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# Critical and Liberative Theories: Applications in Engineering Education

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# Critical and Liberative Theories:
# Applications in Engineering Education

## Abstract

**Background**. Higher educational programs in engineering today are seeking to correct disproportionately low enrollment and success rates of minoritized students. However, most diversity-related programming fails to address systems of structural oppression that cause particular students to be underrepresented in higher education. In addition, typical engineering pedagogical methods fail to address the reality and impacts of structural oppression, as educators cannot overcome the effects of structurally oppressive systems through traditional methods of controlling classroom and curriculum.

**Purpose**. This paper explores the relationship between existing critical and liberative theories and engineering educational systems and re-frames the goals and problems of diversity and equity within engineering education from a critical and liberative lens.

**Methodology/Approach**. We describe existing liberative pedagogies and their aim to dismantle oppressive systems through recognition of hegemonic structures, critical classroom discourse, and opportunities to build solidarity. We present an overview of previous uses of these pedagogies in engineering classrooms under the premise of Freirean critical theory, which is class-based, and other anti-oppressive theories based on race, gender, and sexual orientation. We propose a new model that situates these theories relative to one another within the broader classification of identity-based theories.

**Conclusions**. Class-based exploitation under capitalist economic and governmental structures is identified as the root cause of inequitable educational outcomes. Thus, in order to correct inequities in education, the role of current educational systems in the perpetuation of capitalist oppression must itself be addressed. This will require pedagogical changes as well as explicitly restructuring the goals of engineering education to include equity and solidarity.

**Implications**. Through an embrace of critical and liberative theories and their accompanying pedagogies, engineering educators and engineering education researchers can plant the seeds for change. When engineers develop the skills necessary to recognize and combat oppression, they will be able to work toward liberation for all oppressed peoples.

**Keywords:** diversity, equity, inclusion, oppression, liberation, critical pedagogy, liberative pedagogy, capitalism, socio-economic status

> *"There is, and there always has been, a dialectical relationship among education, politics, and power."*
>
> *– Ana Maria Araújo Freire (McLaren, 2000 p. xv)*

## PART I: The Framework of Critical Theory

In this section, we describe some of the foundational tenants of critical theory. We approach this broad topic from a Freirean perspective and describe how the modern context of increased technology and globalization contributes to the capitalist exploitation of working class people. Understanding this process is an important first step to teaching engineering in a way that addresses structural oppression.

*Capital and Society*

In "Teaching Against Globalization and the New Imperialism: Toward a Revolutionary Pedagogy," McLaren and Farahmandpur (2001) attribute the root cause of global income inequality to be the poor distribution of capital throughout our societies. Capital takes a number of forms, but monetary forms are of paramount importance to individual quality of life. *Consumption capital* is moneys which are earned in exchange for labor provided; one can think of it as wages (Perrucci & Wysong, 1999). *Investment capital* is a surplus of moneys that are invested in order to produce additional capital in the form of interest. Thus, an abundance of moneys above and beyond what is required to sustain life are required in order to obtain any amount of investment capital.

How various forms of capital are distributed is regulated by society (McLaren & Farahmandpur, 2001). Economic production results in capital, and people with similar relationships to the means of production are said to be of the same *social class*. Thus, two examples of social classes are *workers*, who directly sell their labor in exchange for consumption capital, and institutional *owners*, who receive the profits of production for use as investment capital. Because individuals with high class status maintain control of institutions as well as vast amounts of capital, they are able to preserve conditions that ensure the longevity of their own success while limiting opportunities for those outside of their social class (Parenti, 1994; McLaren & Farahmandpur, 2001).

> "There are class interests involved in how the law is written and enforced, how political leaders pursue issues, how science and social science are studied and funded, how work is done, how a university is ruled, how the news is reported, how mass culture is created and manipulated, how careers are advanced or retarded, how the environment is treated, how racism and sexism are activated and reinforced, and how social reality itself is defined" (Parenti, 1994, p. 64).

*Capitalism*

Capitalism is a construct of society, *not* a naturally-occurring or self-sustaining entity, and its "engine … is profit maximization and class struggle" (McChesney, 1996, pp. 4-5). The functionality of a capitalist system "… is predicated on the overaccumulation of capital and the super-exploitation of rank-and-file wage laborers" (McLaren & Farahmandpur, 2001, p. 138). The economic value of the labor produced by workers is more than that for which they are compensated, thus producing a surplus in labor value, called *profit*. This is the inherent contradiction of capitalism: for $x$ labor, a worker is paid $y$ capital, but their labor is actually worth $z$ capital. To turn a profit, $z$ must be greater than $y$. This is referred to by Marxists as the *capitalist law of value* (see Figure 1).

