

Liberation in Education: What Role Do Liberatory Praxis and Theory Play in Fostering Critical Thinking?

Yousef Jalali, Virginia Tech

Yousef Jalali is a Ph.D. student in Engineering Education at Virginia Tech. He received a B.S. and M.S. in Chemical Engineering and M.Eng. in Energy Systems Engineering. His research interests include ethics, critical thinking, and process design and training.

Dr. Christian Matheis, Virginia Tech

I serve as a Visiting Assistant Professor of Government and International Affairs in the School of Public and International Affairs at Virginia Tech. Concurrently, I serve as a Teaching and Research Associate for the Intercultural Engagement Center at Virginia Tech. My research specializations include ethics, political philosophy, and philosophy of liberation. Within these areas, I concentrate on public policy, feminism, race, migration and refugees, and similar topics.

Liberation in Education: What Role Do Liberatory Praxis and Theory Play in Fostering Critical Thinking?

Abstract

The revolutionary changes in ABET EC 2000 accreditation criteria promoted the address of critical thinking in engineering curricula by emphasizing such outcomes as ethics, social and global context, communication, lifelong learning and contemporary issues in addition to technical work in design and problem solving. However, the mainstream notion of critical thinking as used in the educational settings is often connected with the conceptions of reasoning and logic. Critical thinking is often seen as a skill in line with decision making and problem solving applications. The extent and degree of success of addressing critical thinking is still under question.

Liberation as its own field of praxis and theory which has been excluded from formal education, can provide a unique contribution in changing status quo. For the oppressed to get engaged in the process of discovery and transformation, critical thinking is such a crucial component. In this paper, liberation as a program of praxis and theory will be introduced. Then considering different stages in a liberatory process, the role of critical thinking in liberation struggle will be discussed and evaluated. Finally, paper focuses on contribution of liberatory scholars and in particular Paulo Freire and Gloria Anzaldúa in addressing promising components of critical thinking such as relation, communication, and imagination. This paper aims to raise awareness regarding liberation scholarship as a resource for researchers and practitioners in engineering education.

Introduction

The necessity of addressing critical thinking in higher education has been demonstrated by many scholars.¹⁻⁴ Within the context of engineering education, changes in accreditation criteria are an important driver for promoting critical thinking. Introduction of student outcomes by The Accreditation Board on Engineering and Technology (ABET) has expanded the opportunities for addressing critical thinking in engineering curricula. In particular, this has opened the option to expand the default definitions of critical thinking beyond calculative rationality and analytical

strategies to include broader forms of reasoning, such as reasoning about values, assumptions, biases, and the broader social and global role of engineers and the designs engineers produce.

Practitioners and scholars of liberation debate many aspects of the applied and theoretical material and, yet, many also share a particular contention: theories and models of liberation follow from practices and experiments, from praxis. Because of the need for further praxis in liberatory engineering education as a pedagogical imperative, and the limited, almost nonexistent engagement between the topics we place in conversation (pedagogy, critical thinking, liberation praxis and theory), this paper aims to initiate and catalyze attention on the subject matter, but it will not aim to resolve some of the questions it opens. Rather, we emphasize the importance of liberatory theory and praxis for contemporary engineering education and, then, suggest some criteria that might guide praxis and broader shifts in pedagogical strategies. To that end, we intend for the project to prompt further research and discussion on these topics.

Engineering educators have tried to borrow the meaning and strategies for integration of critical thinking into teaching and learning. For instance, the Paul-Elder Critical Thinking Framework developed by Richard Paul and Linda Elder and their guidebook for critical thinking in engineering, “The thinker’s guide to engineering reasoning,” is one of the widely accepted resources among engineering educators.^{5,6} This resource has been used in different studies as a guide for incorporating critical thinking in engineering curricula.⁷⁻¹¹

The major strategies and pedagogies to incorporate critical thinking instruction into curriculum reported by engineering educators are the following: applying Socratic questioning method,^{12,13} integrating liberal education,¹⁴ writing assignments,¹⁵⁻¹⁷ active learning,¹⁸ problem-based learning and design projects,^{7,8,19,20} engineering judgment and problem solving,²⁰⁻²² or a combination of those.²³

Nevertheless, the extent and degree of success of addressing critical thinking in educational settings remains a work in progress. In 1992, for instance, Richard Paul, one of the influential scholars in critical thinking, posed the following questions: “How many generations will it take to shift instruction from didactic to critical thought? How long before students at every level of

schooling will have their thinking stimulated rather than discouraged or deadened?”²⁴ (p.23) The Association of American Colleges and Universities identified that there is a warning sign, which shows critical thinking needs further attention.²

The complexity in defining and understanding critical thinking is one of the major challenges for engineering educators and students.²⁵⁻²⁷ Hicks, Bumbaco, and Douglas argued that exploration of interconnection between different philosophical concepts, in particular critical thinking, reflective practice, and adaptive expertise, may help educators to better understand and apply each concept.²⁸ Yet, some scholars critique the traditional viewpoints on critical thinking. Claris and Riley identified four major themes that engineers generally have given too little attention, or no attention at all: power/knowledge relationships, transgressive validity, reflection and reflexivity, and praxis and relationality.²⁹

