

Engineering Education and the Drive for Social Justice in Africa

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Abstract: *Engineering social justice education (ESJ) is an emerging core subject in engineering education (EE) and profession. However, several EE institutions are yet to incorporate social justice (SJ) into engineering courses, leading to strong advocacy for EE review of programmes. This paradigm shift is align with ESJ revised curricula to increase the power of engineering knowledge integrated with SJ, which explicitly harnessed in serving vulnerable society, thereby addressing injustices and inequalities; hence the crux of this paper. This paper was guided by Nancy Fraser's theory of SJ that elucidates that a more equitable distribution of resources is interrelated with equal recognition of different identities/groups within a society. This theory looks at how individuals are prevented from participating as equals by denying them of available resources to do so. This paper takes a broad look at the impact of integrating SJ in EE in Africa, while examining the extent EE has addressed numerous inequalities and, exploring how engineering practitioners can work towards a more just and equitable society. The significance of SJ in EE in the 21st century were discussed among others. Thus, to address social justice in EE, collaboration amongst educational sector and engineering industrialists are central in building and revising EE curriculum inclusive of SJ themes to consolidate engineering professional ethics. This will transform the way educators think about ESJ through creating or converting existing core curriculum courses to attract, retain, and motivate engineering students to become professionals to enact SJ in engineering field.*

Keywords: *equitable distribution, Fraser's theory, inequalities, professional, social justice*

I. INTRODUCTION

In Engineering, the concept of social justice (SJ) is an innovative thought that provides meaning and significance as well as makes the rule of law dynamic in all spheres of life. As a result of that, SJ can be theorized as a political and philosophical idea highlighting the concept dimensions of justice beyond exemplified principles of civil or criminal law, economic idea, or conventional ethical contexts (Keddie, 2012; Nasser and Romanowski, 2016). Therefore, SJ focuses more on just relations between groups within society as opposed to the justice of individual conduct or justice for individuals. Before examining the relationship between SJ and engineering education (EE), a conceptual understanding of EE is important. EE is characterized by applied and operated, educational and training programmes that help to develop basic human qualities and skills required for social and economic development (Wisnioski 2012). Yet, such programmes do not incorporate SJ and/or have not addressed injustices in EE and in engineering profession as most EE programmes are primarily focused on human capital acquisitions.

Owing to its abandonment of SJ concerns in EE, hence the necessity to take into consideration the ideals of SJ and the need for integration of SJ into EE programmes and curricula. Thus far, human factor and capital are not adequate for individuals to attain technological and development advancement progressions. Lately, there has been much interest in connecting engineering practices and SJ education with the needs and problems of the underserved and less privileged in the society through several programmes (Leef, 2017). This interest has resulted in well-intentioned attempts to help others, but neglects inequalities and injustices occurring in EE and in the profession. This is driven by a mindset that is labelled as "desire to help and the persistence to do it" (Riley, 2008), which is grouped as "Engineering to Help (ETH)". The implication is that this mindset can shade engineers, and educators as well as students not to have in-depth knowledge of SJ impact on EE. Since the 1980s, different educational initiatives were emerging as to build a solid foundation for Science and Engineering courses in higher institutions (Lucena et al., 2010). Yet, most of these initiatives did not take into consideration of policies evaluations that deals with systemic inequalities alongside with socio-economic structure. Most of these diverse programmes were largely focused on social issues related to marginalized women, ethnic and racial minorities in engineering profession. But these programmes have failed to reflect injustices and inequalities in educational programmes (Cech and Waidzunus, 2011; McLoughlin, 2012).

Accordingly, professional engineering bodies such as Engineering and Social Justice (ESJ) workshop and symposium platform made a call for graduate students to be equipped with adequate knowledge on cultural and structural subjects relating to inequalities in EE, and how SJ can find space in revised engineering curriculum. ESJ courses were identified to be integrated in classroom teaching and participation in engineering faculty to create awareness on the benefits of incorporating social justice into engineering fields (Wisnioski 2012).

Specifically in the context of Africa, the drive for SJ in EE requires a paradigmatic shift in changing from conventional to modern perspectives of teaching and learning. This prototype shift has influenced and develops discussion relating to larger subjects of SJ, human rights, racism, corruption and poor governance (Tsang, 2000). The transformative vision of SJ initiatives in EE has led to inspire changes in initiated engineering programs and courses as found in other disciplines such as Education, Business studies, and Social Sciences programmes.

