understand the curriculum's scope fully and see their engagement as relevant. Therefore, we again broke the curriculum into multiple modular components to design and redesign collaboratively. For example, we broke down the pedagogy into 1) learning technology, 2) teacher support, 3) class environment, and 4) organization. We conducted review sessions with students and teachers to redesign to meet the culture of the context. These review sessions were part of our first efforts toward localization. During these earlier sessions, the students designed the class sessions: time spent learning in and out of class, discipline to be followed, tasks to be done before and after class, etc.

Due to the demand for engineering learning in displaced contexts, our program received requests for translating it to other displacement contexts after our first implementation with former street youth in western Kenya. Then, we began translating it in Jordan for people displaced from Syria and the following year in Northwestern Kenya for people displaced from across the Great Lakes Region and the Horn of Africa in sub-Saharan Africa. These translations meant we had to critically examine the curriculum from a relevance and application point of view for the refugee camps in Jordan and Kenya. Breaking it into many curriculum components was critical to ensuring the changes were specific, detailed, and relevant. After two more years, we extended the program to multiple high schools with girl learners who moved to access safe schooling in Zimbabwe and Senegal.

As we continued translating the curriculum to each of these contexts, our process and specific curricular components continued to break into smaller pieces. Now, we see the entire curriculum as a puzzle. The curriculum components are modular, and just like puzzle pieces, they can be fit together to suit each context. This approach also addresses the challenge of transferability and scalability. Briggs [22] found in his review of international development work over the past 20 years that transferability and scalability - or the current buzz phrase 'going from local to global'- has been one of the main concerns of practitioners focusing on local knowledge. He observes that without addressing issues of transfer and scale, work focusing on local knowledge will remain at the periphery of practice and continue to disappoint [22]. Paradoxically, we insist that for a curriculum to be transferable, it must be localized.

Localization in contexts of displacement has its challenges. When individuals are displaced, their knowledge travels with them. However, the dislocation of their knowledge means their new host community/country system does not value them. The international development work with forcibly displaced communities is inherently contradictory in that the system imports outside solutions despite locally available expertise. Therefore, it is critical to unearth this local knowledge and produce a usable response to this paradox.

Our challenge is to design a puzzle - a curriculum - in which, using the same pieces, learners can assemble different final pictures. Each curriculum component has room for customization, not only for the specific location but also for individual learners. So, the same curriculum can give different outcomes. While this may be impossible for a physical jigsaw puzzle, that is precisely what we are designing our curriculum to do - provide similar pieces to help learners get a range of final pictures. Describing how engineering education needs to change, Bucciarelli [35] illustrates this idea with examples of how checkers and a checkerboard can be objects of different games or the variety of games that can be played with the same set of 52 cards. Similarly, the curriculum puzzle can be put together in multiple ways. Our curriculum is implemented with partners of varying needs for students ranging from high-schoolers to adult learners, so expected outputs differ. For some, the goal is to support displaced youth in contributing to society and making a living; for others, it is to encourage students to pursue higher education in STEM fields. With different expected outcomes, the learning goals are also different for each location and partner.

Just as the end goals differ for each location, the starting points differ for each student. Students in displaced contexts may be at different levels based on their previous experiences yet still be in the same class. Of course, differentiated instruction is a challenge in any classroom, but the students' demographics, prior knowledge, experiences, and trauma are wide-ranging in the case of displaced learners. In addition to scaffolding, another challenge was ensuring that our materials were not irrelevant to the learners' context or too similar. One of the risks of focusing on local knowledge is that students are taught things they already know simply through formal settings [36]. Given the reality of continued displacement, we use principles of culturally relevant pedagogy so that learners can connect new concepts to their prior knowledge and apply it in different contexts and communities. Most importantly, even though we recognize that the final picture is important [8], the process of connecting the pieces is also valuable; the process of going through the curriculum is just as important as the outcome of the curriculum for the learner, and this process is where the learning takes place [22].

Even with localization, we continue to critically question our role as EE researchers in the U.S. and reflect on our complicity in reinforcing structures of marginalization in EE. A fundamental understanding within engineering is that a single problem can be approached in many ways. From their first lessons, engineering students are taught that no idea is too outlandish, impractical, or advanced—only that every idea should be considered. Nevertheless, the engineering design process and its variations are seen as the best way to solve a problem — little effort is made to understand problem identification and problem-solving processes which are indigenous to the place. The solutions which are encouraged and eventually developed also carry undercurrents of neoliberalism which can result in environmental degradation, an overemphasis on technological solutions, and social injustice [37].

