

Social Empowerment through Engineering Education in Developing Countries

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Abstract— *The idea of using critical pedagogy to engage engineering students in community development has motivated several education initiatives, in developing countries, to transform students in critical agents. Developing countries received attention from humanitarian organizations, researchers, and multilateral agencies to discuss social issues that cause people to face a lack of choice, agency, and freedom. Consequently, they lose opportunities to build a better life. In this study, social empowerment through engineering education is presented as a multifaceted approach. It is not a unique technology, methodology, or curriculum approach that will trigger a transformative process to turn students into social agents. Social empowerment cannot be built without a daily practice, contextually aligned approaches and continuous living experience within the classroom. This social process is geared by a community-oriented curriculum, socially empowered pedagogy, and social transformative process where students are taught not only to read the world but act and raise their voice in front of real-world challenges that reduce their freedom as human beings.*

Keywords—*engineering education, social empowerment, community development, critical pedagogy*

I. INTRODUCTION

“Once social change begins, it cannot be reversed. You cannot un-educate the person who has learned to read. You cannot humiliate the person who feels pride. You cannot oppress the people who are not afraid anymore.”

— César Chávez

Social awareness is the subject of social choice, and it includes various approaches related to social judgment [1], sense of community [2], and capacity to exercise social agency [3]. This social process that students experience needs to start at the classroom and expand to their community, and consequently, move to their daily lives through a dialogue between students and teachers by grounding in socially oriented pedagogies [4]–[7]. If there is a central question that can be seen as a common question from new education practitioners, it is this: how can it be possible to foster social empowerment in the classroom? How can we integrate any rational basis for community development in the curriculum? By speaking in terms of social empowerment and community development, engineering [8], [9] comes as a key component.

The idea that engineering is central to leading a better society is discussed among several scholars. Given the importance of engineering to advance and build a better world, it is possible to place engineering in a central role to advance the political, economic, and social centrality decisions towards community development. Engineering, considering technology tools and its problem-solving nature, plays a fundamental role to develop a community [10]–[12]. As noted by UNESCO [13], engineering is capable to help and provide benefits to the society, and engineers need to understand the due nature of engineering in terms of professional development and to be vigilant about their role to help society and become a “socially responsible engineer” (p. 44). On the other hand, engineering and technology does not solve problems or advance communities by itself. For example, adoption of technology-oriented solutions, either used for enhancing engineering learning or solving social problems, has to take into consideration a number of factors to be successfully implemented, such as computer literacy [14], [15], access, availability, and skills needed [16], socioeconomic factors [17], and human capability [18], [19]. As Lucena et al. noted [8], community must be truly considered in order to make a project sustainable. According to them, “*people are the main variable that can make or break a solution and ensure*” (p. 5).

However, the contrast between developed and developing countries calls attention to what extent existing education strategies should be reconsidered in both scenarios. Engineering for community development is even more sensitive in developing countries where economic [20], [21], social norms [16], humans rights and political factors [22]–[24] are even more relevant. This humanitarian problem calls for immediate action, and over the last decades, international agencies and multilateral organizations are addressing issues in developing regions. But the reach and relevance of engineering in fragile settings is far wider than actions to provide minimum living conditions for people in these developing regions. This scenario in emergency foster engineers and stakeholders to address low and high development degrees of development. These development degrees address basic notions for sustainable economic and living standards, as well as more intrinsic social values and political analysis.

Education in developing regions helps to save lives and offer protection and developing countries have put massive investment of their GDP on education [25]. Considering that

engineering is an element to advance and build communities, engineering education can be fruitfully reexamined by considering more adequate attention to the perspective of community development and social empowerment in the classroom. Social empowerment in engineering education implies that beyond professional development, the curriculum, pedagogy, and assessment need to reflect the social subject. However, critical pedagogy and social development is a broad discipline, covering a variety of assumptions and scenarios. How can we translate this theory into engineering education? How can we accommodate social choice, freedom, and agency in the curriculum? This paper is devoted to addressing this approach to advance engineering education practices for developing regions and showing the foundational pedagogical strategies to foster social empowerment in engineering education programs.