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Teaching ESJ requires faculty collaboration with relevant stakeholders from within and outside learning platforms, that will assist to develop and internalize SJ as part of an engineering perspective in higher education (Kabo et al., 2012). Furthermore, engineering students are required to develop a complex understanding of SJ and skill development, that will critically reflect and identify social injustices in human relations and in career pathways (McLoughlin, 2012). To a greater extent, this will provide rational arguments for SJ foundation that will plan to eliminate injustices within EE and profession. This becomes vital as engineering educators will prepare effective core curriculum, classroom teaching and learning approaches (Wisnioski 2012). This paper review literature that uses secondary sources mainly from Sociology and Education, to explore the drive for ESJ in Africa. It uses secondary sources and illustrations to explore practical recommendations. Specifically, the study investigated the extent in which EE has addressed numerous inequalities in Africa and how engineering practitioners can work towards a more just and equitable society as well as its implications in Africa higher learning of institutions.

1.1. Overview of the drive for Social Justice in Engineering Education in Africa

Engineering historians have relatively narrated and described the importance of involving ESJ, which has repeatedly calls for a change (Wisnioski 2012). These calls for a change are persistent, with adaptations to specific issues relating to political and economic challenges (Naser and Romanowski, 2016). Recently, stringent competition in technological innovation started to emerge in the United States of America (USA) and, as well as in the production of engineering graduates in countries like China and India (McLoughlin, 2012). This competition led to new calls for ESJ to be more socially relevant in order to increase recruitment and retaining of engineering graduates in industries. Also, educational programmes outside SJ themes were discovered to be out-of-date in engineering practices, as up-to-date requirement in engineering profession were highly recommended in revolutionized industries (Kabo et al., 2009). Moreover, a growing community of engineering educators was committed to bringing service learning into engineering, which at that time were fully participated in regular Engineering Faculty learning engagement. This became imperative as service workshops, and other learning platforms were developed long side with engineering projects and activities that incorporate all forms of knowledge on SJ (Bielefeldt et al., 2017). Many engineers consider that EE and profession should not include SJ into their programmes as result of their commitment to depoliticization ideology. This ideology draw a boundary around the technical content and put away non-technical aspect of engineering. Till date, many engineers accepted meritocracy as true pathway for engineering to tread on; and inequalities and social injustices were just outcomes of a fair system, due to its social nature in the technical realm of engineering (Wichman, 2017). Hence, modified SJ engineering prospectus was suggested and recommended as one of the best methods that will aid teaching and learning to provide engineering designs as well as specified solutions to real-life problems. The applicability and social

importance of engineering involving technical designing were obvious in the profession, requiring engineering students to be efficacious and in leading the world in engineering (National Academy of Engineering, 2004). The social significance of engineering pathways should be included in specific built programmes, connecting engineering curriculum with service learning, community development, humanitarian engineering and its implications for sustainability. Also, stakeholders from engineering industries joined in building new programmes and initiatives that integrates SJ into the programmes. This process will eliminate bias and barriers in recruitment and retaining of graduate students in engineering industries as they have adequate knowledge of ESJ after completion of studies (Wichman, 2017). Notwithstanding, engineering profession has missed a fundamental point that engineers failed to identify and, more importantly, to address issues of injustices compounded by poor engineering educational facilities (Kabo et al., 2009). A study reported that approximately 80% of engineering graduates were not required to take ethics-related courses within or outside engineering disciplines (Herkert, 2011); and several studies have mentioned lack of teaching ethics in engineering classes has grave implications for future employers, clientele as well as in the society in which they serve as a whole. This becomes key as engineering professionals need to embrace ethical practices as an integral part of their profession and learning. Emphasis on transformation in EE brings about an impetus of change, developing useful discussion that will bring about expanding ethical education of engineers (Wichman, 2017). Importantly, in year 2000, the Accreditation Board for Engineering and Technology (ABET) stated their outcome standards including a number of non-technical learning outcomes engineering students must develop (ABET, 2010). Some of the important learning outcomes were understanding of professional and ethical responsibility, and ability to design a system process that will meet desired employers' demands with knowledge of contemporary issues within realistic constraints (ABET, 2012). Integrating SJ into engineering courses has challenges in adopting the subjects as most engineering educators are arguing about the subject placement in departments and SJ definition. Several studies on SJ have reminded us that SJ does not have an easy and direct meaning (Riley, 2008; Brooks, 2008), as its definition is basically influenced by cultural, political, and social orientations. These orientations were further linked to social marginalized groups experiencing inequities and inequalities as well as every forms of injustices that need to seek justice for. A working definition of SJ with key elements drawn from the Philosopher Brian Barry (2005) focuses on engineering practices and designs as: "social justice practices, including those by engineers, should attempt to share an equal distribution of rights, opportunities and resources in order to enhance human capabilities and reduce risks and harms among citizens of a nation" (Barry, 2005).