Through reflections, ongoing implementation, and discussions with practitioners, we have observed how a curriculum is socially constructed and reproduces the values of those with power. For example, teachers gave us feedback about the struggles in teaching the engineering design process. In response, we are piloting a Recognition of Prior Knowledge (RPK) test to understand local problem-solving processes and embed them into the curriculum. Other changes we made over the years include: shifting our focus from technology to human connections/relationships [38], [39], collaborating prominently with teachers instead of students [40] for long-term sustainability, providing teacher training to help teachers form their community of practice and take on the role of mentors for each other and new teachers [41]. We also have a research study in progress to examine our past work critically and see how we can further use an asset-based approach and minimize the imposition of dominant practices through our work [38].

The pieces

While we have made many major and minor changes to the curriculum over the past seven years, in this paper, we are focusing on five new pieces:
EngStarter kit: A self-contained kit of microelectronics materials, tools, and a raspberry pi setup. It is a flexible and dynamic curricular component and provides technical tools and resources so students can practically learn STEM concepts and develop prototypes addressing community issues. The EngStarter kit provides contextualized tools/materials in alignment with the technical classes of the LED curriculum, allowing students and teachers to learn about electronics.
Design notebook: A notebook with references to class material and prompts for students to answer, reflect, and record information. Students get a space for brainstorming and reflection throughout the scaffolded design process in the curriculum. This structure makes it explicit that the students co-create the learning materials while learning and generating new knowledge. Additionally, the prompts within the design notebook focus on local knowledge sources, assisting students with designing community-based solutions. Simultaneously, instructors utilize the notebook as an additional assessment tool and communication channel with students. Students use the notebook daily during class to record their thoughts and

answer guided prompts. Likewise, instructors use it formatively to track their students' overall progress.
Spatial visualization assessments: A paper-pencil assessment to understand students' spatial visualization skills. These assessments identify prior skills in modeling practices, leverage students' background experiences in spatial visualization curriculum development, and continuously build strong modeling habits so that students can communicate their abstract ideas with others.
Teacher guide: A lesson planner with references to class materials and reflection prompts for teachers. The teacher guide is modeled after the design notebook and allows teachers to add translations, local examples, local ways of knowing and doing, and relevant analogies.
Co-design workshops: In-person and virtual sessions with teachers to collaboratively re-design the curriculum. We go through the process of understanding the challenges in implementing the latest version of the curriculum, discuss potential solutions, and make appropriate changes to the curriculum.

Several factors shaped the curricular and design decisions for these five pieces, some apparent and some latent. This section will illustrate some visible and invisible factors influencing the curriculum design. We will also briefly discuss our efforts to make some latent factors more apparent.

The visible

Listening to the students and teachers was the most visible factor influencing the curriculum and curriculum components [8], [19]. The idea for the design notebook originated from our lab's work in refugee camps and their desire to build and utilize an engineering curriculum better suited to their blended learning environments and network issues. The network issues often made it challenging for students to prepare assignments digitally and access the learning platforms for submission. Therefore, we saw the design notebooks as an alternative for simplifying access to assignments and submissions. Another factor that influenced the adaptation of the design notebook was the need to document the various stages of the design process in one place to support iteration and the evolution of students' design solutions. The idea for the EngStarter kit came from the intersection of education, technology, and experience from refugee camps in Jordan and Kenya, resulting in a contextually relevant kit composed of various tools and instruments. The request for modules on spatial visualization and 3D modeling came from the facilitators in Kenya. They requested that students be offered resources in practicing modeling skills with sufficient scaffolding so that they get comfortable with the technology in their projects.

A second factor was resource constraints at the location. For the EngStarter kit, this impacted the materials provided in the box; the components/sensors included were chosen based on whether they were relevant to the problem students wanted to address or the power supply at the students' location. We designed the kit to be self-contained, portable, and provided with ways of charging/supplying power. The prevalence of power and connectivity issues also prompted reformatting the design notebook. We are now changing the design notebook to resemble a workbook so that the content for the course is contained within the book and teachers are not reliant on online slides or content. However, the design notebook's crucial elements are retained, such as spaces for brainstorming and reflection.

A third factor was student-centered design. EngStarter kit was designed to be complete and self-contained [34], emphasizing using all the available space while making it manageable for the students. To make the kit accessible, we embedded multiple layers to utilize the briefcase's depth. We placed standard circuit components on the top layers to allow the students to work through the increasing learning complexity from the top layer to the bottom. The design notebook was also designed to allow students to co-create the curriculum. This co-creation process gives students the agency to choose the relevant problem in their community and develop a solution for addressing it. The co-design workshops are also another example of student-centered design. Although the workshops are conducted with teachers, activities such as mapping the journeys of displaced students give teachers concrete ways to center the students' prior experiences in the classroom.