II. THEORETICAL BACKGROUND

Teaching for social justice requires an exploration of the many factors that support an instruction position. Debates in development studies related to social empowerment, sustainable community development, self-agency, and social progress towards foundations of well-being, opportunities, and human development. Critical pedagogy [5], [26] emerged as a theory to sustain pedagogical practices grounded in freedom and social empowerment. Critical pedagogy is grounded in the principle of critical theory and the notion that education should promote liberty in terms of ideas and power to making changes in the social, political, and economic context through education [27]. Paulo Freire is one of the foremost theorists in this field, and he developed fundamental ideas about critical pedagogy [4]. Freire argued that education is not only a matter of teachers transmitting knowledge [28]. Education is a mutual process where teachers and students learn together [29], and their potential is used towards significant changes in our society. In fact, this is the central premise discussed by critical pedagogy where teachers and students develop critical lenses towards social problems through education. Critical pedagogy also helps individuals to develop critical literacy by creating a sense of social justice [30] in which education relates to the relationship between individual and society.

III. ENGINEERING EDUCATION FOR SOCIAL JUSTICE

Our sense of social justice is shaped throughout our life by our education at home and life experiences. However, social justice is a broad concept and difficult to define. Its mutability and multifaceted nature make people see its definition through different lenses. This paper takes into consideration the role of social justice to social empowerment [31]–[33], freedom [21], [34], social responsibility and agency [13], [35], [36] within a community .

When it comes to engineering education, there are various approaches that can be found in the literature in terms of social justice within the engineering curriculum [9], [10], [35], [37]. It is fair to say that, out of the research scope, the professional-development view has been traditionally the dominant one. In this study, engineering education concentrates on community-oriented issues, including policies, economy, and culture on social terms. Therefore, by pointing to the important aspects of

the engineering education/social justice-nexus and its bearing on the engineering practices toward community development, the only substantial objection refers to a notion of community development before translating it into the classroom.

IV. COMMUNITY DEVELOPMENT IN DEVELOPING COUNTRIES

Within the context of community development in developing countries, education is fundamental to raise social awareness and provide a voice for students. Engineering helps students to see the world through the development perspective and grasp an in-depth analysis of their situation by considering the problem nature, root causes, and potential action for an effective change. The literature may present different frameworks for problem-solving, as well as engineering application dilemmas, theorems, and community-oriented approaches which lie close to each other. The real issue in developing countries is not, therefore, presenting a solution or derivation of any specific technique to solve local problems, but the resilience and capability to develop communities while addressing vulnerability, emotional conditions, local constraints, and major adverse events due to the nature of these fragile settings.

In fact, the systems involved in community development are arranged in all sort of categories that affect the economy, political, social, cultural, environmental, and ethical. To lay the foundations of an effective education approach, we must address three important outcomes: choice, freedom, and agency. However, given the nature of the subject and practical difficulties to incorporate these outcomes into the curriculum, all three components are framed separately so that each outcome can be explored and examined through theoretical and practical lenses within the engineering education field.

V. CHOICE, FREEDOM, AND AGENCY

A. Choice

People living in developing countries are prone to miss their dignity and hope due to a lack of choice opportunities. The main reasons for such restriction are conditioned by policies, economic rules, social organization, or environmental constraints. When Paulo Freire claimed that students should be able to read the world, it includes empowering them to visualize potential changes that may happen based on their agency as students. Choice cannot be supplemented by an oppressor system that tends to reduce students' choice opportunities to a mere secondary decision that will not move beyond socioeconomic and political barriers in developing countries. Choice must be empowered and heard within and outside of the classroom and facilitated by a system that promotes freedom.

B. Freedom

To achieve opportunities, students need freedom to decide about their lives. Freedom is attached to students' decisions in terms of what they would like to do and importance of the process of choice itself, where students are not forced into some state [38]. Freedom comes into different shapes [21] and it is important to emphasize certain specific features of this

freedom approach that should be clarified at the classroom. These different shapes are transformed in three different components. First, education to foster capability focused on human nature and social development. Second, learning environment to promote cultural freedom where students can express their beliefs, values, and thoughts. Last, but not least, the sense of liberty where students lead their lives towards their own desires, and professors play a fundamental role to open channels and opportunities for students through education.