Similarly, engineering campaigns on SJ and engineering initiatives were directed at vulnerable individuals and professionals, with several number of non-governmental organizations' involvement with their affiliations supporting the movements over the past decade (Nieusma and Riley, 2010). Various approaches to SJ are signified in modern-day engineering education and practices, where SJ are clearly identified and defined. Other approaches were inspired by apprehensions from social injustices movements, tagging "social justice" to strategic struggles in order to eliminate injustices in EE and profession (Wichman, 2017). Still, another social activist groups carried out direct work with implications for SJ innovation and development, without being stirred directly by specific goals and aims.

National Academy of Engineering (NAE) (2008) in their report has supported open application of engineering resourcefulness to present-day social problems in a way that is generally consistent with SJ agenda (National Academy of Engineering, 2008). Network of engineering educators, practitioners, and students may promote the vision of introducing SJ into EE, and will go beyond assisting marginalized populations by identifying and confronting failed systems and structures that uphold injustices. Thus, working towards building SJ in EE and professional practices will further enhance equity and equality to social groups with similar opportunities (Wichman, 2017). This paper explore existing literature in relating the importance of SJ in EE, within the context that will assist in shaping engineering practices, by promoting knowledge empowered and highly skilled graduates with SJ and ethical philosophy in Africa.

1.2. The Extent EE has addressed numerous Inequalities in Africa

EE is key as it aligns with research and developmental practices, consisting of technical and non-technical aspect engineering. These are historically-rooted built into rich in-depth-knowledge, skills and practices that are centred round professional cultures in SJ and EE (Leef, 2017). These professional cultures are embedded in professional practices pertain to intellectual content in beliefs, myths, and rituals, giving scholarly meaning to EE. Hence, this has a relatively independent values from the larger societal culture to professional culture (Boni and Perez-Foguet, 2008). In this regards, culture of engineering professionalism makes the profession to extend its competence beyond specific engineering tasks. Cultural ideologies in EE are the main integral part of engineering that promotes understanding of engineer's roles and responsibilities therein (Catalano et al., 2010). These specific cultural principles has shaped engineers to comprehend their work and responsibility to broader society, which counts in engineering work and eliminating redundancy in engineering profession. This will provide professional members the understanding of complex aspects of social life within and outside the profession (Leef, 2017). Engineering profession do not allow only learning of proper skills and practices but required competencies to fit into culture of engineering by adhering to these ideologies (Wichman, 2017). This is then translated into building a crop of next generations of engineers, driving with ESJ ideology. Reform strategies centred on EE, revolves around

a range of initiatives in pedagogy, curriculum design, and institutional restructuring. Here, pedagogy refers to strategies and methods for teaching engineering students, usually but not confined classroom context; while curriculum design requires educational program requirements beyond individual classes and their instructors; and restructured educational programmes are funded and sustained by specific educational institutions through voluntary or mandatory accreditation requirements (Catalano et al., 2010). These reformed initiatives have turn engineering SJ programmes to confront injustices arising from EE practices and profession.

Regarding challenges associated with SJ and its role in EE, actors such as students and educators as well as industrial professionals are the best individuals that will provide progressive report as regards its implementation. These actors are significant in interpreting the role ESJ plays and its effects on the profession (Shutaleva and Kartasheva, 2018). Through consultations and meetings, the actors' voices will be heard and used to develop an understanding of the present role SJ plays in engineering schools. This will engage faculty members and students to offer recommendations that will empower the process and sustainability of SJ in EE to empower and equipped graduate students.