Through this process, as well as racist and sexist economic and social practices, unfettered capitalism results in the labor of millions of workers being exploited to generate profits for owners, who are members of the *ruling class*. The consumption capital consisting of workers' unpaid wages is accumulated by institutional owners and forms the basis of their wealth. Today,

this wealth is the singular value of society on Earth as a whole. As the basis of economic analyses, wealth ignores morality, human needs, and social conscience, promoting a global culture focusing instead on money and consumerism (McLaren and Farahmandpur, 2001).

Critical theory concludes that the modern combination of capitalism and globalization worldwide is resulting in further increases in global inequality (McLaren and Farahmandpur, 2001). It is common belief that, in light of globalization, national power can advocate for corporate interests but cannot save the middle class. This plays right into the hands of those who stand to benefit the most from this exploitive capitalist system. McLaren and Farahmandpur fittingly describe the plight of those who would offer opposition to the consolidation of corporate power: "...we are hard-pressed to chart out our daily struggles against oppression and exploitation instituted by a growing cabal of techno-crazed global robber barons" (2001, p. 137).
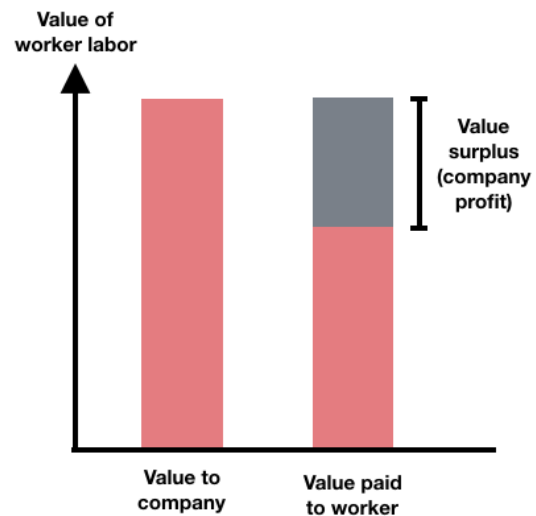
*Figure 1: The capitalist law of value*

## PART II: Critical Theory in Education

This section considers the effects of capitalism on educational systems from a critical perspective. We explain why our educational system is inherently political and introduce the concept of critical pedagogy as a classroom-based intervention to support students who aren't privileged under capitalism.

> *"No education is politically neutral."*
> *– bell hooks (1994)*

*Education Under Capitalism*

McLaren and Farahmandpur describe the process through which the combination of capitalism and globalization, in addition to increasing global inequality, also results in a decrease in educational quality for working class people (2001). In capitalist countries, the paradox of education becomes apparent as education is seen as the vessel that brings people out of poverty, but, at the same time, education is viewed as fuel for the capitalist economy (Spring, 1998; McLaren & Farahmandpur, 2001). Both can't be true, because capitalism itself is locking people in structural oppression. Thus, our educational systems are actually reproducing the inequalities they are said to be fighting (McLaren & Farahmandpur, 2001, also see Figure 2). For example, if the academic system was in fact a meritocracy, as is widely believed, excellent academic performance from the masses of the working class would achieve the extraordinary economic mobility purported to result from such excellence. However, this could not possibly be allowed to occur because it would destroy the national economy; in a capitalist society, most people must

be workers, not owners. Our current beliefs about education under capitalism, therefore, contain a contradiction that is insurmountable for members of the working class.

**Common beliefs about education in capitalism:**

Education brings people out of poverty

≠

Increased inequality means more people are in poverty

**and**

therefore ↑

Education supports the capitalist economy

but →

Stronger capitalist economy means increased inequality

*Figure 2: McLaren's critical theory of education*

Who, then, is able to succeed educationally within a capitalist system? McLaren and Farahmandpur explain that success "… is not the result of individual capacities but rather is constrained and enabled by asymmetrical relations of power linked to race, class, gender, and sexual economies of privilege" (2001, p. 146). What knowledge is offered to students varies by class, gender, and race, holding them firmly in the same social status into which they were born. One common mechanism through which this occurs is educational cost. While many countries have government programs intended to combat the exclusionary nature of education under capitalism, there are innumerous studies that document the failure of these programs to provide access to quality education for members of the working class (Harper, et al., 2009; Long and Riley, 2007; Wyner, et al., 2007). Neoliberal initiatives have not and will not remedy the ills of capitalism, in education or on any other front.