C. Agency

If choice is important and freedom is fundamental to promote choice opportunities, it is right to presume that agency is a fundamental component in the critical education. This is so for several reasons. First, choice is, as noted by Kleine [39], a component that can be operationalized in order to allow people to live according to their values, and it has to be involved on actions and agency to raise their voice. Second, freedom is attained to development, and freedom of choice relates to development within the personal, social, economic, and political sphere [38]. Third, agency can be empowered through capabilities, and developing capability through education is giving confidence to students advance in courses and foster their self-agency as engineering students.

VI. EDUCATION PROCESS: TEACHING AND LEARNING

Although critical pedagogy focuses on translating social justice values to the curriculum, it is equally important for educators to understand the education process and cognitive aspects that surround teaching and learning. In doing so, education practitioners can guide their pedagogies towards best practices and take informed decisions about socially oriented curriculum applied in the course. One of the fundamental challenges to understanding the learning process. Equally important is the reflection and conceptualization of this process. By knowing that, this study considers that learning occurs through genuine [40], participatory and social constructivism [29], [41], [42] experience where the learner can process and retain the knowledge through social interaction and internal manipulation of the information in a pre-disposal cognitive structure. More than that, this learning process is influenced by social/cultural analysis [43], language [43], misconceptions [44], and metacognition [45]. By taking advantage of an analogy, consider that the architecture for a house consists of an overall external and internal design, as well as roofs, foundations, furniture, and so on. On the one hand, we can easily modify, rearrange, or replace furniture which is more manageable (manageable). On the other hand, we need a considerable effort to rearrange or modify walls, foundations, or roofs (consolidated). By the same token, the learning process includes an overall organization and manipulation of knowledge which consists of an essential relationship between long-term memory [46] (consolidated) and short-term memory [47] (manageable). The learning process is essentially influenced by types of analysis in which social and cultural elements, as well as language, misconceptions, and metacognition will serve as foundations to store, retrieve, and process knowledge. This complex cognitive learning process makes significant the role of the educator in

the classroom that have to create strategies to improve the learning experience while taking a multifaceted role to guide students towards their self-reflection and role in the society as engineering students. Therefore, teachers become a central role to improve the success of education models in any context, including developing countries.

Indeed, teachers are more than educators. Teachers are leaders, mentors, and facilitators. First, teachers are educators because they are in charge to have a profound impact on students' life through education; however, education strategies are not from professor to students only. It is important to receive continuous feedback from students in order to improve the teaching experience in the classroom. Teachers are leaders [48] because they need to understand and interpret the learners in order to adjust the strategies to improve the learning experience, also explained by context responsive pedagogy [49]. In the same way, teachers need to represent the educational institution, establish policies, and integrate the content, assessment, and pedagogy with the course goals. Teachers are mentors [50] because they need to offer support to students regarding providing support to the right direction toward specific goals. Finally, teachers are facilitators because they need to support the learning experience in the classroom by tailoring their pedagogies to the needs of the students. This facilitation process is also known as instructional scaffolding [51]. It is important to comprehend the teacher/student nexus since this is not merely because the learning context, but it is important to enhance the chance of success of socially oriented intervention in engineering courses to achieve learning outcomes.

VII. IMPLEMENTATION GUIDELINE

Concern with learning outcomes in community-oriented curriculum takes on different shapes depending on whether the context or designing instructional strategies for community develop speaks with technically-oriented engineering curriculum. From the practical standpoint, an engineering course designed to foster social empowerment needs to respond to the criticism that traditional teaching and learning fail to prepare and empower engineering students in developing regions.

This section is intended to present a community development model to be implemented in engineering programs addressed to tertiary education based in developing countries. Some of the very characteristics that make an engineering classroom socially relevant relies in transposing social awareness to all pedagogical components, such as content, assessment, and pedagogy. For example, teachers whose students are developing a project under a project-based learning approach, need to adjust to the fact that their classroom now contains a fundamental social development element that needs to reflect into the course outcomes and rubrics.