II. ENGINEERING PRACTITIONERS WORKING TOWARDS A MORE JUST AND EQUITABLE SOCIETY

Engineering profession has impact and implications on economic, environmental, socially, and society. However, society is not uniform as some individuals will benefit and while others will be adversely impacted more than others (Wichman, 2017). An important decision making and access to EE is an important factor in determining the impact of injustices on different social groups. Thus, educational impact will help to eliminate injustices, resulting to a just and more equitable societies. Hence, SJ can be attributed to equal distribution of wealth and privileges to vulnerable populations who are inclined to poverty and poor self-development in the society. SJ in EE encompasses engineering social responsibility and should be inclusive in core engineering courses (Catalano et al., 2010). Even with devoted social groups such as Engineering, Social Justice and Peace (ESJP) fighting for SJ education for engineers, some pessimist engineers voted against seeking for ESJ. For instance, studies have revealed that employers have shun engineers suspected to be indoctrinated with SJ ideologies. To this present day, employers and educators have perceived SJ ideology as a highly 'destructible virus', while other studies have asserted that majority of engineering activities in the industries are owned by individuals of higher affluence, penetrating injustices in the profession (Chasmar and Wichman, 2017; Bielefeldt et al., 2017; Adam, 2020). ESJ courses does not appear to be a widespread formal education for engineering students about SJ prominence.

Despite the significant efforts of several scholars who have clamored for SJ to be incorporated into EE and practices remains a very open question in engineering field. One of the ways to address the open question is to express strong commitments and liaise with non-governmental engineering organization (NGEOs) towards SJ in building EE. The NGEOS were established and supervised by engineers with clear objectives of designing technologies to improve conditions of vulnerable individuals in engineering profession. Also, a pragmatic openings were offered to examine daily practices engineering activities in line with SJ guidelines (Wichman, 2017). By doing so, engineers can put forward their complaints of injustices to seek for justice and clarifications that will influence positive engineering practices. Capturing and documenting action-driven in ESJ is held to have a better understanding of the dynamic interactions between the interplay in engineering and social justice (Brown and Wisby, 2020).

One way of accomplishing the objective of NGEOS is to provide engineering students a paradigm shift that centers on issues of SJ rather than profit or technical expertise (Bielefeldt et al., 2017). Engineering students should utilize SJ as a critical lens that allows for change of philosophy to integrate, uncover patterns and connect SJ into practices and profession. However, the traditional context have played a significant role in educating graduates with knowledge rooted in SJ. The understanding of SJ in EE context is embedded in SJ engineering programmes, building intelligent and knowledgeable professional engineers that will stand and oppose against oppression and social injustice (Leef, 2017). This will further create not only awareness but also act as an agent of change that strives for appropriate human rights and SJ. Also, this requires providing a learning space where engineering educators will have better opportunities to awaken their consciousness and discover ways to develop their understanding with students to instill the knowledge of ESJ (Bielefeldt et al., 2017).

III. THEORETICAL FRAMEWORK

This paper was guided by Nancy Fraser's theory of Social Justice and which was adapted and could be applied to interpret the ideals of SJ in EE. Nancy Fraser (2008a; 2008b) restructured the theory of justice by criticizing the justice system of Western society represented by the United States of America and theorists Axel Honneth and Charles Taylor. According to Nancy Fraser (2007; 2008), the theory of justice takes participation equality as its normative foundation and takes redistribution, recognition, and representation as its dimensions and justice should first have redistribution of dimension. This theory explains that SJ requires social arrangement which will make it possible for all individuals to participate on an equal footing in social life called participatory parity (Fraser, 1995; 1996; 1997; 2008). Creating social arrangements will foster parity that will improve students' capacity to take advantage of EE.

Also, recognizing how students are differently positioned in terms of their equity needs and providing differential support to students to address injustices in education (Lydens and Lucena, 2018; Lambert and

Czerniewicz, 2020). Coping with complexities of the recognition and provision of ESJ is one of the major issues for engineering educators, especially those committed to integrate SJ into EE, to accommodate disadvantaged or marginalized students. Importantly, all the three dimensions are mutually entwined and reciprocally influenced and reinforced with each other but none are irreducible to the other. As this theory explores the issues of EE and SJ, the interpretation of matters pertaining SJ in EE requires an in-depth overview of the underlying principles of economic, cultural and political justice as replicated in patterns of equity and educational policies and practices (Fraser, 2008).