The invisible

One of the invisible factors is power differentials in resource access. In some situations, it may not be that the resources are unavailable; rather, the power dynamics of resource distribution create scarcities that can be avoided. For example, students must be provided transport or internet remunerations in the refugee camps. The decisions and timing of giving these remunerations affect how students learn. It means conducting virtual classes flexibly if students and facilitators cannot travel and meet in person. This also makes it more challenging for students to get hands-on experience and in-person interaction, which are essential elements of engineering and teamwork.

A second invisible factor is the hegemony of engineering knowledge and practices in engineering education. A simple example was the choice of images popularly used to demonstrate engineering activities. As the design notebook has been changed based on feedback, we have added more locally relevant examples of engineers and problems faced in their community. A more nuanced example of this dominance is the spatial visualization test. Spatial visualization, the ability to mentally manipulate objects in their size/orientation, is recognized as an essential skill for engineers [42]–[46]. For engineers in training, these skills are often formally developed in graphics/3D modeling/CAD courses but can also be supported in core engineering courses through problem scoping. From a cultural standpoint, these skills and background knowledge can vary across different learning contexts.

Popular spatial visualization assessments are often developed in the U.S. (Purdue Spatial Visualization Test: Rotation, Mental Cutting Test, Mental Rotation Test, etc.) [44], [47]. The U.S.-based tests are all generally timed, multiple-choice, designed by Western researchers in the early to mid-1900s, and use objects familiar to the assessment creators. A common trend in previously published literature shows that historically minoritized students score lower, even after interventions of a course or workshop, as compared to the dominant group (white/men)[44]–[46]. However, an overlooked fact is that such assessments often ignore the existing cultural knowledge of the students [48], [49]. Chilisa [50] argues that such deficit-based theorizing is typical in research. Academy and research have a long history and a tendency to perpetuate the dominance of one group by building a collection of theories, methods, and tools which disparage or ignore the knowledge and skills of marginalized groups [50]. To address the hegemony of knowledge in the spatial visualization tests, we have developed an open-ended assignment that allows students to showcase their thinking processes when communicating abstract ideas. This assessment is a work-in-progress, and we are co-designing it with local facilitators to make it more effective.

With each co-author working on a different curriculum component, we have found frequent reflection and critical questioning essential to identify which facets of a curriculum need to be changed to make them non-hegemonic. The first step for us was explicitly stating some of the invisible factors shaping the curriculum. Then, through discussions within our group and with local partners, we (re)designed the curricular components to re-center local knowledge.

Putting the puzzle together

Although the curricular pieces are designed separately, they are intended to work cohesively as a localized and holistic engineering curriculum. The curriculum contains content centered on problem-solving, engineering design, professional competencies, and STEM fundamentals based on the type of problems identified by the students. The STEM concepts introduce students to the electronic components and theories needed for using the EngStarter kit. The EngStarter kit, in turn, supports the hands-on learning of technology concepts and further aids in prototyping the final design solution. The spatial visualization curriculum is integrated into the curriculum's 2D/3D modeling and prototyping content. The RPK test helps determine students' existing knowledge and skills, which then informs contextualized changes to be made in the class content. The design notebook and teacher guide are places where students and teachers have structure and space [51] for learning and reflecting. The co-design workshops help tailor each component individually and the curriculum as a whole for each location.

As students work through the curriculum, they may assemble some pieces and get seemingly disconnected sub-assemblies. However, over time all the sub-assemblies connect to form a clear picture. For example, the content about the electronic components in the EngStarter kit might seem disconnected from the initial localized problem identification. However, as students move closer to solution development, the utility of the EngStarter kit comes into focus.

A lot of the time, things get transformed when the pieces all come together. The picture of our imagination emerges differently when the curriculum is implemented in the classrooms. Huge missing pieces are apparent. While other carefully crafted pieces suddenly seem bulky and hard to maneuver. Conversations with teachers and students are crucial to putting the curriculum components together. In some locations, the new facilitators are past students and have valuable suggestions to add. In other places, some teachers have been teaching the curriculum since its inception and are familiar with its intricacies and challenges. They can better dictate the milestones for students in their engineering learning. By putting together these curricular pieces, we have understood how valuable it is to have multiple interactions with partners in each location.

The emerging picture

Some clear patterns emerge from the curriculum design process in its present version. The first takeaway is that the curriculum needs a cohesive integration of various curricular components. Second, despite best efforts, we see a subtle dominance of Western epistemologies woven throughout the curriculum. Third is creating a careful balance between seeming paradoxes.