The ways in which social justice can be brought to the classroom could be based on user-centered design approach, socially oriented assignments, or participatory design processes in which students and local problems are taken as the main outcome. Indeed, socially oriented curriculum needs to be fully

grounded in community development, so that students develop intrinsic grasp about engineering application towards social good. Researchers and education practitioners built on this notion that social justice and social good can be integrated in the curriculum through a variety of ways.

Lottero-Perdue, Lovelidge, and Bowling [52] adopted a middle school program to motivate students to use engineering for social good by taking advantage of engineering design to engage students in the development of solutions about water and food while they learned about engineering. A similar approach was developed by Freitas et al. [37] where they created an engineering course focused on social development where students in refugee camps were trained to use engineering skills for community development. In this project, they used engineering design process as a relevant tool to help students identify problems and develop solutions.

Among scholars, the discussion about engineering for community development has been underlined in recent researchers [19]–[21]. Gilbert et al. [12] revealed that engineering, as with any discipline, cannot be addressed to cover all aspects for community development, and this process requires a collaborative approach among many disciplines. However, engineering education in developing countries still can play a central role to engage students and develop their social awareness through engineering thinking. In doing so, students can be empowered to face their problems and move forwards by taking engineering as a tool for development.

It is not a unique technology, methodology, or curriculum approach that will trigger a transformative process to turn students in social agents. But recent findings suggest that a contextually aligned use of engineering tools and knowledge in engineering programs are fundamental approaches to training students and promoting a transformative growth in both engineering and social agency towards community development. In light of social empowerment, particular importance has to be attached to the learning environment and human approach of students in fragile settings. Social empowerment cannot be built without a daily practice and continuous living experience within the classroom being geared by a community-oriented curriculum, social empowered pedagogy, and social transformative process. Thus, students are taught not only to read the world, but act and raise their voice in front of real-world challenges that reduce their freedom as human beings.

VIII. A CONCLUDING REMARK

This paper began with a central question between social empowerment and engineering education to the community development. The lack of choice, agency, and freedom in developing regions is shown as a social problem and it is not about bringing a single technology and engineering curriculum to solve this issue. This paper is not intended to deny the importance of technologies or curriculum approach to foster community development. But, community development involves a human approach that consider people as a central value to an effective change, supported by contextually aligned policies, economic models, and an effective education model

that is intended to giving choice, fostering agency, capability, and promoting freedom in developing countries.

REFERENCES

- [1] M. Galesic, H. Olsson, and J. Rieskamp, "A sampling model of social judgment.," *Psychol. Rev.*, vol. 125, no. 3, pp. 363–390, Apr. 2018.
- [2] D. W. McMillan and D. M. Chavis, "Sense of community: A definition and theory," *J. Community Psychol.*, vol. 14, no. 1, pp. 6–23, Jan. 1986.
- [3] A. Hempel-Jorgensen, "Learner agency and social justice: what can creative pedagogy contribute to socially just pedagogies?," *Pedagogy Cult. Soc.*, vol. 23, no. 4, pp. 531–554, Oct. 2015.
- [4] P. Freire, *Pedagogy of the oppressed*. New York: Herder and Herder, 1970.
- [5] H. A. GIROUX, "Introduction: Democracy, Education, and the Politics of Critical Pedagogy," *Counterpoints*, vol. 299, pp. 1–5, 2007.
- [6] A. G. Dover, "Teaching for Social Justice and the Common Core: Justice-Oriented Curriculum for Language Arts and Literacy," *J. Adolesc. Adult Lit.*, vol. 59, no. 5, pp. 517–527, Mar. 2016.
- [7] J. McArthur, "Time to look anew: critical pedagogy and disciplines within higher education," *Stud. High. Educ.*, vol. 35, no. 3, pp. 301–315, May 2010.
- [8] J. Lucena, J. Schneider, and J. A. Leydens, *Engineering and Sustainable Community Development*. San Rafael, UNITED STATES: Morgan & Claypool Publishers, 2010.
- [9] D. Nieusma and D. Riley, "Designs on development: engineering, globalization, and social justice," *Eng. Stud.*, vol. 2, no. 1, pp. 29–59, Apr. 2010.
- [10] B. Moskal, C. Skokan, D. Munoz, and J. Gosink, "Humanitarian Engineering: Global Impacts and Sustainability of a Curricular Effort," *Int. J. Eng. Educ.*, vol. 24, pp. 162–174, Jan. 2008.
- [11] J. Schneider, J. A. Leydens, and J. Lucena, "Where is 'Community?': Engineering education and sustainable community development," *Eur. J. Eng. Educ.*, vol. 33, no. 3, pp. 307–319, Jun. 2008.
- [12] D. J. Gilbert, M. L. Held, J. L. Ellzey, W. T. Bailey, and L. B. Young, "Teaching 'community engagement' in engineering education for international development: Integration of an interdisciplinary social work curriculum," *Eur. J. Eng. Educ.*, vol. 40, no. 3, pp. 256–266, May 2015.
- [13] UNESCO, "OEC - Engineering: Issues, Challenges and Opportunities for Development," 2010. [Online]. Available: <http://unesdoc.unesco.org/images/0018/001897/189753e.pdf>. [Accessed: 22-Sep-2018].
- [14] I. M. Venter and R. J. Bignaut, "Approach to computer literacy education in a third world setting," *Comput. Educ.*, vol. 27, no. 1, pp. 23–29, Aug. 1996.
- [15] G. E. Jacobs and J. Castek, "Digital Problem Solving: The Literacies of Navigating Life in the Digital Age," *J.*