*Critical Pedagogy*

The solution to cyclic oppression lies in a revolutionary approach to educational experience; in literature, this approach is referred to as *revolutionary pedagogy*, *working class pedagogy*, or *critical pedagogy*. This pedagogy is based on the work of Paulo Freire, who first described "education as the practice of freedom" in his seminal text *Pedagogy of the Oppressed* (2018), originally published in 1970. The aim of this approach is to encourage marginalized social groups to transform capitalist social and economic structures through an understanding of their role in the production process. In recognition of education's role in perpetuating oppressive systems, the classroom is used as a "political arena" for worker empowerment (McLaren & Farahmandpur, 2001, p. 145). Advocates for critical pedagogy call on educators to demonstrate a strong commitment to social justice as well as to promote networks that actively organize against capitalist structures (Cole, Hill, & Rikowski, 1997; McLaren & Farahmandpur, 2001).

The accomplishment of these tasks is predicated on the development and use of language identifying the sources of oppression and exploitation (McLaren, 1998; McLaren and Farahmandpur, 2001). Current methods of discourse conceal power imbalances, favoring socially privileged classes and protecting the status quo (Giroux & McLaren, 1986). Alternatively, educators must raise consciousness of class through opportunities for discovery; they must create the space to allow marginalized groups to share their realities with other students who may or may not be aware of the structural oppressions of capitalism (Giroux et. al, 1996; McLaren and Farahmandpur, 2001). Additionally, through the understanding of the educational institution itself as an engine of the capitalist system, students should come to identify their own role as workers within the hegemonic structure of the institution (Weinbaum 1998; McLaren and Farahmandpur, 2001).

Within the context of classroom interactions, teachers and students must develop skills that McLaren and Farahmandpur refer to as *critical literacy* and *critical consciousness*. Critical literacy is the ability to reflect on, analyze, and make judgements about political, social, and economic issues (2001). To practice this, individuals should draw from their own lived social experiences and understandings. Through this discourse, they will then begin to build solidarity within the working class. The perspective that is developed as this occurs is termed *critical consciousness*. By stressing solidarity instead of differences, educators can start to combat the isolation that results from capitalist structures of production. Working in unity, the working classes can then begin to attack capitalist structures through mass organized political action. By removing the barriers that prevent students' realizations of structural oppression, teachers can help students develop their critical consciousness into the *revolutionary consciousness* that the working class needs in order to combat these oppressive systems.

## PART III: Critical Theory in Engineering Education

Now that we have established a framework for the application of critical theory in education, we further tailor the discussion specifically to the area of engineering education. We explain how traditional engineering pedagogies are amplifying inequities that plague marginalized students. In presenting alternative pedagogical approaches, including critical pedagogy, we also introduce liberative and other identity-based frameworks, develop a model to help educators visualize their scopes, and provide examples of their uses in engineering classrooms.

*Traditional Pedagogy in Engineering*

"Traditional engineering education has been so widely understood to be inadequate that it has become cliché: 'from professor's notes to student's notes and through the minds of neither'" (Riley, 2003, p. 139). The typical engineering educator views teaching as a simple transmission of information and perspective. This creates a massive power differential in the classroom, but the educator is as ignorant of this as they are of the effects of race, class, and gender (Freire, 2018; Riley, 2003). Students who experience this mindless style of pedagogy go on to practice it in their own classrooms; thus, Riley concludes that "…bad pedagogy [is] a rite of passage" in engineering (2003, p. 141).

The teacher-centered teaching methodology commonplace in engineering education is a means by which teachers hope to maintain absolute control (Riley, 2003). Educators also implement reductionist curriculum structure as a way to further control the transmission of content in the classroom. Within a reductionist structure, content is broken down into what is perceived to be manageable pieces and educators supply material, supervision, and feedback for each piece (Wickenden, 1930; Riley, 2003). This dissuades students from thinking critically and making interdisciplinary connections. Freire argues that this is a purposely executed technique – if they did so, students might grow to challenge the system that is so beneficial to the oppressors (2018; Riley, 2003). Educators also often cling to the belief that engineering is objective, failing to recognize how social biases manifest within the material and influence students' educational experiences.