The first emerging pattern is the need to introduce and scaffold each curricular component from the beginning for a smoother synergy between the pieces. This cohesive integration looks different for each location, depending on the specific goals and constraints of the partners in each place, so we are redesigning the entire curriculum to be a spiral curriculum. Each topic will be revisited with increasing complexity, allowing students to be introduced to each piece gradually and to see how adding a new piece helps them evolve their knowledge of all the other pieces. This will enable students and teachers to determine how they want to develop their understanding. The spiral curriculum can also reinforce the idea of iterative design for students as they revise their understanding of the problem and the potential solutions through each iteration of increasing complexity. The idea for the spiral curriculum came from brainstorming sessions with teachers, who indicated that we needed to be more intentional about revisiting previous topics to emphasize that design is an iterative process. Each piece should also be well aligned with other pieces to create a localized, holistic curriculum.

Another pattern is the dominance of Western epistemologies. Despite our efforts to be critical, this hegemony still exists; at least, it is visible now. This dominance is seen in using the engineering design process as the approach to problem-solving and engineering. Also, the way we do assessments is still in English, even though we encourage teachers to use translations in local languages. The dominance of the written word is also clearly seen in the design notebook and the teacher guide, a shift from local forms of learning and teaching. Most of the time, these forms of dominance are present because it is the only way of doing things known to us or considered the best way. We address this through the co-design workshops by encouraging teachers to teach us about the local and traditional ways of knowing, doing, and being in engineering and education.

Lastly, a meaningful pattern is balancing between seeming paradoxes. We balance using an asset-based approach while listening to the stakeholders about their needs. While a purely need-based approach risks being deficit-oriented [4], [37], [38], focusing purely on an asset-based approach has the potential risk of recentering the “problem” as residing within the marginalized community by suggesting ways in which they can capitalize on their strengths [52]. A dynamic relationship between the two approaches resulted in this curriculum design process. We also balanced between providing flexibility and structure to students and teachers. As endorsed by Palmer [51], authentic learning only happens when space for exploration is supported with boundaries. Moreover, since developing curricular materials with structure and space takes effort, we do not want to add to the burden of local facilitators by expecting them to design the curriculum entirely. However, we do not want to prescribe a curriculum that may reinforce our knowledge and value systems. So, once again, the balance between flexibility and structure in the curriculum design process resulted in a holistic and localized evolving curriculum.

Our takeaways are that teachers and students are essential parts of curriculum design, the hegemony of Western knowledge is hard to separate from engineering and engineering education, and balancing paradoxes is needed to create a relevant curriculum. Based on these takeaways, our paper is relevant for engineering educators and EE researchers who want to (re)design their curriculum and make it relevant to their students. It is also helpful for practitioners who strive to ensure that dominant curricula do not reinforce the exclusion of marginalized students. What we have described here does not guarantee a holistic, localized curriculum. There are still ways in which such a curriculum design process can become extractive [28], or the curriculum merely a checklist of things to do. However, if used within the paradigm of reflective action, our processes offer ways to maximize the opportunities for students and teachers to center their knowledge within the curriculum and use it to grow toward their aspirations.

The unfinished puzzle

The curriculum remains an unfinished puzzle as we identify new gaps, try to fill existing gaps, replace broken pieces, or as new directions for expansion emerge organically through our work with partners. One example of filling in an existing gap is an additional section on “Why Engineering" which encourages students and teachers to think critically in and of engineering [53]. It is a space for conversations about the role of engineering in problem-solving and the problems created by engineering and engineers. We are also attempting to replace the misaligned piece of the engineering design process by exploring the local alternatives to the engineering design process. Additionally, we are constantly thinking of how the curriculum can be a sustainable pathway for students to achieve their goals. For some students, this means getting transferable credits to pursue higher education, and for others, it means producing viable prototypes which they can use to launch their entrepreneurial efforts.

We also have some challenges and limitations which still need to be addressed. In co-design, we found that students and teachers are not homogeneous. So, we need to be vigilant and considerate about whose local knowledge gets prioritized in the curriculum. Another limitation of this paper is that we have only shared the process from our perspective. The evolution of the curriculum and the apparent gaps we need to address urgently will look completely different from the perspective of each of our partners in the various locations.

As critical reflection becomes more embedded in our approach, we are constantly taking apart the curriculum to examine what dominant ideologies have been built into it which are misaligned with the place where the curriculum is being implemented. Most importantly, we find that the more we localize, the more there is to localize; therefore, we need to split the puzzle into even smaller pieces. Localization is a continuously evolving process. Consequently, the curriculum is and should be an evolving product, where the process of evolution is just as important as the product. We want to embed reflexivity and praxis into each element of the curriculum and the people interacting with it. That is the approach we suggest to tailor the curriculum consistently.

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