- Adolesc. Adult Lit.*, vol. 61, no. 6, pp. 681–685, May 2018.
- [16] D. Kleine, *Technologies of Choice? ICTs, Development and the Capabilities Approach*. Cambridge, MA: The MIT Press, 2013.
- [17] R. W. Harris, “How ICT4D Research Fails the Poor,” *Inf. Technol. Dev.*, vol. 22, no. 1, pp. 177–192, Jan. 2016.
- [18] J. L. Enos, *The Creation of Technological Capability in Developing Countries*. Pinter Publishers, 1991.
- [19] S. Wigley and A. Akkoyunlu-Wigley, “Human Capabilities Versus Human Capital: Gauging the Value of Education in Developing Countries,” *Soc. Indic. Res.*, vol. 78, no. 2, pp. 287–304, Sep. 2006.
- [20] M. Alipour Khonakdari, N. Hosseinzadeh, Z. Miralaei, M. Yaghoub Pour, and A. Molaie, “Economic globalization and its challenges in developing countries with emphasis on Iran,” *Bull. Société R. Sci. Liège*, Dec. 2016.
- [21] A. Sen, *Development as Freedom*. Oxford University Press, 1999.
- [22] B. Dujardin, “Health and human rights: the challenge for developing countries,” *Soc. Sci. Med.* 1982, vol. 39, no. 9, pp. 1261–1274, Nov. 1994.
- [23] E. M. Hill King, “Women’s education in developing countries : barriers, benefits, and policies,” The World Bank, 12171, Jun. 1993.
- [24] P. Glewwe, “Schools and Skills in Developing Countries: Education Policies and Socioeconomic Outcomes,” *J. Econ. Lit.*, vol. 40, no. 2, pp. 436–482, 2002.
- [25] I. M. Mbiti, “The Need for Accountability in Education in Developing Countries,” *J. Econ. Perspect.*, vol. 30, no. 3, pp. 109–132, Aug. 2016.
- [26] P. Freire, *Pedagogy of the Oppressed*. Bloomsbury Academic, 1970.
- [27] A. Darder, *Freire and education*. New York, NY: Routledge, 2015.
- [28] P. Freire, *Pedagogia da esperança: um reencontro com a pedagogia do oprimido*, 7th ed. Sao Paulo: Paz e Terra, 2011.
- [29] T. B. K. Tsien and M. Tsui, “A Participative Learning and Teaching Model: The Partnership of Students and Teachers in Practice Teaching,” *Soc. Work Educ.*, vol. 26, no. 4, pp. 348–358, Jun. 2007.
- [30] R. Gibson, “Paulo Freire and Pedagogy for Social Justice,” *Theory Res. Soc. Educ.*, vol. 27, no. 2, pp. 129–159, Mar. 1999.
- [31] J. A. Gorlewski, *Power, resistance, and literacy : writing for social justice*. Information Age Publishing, 2014.
- [32] J. Dorn, “The Power of Influence!,” *Educ. Dig.*, vol. 81, no. 6, pp. 43–47, Feb. 2016.
- [33] A. Adams, A. Blandford, and P. Lunt, “Social Empowerment and Exclusion: A Case Study on Digital Libraries,” *ACM Trans Comput-Hum Interact*, vol. 12, no. 2, pp. 174–200, Jun. 2005.
- [34] B. Hooks, *Teaching to transgress: Education as the practice of freedom*. New York: Routledge, 1994.