*Anti-Oppressive Frameworks in Engineering*

Throughout the history of western education, engineering has been widely accepted as a trajectory suitable for white, cis, straight, affluent men. Implicit and explicit bias continues to plague efforts to diversify the profession. Through quantitative analyses and rigorous control of both curriculum and classroom, engineering educators are tempted to believe that they can control the outcomes of the educational process (Riley, 2003). This demonstrates a failure to recognize how individual privilege contributes to academic success and how systems of oppression continue to prevent inclusivity toward women and minorities in engineering education. Although academic institutions often recognize that certain groups are underrepresented within their programs, diversity programming designed to remedy the situation only serves to assimilate underrepresented students into the existing culture. This carries a clear implication that it is the underrepresented students who need to be "fixed," rather than the existing cultures, which are exclusive and hostile. While these diversity programs are often shown to aid in retention in the short term, "we will never be successful in raising the number of traditionally underrepresented people in engineering by merely teaching them to mimic the thoughts and actions of the majority" (Riley, 2003, p. 142). This is an important distinction because, as Freire explains, it, too, is purposeful: "the more the oppressed can be led to adapt to that situation, the more easily they can be dominated" (Freire, 2018, p. 74).

As Trytten, Lowe, and Walden explain in their examination of Asian American engineering student experiences (2012), proportional representation does not guarantee inclusive culture. Oppressed peoples are not always minority populations, as is the case in western capitalist societies, in which workers far outnumber owners. Trytten et al. employ a framework of critical cultural theory, also called liberative theory, which posits that structural oppression occurs on the basis of many manufactured societal constructions, including ethnicity and gender in addition to class; liberation, therefore, requires consideration of the experiences of all oppressed peoples (Riley, 2003; hooks, 1994). Within the field of engineering, the marginalized status of women, African Americans, Hispanics, Native Americans, and working class people corresponds to disproportionately low representation of these groups (NSF, 2019; Lord, et al., 2009; Anderson and Kim, 2006). For Asian American men, however, overrepresentation has not spared them from ethnicity-based oppression (Trytten et al., 2012). Further studies employing both critical and liberative theories may shed light on the realities experienced by members of various identity groups pursuing engineering education.

We propose new models, shown in Figures 3 and 4, that situate critical, liberative, and other oppression-based theories relative to one another within the broader classification of identity-based theories. While social identity theory focuses on dynamic cognitive processes and perceptions that shape an individual's identity (Gee, 2020), liberative theory instead emphasizes the role of structural factors in presenting or withholding opportunities based on static aspects of identity. Liberative theory can encompass infinitely many aspects of identity and strives to achieve emancipation from all forms of oppression. By narrowing the focus to socio-economic status, critical theorists such as McLaren and Farahmandpur pose that addressing the class struggle is the means through which we can bring an end to all forms of social oppression, since gender and race, like class, are in fact social constructs; thus, "… it is only through class politics that human liberation can truly be reached" (McChesney, 1996, pp. 4-5). Alternatively, theories
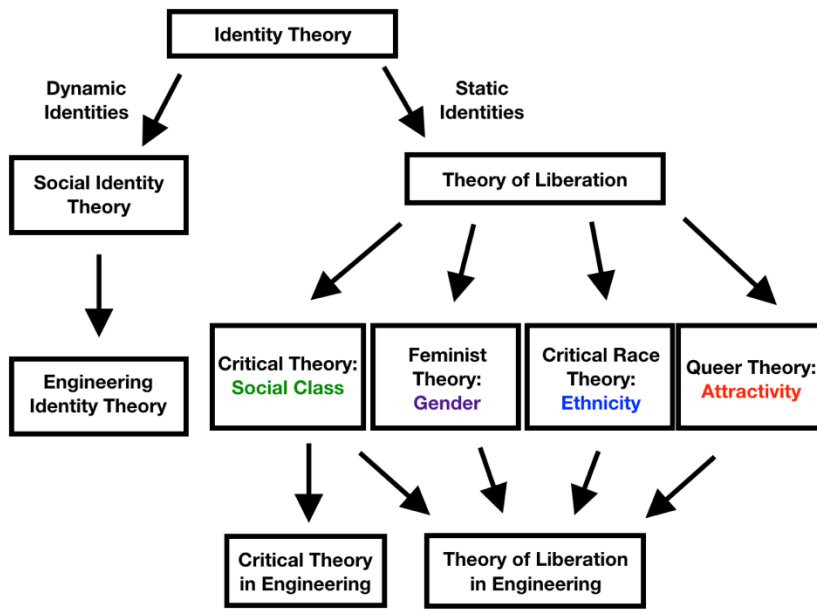
*Figure 3: Model of relations between identity-based theories*



*Figure 4: Model of relations between liberative theories*

exist that highlight oppression against marginalized groups based on gender, ethnicity, and attractivity, all of which have previously been applied to studies of engineering and engineers (Riley, et al., 2009; Dietz, et al., 2019; Riley, 2008). Riley states that "no single pedagogy… will liberate all people" (2003, p. 138), so she employs liberative pedagogy to refer to their commonalities. The theory of intersectionality poses that specific attributes of various aspects of identity must be considered concurrently (Cho, et al., 2013). However, the ultimate aim of all liberative pedagogies are identical: to "collectively [create] democratic classrooms that encourage all voices" (Riley, 2003, p. 137) and ultimately dismantle the systems that lock people into oppressive realities. All of these theories, and their corresponding pedagogies, can and should be applied to engineering education, and, as we'll discuss in the next section, some already have been.