Regarding the dimension of SJ, according to Fraser (2008a), people's appeal for redistribution and recognition goes beyond territorial states in the context of globalization era. This concerns the nature of state power and decision rule as social justice have political dimension of representation; as the term political representation can be equated to mean both symbolic framing and political voice (Fraser, 2000; 2003; 2008). Relating social injustices in engineering is an important process to implement SJ in EE, as this will promote and encourage equal accessibility to the profession for all. SJ in EE has a key role to play in improving unconventional knowledge, especially among under-represented individuals in engineering profession (Brown and Wisby, 2020).

Appropriate and new environment can be created to allow SJ to have a significant meaning in EE, as well as in the profession. Creativity and critical thinking are needed by engineering educators that navigates EE curriculum around SJ (Keddie, 2012; Leibowitz and Bozalek, 2016). Within this context, creativity and critical thinking will enable ESJ, to thrive and incorporate ideals of SJ into EE and training programmes (Anderson et al., 2017; Adam, 2020). This has a great potential in providing engineering graduate students the intellectual discerning when encountering injustice concerns pertaining to EE and human experiences. Besides, integrating SJ into EE shows a promising potential and intellectual opportunity for engineering graduates to consolidate with industrial professionals and social scientists offering ESJ interactions and opportunities (Nasser and Romanowski, 2016; Shutaleva and Kartasheva, 2018). The incorporation of ESJ values and principles is an imperative for SJ training programmes and the movement to constitute SJ in EE should be all-encompassing to ensure a potential pathway for novice engineers (Mladenov, 2016; Anikina, 2020). Also, this will inspire beginners to opt for engineering courses to exhibit capital value for ESJ and these courses should be carefully evaluated so as to make it important and fun classes for engineering students to embrace.

IV. DISCUSSION

The global economy is continuing to develop and the 21st century society is preparing better to improve SJ as engineering profession is receiving attracted diverse nationalities and cultures.



The degree of improvement can be enhanced through programs that suitably train engineers and faculty members in the colleges and schools of higher learning of engineering (Riley, 2008; Leef, 2017). In order to achieve this, engineering curriculum should include preparation for beginners to act to change the profession to be passionate for SJ and to solve problems of their discipline within the engineering profession. Engineering educators should make beginners to implement engineering professional ethics throughout the globe, protect human well-being, and permit SJ as well as work to attain a sustainable environment while achieving the goal of economic growth and development (Chasmar and Wichman, 2017).

Hence, the learning outcome of the revised engineering SJ curriculum should continue to embrace engineering learning outcomes that include the influence of the power to choose, critical thinking, and effective action skills to comprehend social change. ESJ include a skill and practice that is appropriate by integrating engineering specific skills with SJ skills (Nieusma and Riley, 2010; Adam, 2020). Accepting ESJ becomes part of the profession that requires some interpretation of professional experience and strategies used for engineering schooling and training. Professionals applying SJ in engineering fields must move beyond a strict consideration of engineering specifications alone to a rational thought open to innovation that includes SJ (Shutaleva and Kartasheva, 2018; Anikina, 2020). Making SJ visible in EE requires deliverable solution to meet engineering specifications integrated with SJ requirements. Engineers are perceived to frequently criticize SJ courses as being too theoretical but integrating SJ learning outcomes with engineering learning outcomes in a single course that will help to overcome this concerns (Nasser and Romanowski, 2016).

The high degree of social-justice oriented innovation in pedagogy and, to a lesser extent, curriculum development is partly driven by the institutional requirements that structure most engineering programs in Africa. Such requirements include those imposed variously by individual educational institutions on themselves as well as those imposed across many or all engineering programs in a given setting (Teschler, 2010). For instance, in the United States of America, ABET accredits engineering and related programs and increasingly and internationally have accredited over 2,000 engineering programs in 2010 across developed and developing countries (Abet, 2010; Kabo et al., 2012). However, similar accreditation institutions and engineering accreditation requirements exist in other contexts in other countries such as in Africa.

Oftentimes, pedagogical and curricular experimentation is driven by institutional constraints, which require ground-breaking approaches that work around conservative ways of educating engineering students (Riley, 2012). The institutionally rooted departure between technical and non-technical content created a negative model for ESJ, which inspire the drive for SJ in engineering program in design and innovation across the globe (Sandekian et al., 2014; Leibowitz and Bozalek, 2016). This departure and negative model were and remains deeply embedded in specific educational institutions' structures even as ABET accreditation practices and requirements has

imbibe it as their primary goals to integrate technical and social domains in core engineering teaching and learning syllabus. Given their comprehensive effect in EE, accreditation requirements play an important role in enabling or constraining engineering programme research (Kabo et al., 2012).