- [35] D. Douglas, G. Papadopoulos, and J. Boutelle, *Citizen Engineer: A Handbook for Socially Responsible Engineering*. Pearson Education, 2009.
- [36] A. G. Dover, N. Henning, and R. Agarwal-Rangnath, “Reclaiming agency: Justice-oriented social studies teachers respond to changing curricular standards,” *Teach. Teach. Educ.*, vol. 59, pp. 457–467, Oct. 2016.
- [37] C. C. S. de F. Freitas, Z. J. Neyer, H. A. Yagoub, and J. DeBoer, “Fostering Engineering Thinking in a Democratic Learning Space: A Classroom Application Pilot Study in the Azraq Refugee Camp, Jordan,” presented at the 2018 ASEE Annual Conference & Exposition, Salt Lake City, UT, 2018.
- [38] A. Sen, *The Idea of Justice*. Belknap Press: An Imprint of Harvard University Press, 2009.
- [39] D. Kleine, “ICT4WHAT?-Using the choice framework to operationalise the capability approach to development,” *J. Int. Dev.*, vol. 22, no. 5, pp. 674–692, Jun. 2010.
- [40] J. Dewey, *Experience and education*. New York, NY: Kappa Delta Pi, 1938.
- [41] J. Heywood, “The Human Side of Engineering,” *Synth. Lect. Eng.*, vol. 11, no. 1, pp. 1–166, Jan. 2017.
- [42] M. M. Atwater, “Social constructivism: Infusion into the multicultural science education research agenda,” *J. Res. Sci. Teach.*, vol. 33, no. 8, pp. 821–837, Oct. 1996.
- [43] L. S. Vygotsky, *Thought and language*. Cambridge, MA: The MIT Press, 1986.
- [44] J. P. Smith, A. A. DiSessa, and J. Roschelle, “Misconceptions reconceived: A constructivist analysis of knowledge in transition,” *J. Learn. Sci.*, vol. 3, no. 2, pp. 115–163, Apr. 1994.
- [45] J. H. Flavell, “Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry.,” *Am. Psychol.*, vol. 34, no. 10, pp. 906–911, 1979.
- [46] M. J. Dehn, *Long-Term Memory Problems in Children and Adolescents*. Hoboken, NJ, USA: John Wiley & Sons, Inc., 2010.
- [47] D. Deutsch and J. A. Deutsch, *Short-term memory*. Academic Press, 1975.
- [48] D. J. Simpson and S. F. Stack, *Teachers, leaders, and schools : essays by John Dewey*. Southern Illinois University Press, 2010.
- [49] C. R. Rogers, *Freedom to learn*. Merrill, 1969.
- [50] B. Field and T. Field, *Teachers as mentors : a practical guide*. Falmer Press, 1994.
- [51] J. S. Bruner, *The process of education*. Cambridge, MA: Harvard University Press, 1960.
- [52] P. S. Lottero-Perdue, S. Lovelidge, and E. Bowling, “Engineering for All,” *Sci. Child.*, vol. 47, no. 7, pp. 24–27, 2010.
- [53] S. K. Bhatia and J. L. Smith, “Bridging the Gap Between Engineering and the Global World: A Case Study of the Coconut (Coir) Fiber Industry in Kerala, India,” *Synth. Lect. Eng. Technol. Soc.*, vol. 3, no. 1, pp. 1–58, Jan. 2008.