*Liberative Pedagogy in Engineering*

In her qualitative research study, "Employing Liberative Pedagogies in Engineering Education" (2003), Smith College professor Donna Riley applies a liberative pedagogical framework to the field of engineering and specifically to an undergraduate thermodynamics course for which she was the instructor. She suggests teaching methods for use in engineering classrooms and provides examples of these methods as she employed them within the course. These methods include learner-centered methodology (see also hooks, 1994); problem and example selections that are relatable to diverse groups of students (including women); cooperative pedagogy (for example, paired examinations); circular seating; the incorporation of discussions of ethics and policy; and emphasis on the contributions of non-western, women, and minority scientists to the
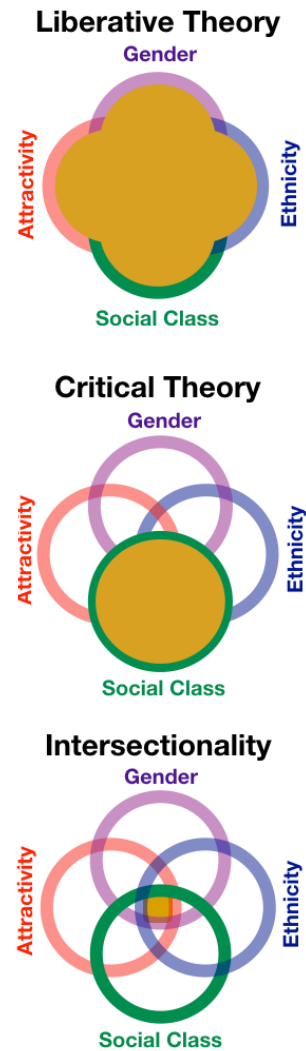
field, including candid discussion of the social and political circumstances that often prevented oppressed peoples from contributing and/or buried their contributions. This work is a helpful resource, as it provides concrete examples of classroom interventions designed to meet the goals of critical and liberative pedagogies.

Critical and liberative theories underscore the roles of privilege and power in all educational settings and work to address them through purposeful discourse and student empowerment (Freire, 2018). Implicit, as well as explicit, bias is ever present in engineering education, and teachers must confront these biases in both themselves and their peers in order to adequately support their marginalized students (Riley, 2003). For example, textbooks (as well as teachers) frequently refer to engineers with he/him/his pronouns. It is imperative not only to avoid the use of biased tropes but also to address them openly in the classroom, so engineering teachers must be able to hold critical conversations on race, class, culture, and systems of oppression. Underrepresented students rely on these conversations to learn how to address discriminatory behavior as they encounter it, and students who are not underrepresented use them to develop the critical consciousness to stand with their underrepresented classmates in solidarity. These conversations plant the seeds of change as students begin to pursue critical discourse that combats oppression at all levels of society.

## Further Research and Ultimate Objectives

Future research into critical theory and engineering education should examine the roles of corporate structures such as those described in McLaren and Farahmandpur in engineering academia (2001). Additionally, as Riley points out, better coordination is required between engineering education researchers and those in the fields of women's studies, ethnic studies, and the history of science and technology (2003). She also recommends further research into class-related issues in engineering. In this vein, we are currently pursuing a study applying critical theory to issues faced by engineering students from low-income backgrounds. Our quantitative data shows that working class students are underrepresented, less likely to graduate, and have lower GPAs compared to ruling class students studying engineering at a highly-ranked American public university (Bowen, et al., 2020). We will next be gathering qualitative data in order to better understand the mechanisms through which these outcomes are occurring. Until we are willing to contend with the underlying structural issues that lock individuals and families into cycles of poverty from within our roles as engineering educators, we will never be able to erase the injustices experienced by our students of low socio-economic status. Through these and other efforts to apply critical theory to engineering education, we can better position the field of engineering to support the development of a new social structure in which labor directly fulfills human needs and every sector of humanity achieves true liberation (McLaren & Farahmandpur, 2001; hooks, 1994).

## Acknowledgements

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