The culture of ESJ is concerned with relevant engineering practices as engineering educators must deconstruct these ideologies before cultural space can be made for serious consideration of SJ issues (Leef, 2017; Anderson et al., 2017). Sometimes, these ideologies do not explicitly explain why some professionals will prevent SJ from having a central place in EE. The reasons here is to show why engineering educators must first disassemble these ideologies and reframe SJ issues in order to make them more central to engineers' ideas of what it meant to be a professional members (Herkert, 2011). Thus, the perception that an engineering work can in some way be separated from the social world is itself a cultural frame for understanding what engineering is. They have important effects on SJ and equality outside and within engineering profession because these ideologies frame the way engineers understand SJ issues in the context of their engineering work (Lambert and Czerniewicz, 2020).

There are many engineering educators and students who, although seriously interested in SJ, believe that the place to deal with SJ should be outside of the technical curriculum, perhaps in humanities and social science courses. While there are others who believe that SJ does not belong in the curriculum at all, as it might be a distraction in an already over-crowded curriculum and as such it might better live in service and/or faith-based student organizations (Wichman, 2017; Leef, 2017). From learning platforms, students might be able to learn how to analyze the elements of the ideologies undergirding engineering, by locating these historically, and then look for them in their sites of EE and practices. These ideologies become perceptible, and engineering students will have capital value for integration of SJ into EE.

V. CONCLUSION AND RECOMMENDATIONS

This paper attempts to move beyond engineering analytic assessment of competing views of engineering profession but discussing the drive for ESJ becomes an imperative in social scientist background. Several advocates has provided a framework that will draw a greater attention to SJ by engineers or any similar reform agenda. The importance of SJ in EE is key as these reinforced strategies to reform engineering to promote a shared vision of SJ with collaboration from other line of disciplines. However, an emergent and coordinated set of reform strategies of revised engineering curriculum and instructional materials are targeted at multiple scales of intervention to understand ESJ problems. Several bodies and non-governmental organizations have adopted the SJ lens to engineering that will open discussions of injustices in EE. This will assist to look at range of approaches to bring SJ centrally into EE.

Thus, this suggests developing ESJ will entails a variety of approaches to promote greater attention to SJ issues. Engineering knowledge is key to challenge the primacy of the technical core without rejecting its essential contribution and to accept, in principle and in practice, the various social facets of engineering work as equally constitutive of engineering pathways. The culture of engineering is perceived to hinder engineer's ability to see SJ concerns in EE is as relevant to the profession. Engineering has its own professional culture, complete with cultural ideologies that frame engineers on how engineers see the social world and understand their roles and responsibilities within.

EE provides the ideal site for deconstruction in which beginners are first introduced to the culture of engineering. Thus, cultural space can be made for discussions of SJ concerns as these ideologies are deliberately deconstructed. Further, the ideologies of depoliticization and meritocracy has reproduce inequalities for vulnerable individuals within the profession by silencing serious discussions of power, privilege and voice with the profession's boundaries. This suggest that the culture of engineering, and the ideologies therein, are not intractable. Therefore, we identified the following practical recommendations in addressing seeking for drive for SJ in EE in Africa:

1. Engineer and social justice expertise can work together to design and implement learning experience, and the outcome would entail a great improvement over each working on implementation of ESJ.
2. Difficulties in engineering requires a lot of working efforts from engineer and industrial educators prepare a curriculum prospectus that will involve integration of engineering and social justice courses. This will improve a better understanding incorporating SJ into EE from these stakeholders
3. Engineering educators should make efforts to collaborate with public and global partners involved in the realization of SJ in their fields. This will lead to an exciting and rewarding experience within an innovative engineering activity that will provide a chance for novice engineers to work in partnership with highly skilled engineering professionals to build policy plan of action to address injustices in engineering education and profession.
4. Opportunities involving service learning should expose engineering students' beginners to global organizations applying social justice research and development such as World Federation of Engineering Organizations, American Society for Engineering Education, Engineers without Borders and so forth to engage them in critical thinking and learning practices.
5. Engineering educators should open up a teaching and learning platforms and opportunities for engineering students to subject them to research collaboration and working relationship with local community engineering partners involved with social justice plan of action, especially at the grassroots' level.

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