In this paper, we argue that the notion of critical thinking, as predominantly used in the educational settings today, underemphasizes rich resources found in liberatory praxis and thought; namely, liberatory conceptions of relation and imagination. Common conceptions of critical thinking will be discussed first. Next, we will introduce liberation as a specific program of praxis and theory guided by a particular priority and objectives. Despite widespread use of terms like “liberation,” “emancipation,” and “abolition” as synonymous with outcomes, such as securing liberties or establishing equity, liberation refers more appropriately to the processes preceding outcomes. To understand liberation in this way as preceding and bringing about just outcomes, as a vanguard of justice and community, requires an understanding of the key concerns and intentions that guide strategies. Likewise, pedagogy and critical thinking informed and guided by the priority and objectives of liberation will likely call for a particular set of teaching practices and commitments that differ from more well-known and widely accepted versions. Following from that part of the discussion, this paper then focuses on the role of critical thinking in liberation struggles informed by liberatory scholars and, in particular, Paulo Freire and Gloria Anzaldúa in addressing promising components of critical thinking. Finally, some liberatory criteria will be highlighted to bring these components of critical thinking to greater prominence in engineering education.

Critical thinking: conventional perspectives

One of the earliest attempts in framing a comprehensive definition for critical thinking has been made by Robert H. Ennis.³⁰ Influenced by the work of John Dewey, Max Black, and B. Othanel Smith, Ennis proposed 12 aspects of critical thinking and initiated the mainstream critical thinking movement.³¹ Ennis, in his groundwork, assumed that critical thinking is teachable as a general skill, and there would be improvement of critical thinking as a result of deliberate instruction.³⁰ Ennis later revised the definition of critical thinking and included disposition in addition to skills to highlight the importance of one's tendency to think critically. He defines critical thinking as "reasonable reflective thinking focused on deciding what to believe or do."³² Here, we find critical thinking posed as a skill or strategy versus an outcome or end-stage product.

John E. McPeck challenged Ennis' conceptualization of critical thinking as a general thinking skill, arguing that critical thinking must be taught in specific disciplinary contexts; if thinking always occurs around a specific topic, localized to a field's particular subject matter, and thus cannot be generalized, then it follows that critical thinking is not a general ability and cannot be taught as such.³³ For McPeck, critical thinking requires what he calls "reflective skepticism." Such healthy skepticism should be purposeful in resolving a problem and also be qualified in its ability to offer a "plausible alternative."³³ That is to be a critical thinker in a particular field, one needs to know basic knowledge about that field; a critical thinker in mathematics might not be a critical thinker in history *and* also suspend commitment to that knowledge because it is not final or intractable. In its time, McPeck's position attracted less attention and, as Weinstein described, he was a "prophet crying in the wilderness."³⁴ The more common viewpoint on critical thinking is that critical thinking skills can be taught in a generalized fashion.³⁵

Nevertheless, the definition proposed by Ennis is oriented to reasoning and logic and, furthermore, is concerned with the quality of argument in a so-called sound argumentation process. Richard Paul, another influential figure, invites educators to move from weak-sense critical thinking as a mere tool for serving the interests of a particular individual or group to a strong-sense critical thinking that includes interests of diverse persons or groups.²⁴ According to Paul, unless students can critique their own biases, prejudices, and misconceptions, they will

maintain their beliefs and rationalize their biases despite evidence and arguments to the contrary. Paul recommends addressing critical thinking dispositions by applying controversial and complex issues in the educational settings.³⁶ As people try to maintain their rationalized prejudices, “[doing so] enables people to sleep peacefully at night, even though they flagrantly abused the rights of others during the day. It enables people to get more of what they want, or get it more easily”²⁴ (p.15). Richard Paul’s critical thinking model introduced major improvements by connecting critical thinking conception to everyday life and, moreover, by welcoming ethical reasoning as a core component of critical thinking. One who merely develops intellectual skills in logic and reasoning might not bother herself to think about others and/or to consider consequences of human behavior.³⁷ However, the model maintains its position as a logic-oriented framework without taking into account the role of individual differences, community and cultural influences, or institutionalized discrimination and cultural hegemony.

Liberatory struggle

Despite much emphasis on ethics and social justice in recent decades, the careful study of liberation has not been welcomed, on par, in higher education. Across the research, teaching, and outreach missions of the broader higher education networks worldwide, one will find great difficulty locating research programs, courses, or public interest programs informed by liberatory praxis and theory, in either a formal or informal sense. However, throughout the world various socio-cultural, political, and economic movements stem from decolonial projects engaged in the praxis and study of liberation, and precisely where conventional conceptions of morality and justice have fallen short.³⁸ The unsettling contention for scholars in industrialized nations appears as such: whereas systems of moral community and political justice may appear sufficient for well-organized societies, to the extent that a group of people suffer oppression, the conventions of moral and political thinking will fall short of liberation. Ethics and fairness do have traction among people similarly positioned in a well-ordered society (“well-ordered” here refers to the Rawlsian notion of a society with a generally stable system of institutions governed by both participatory democracy and representative democracy). That is to say, one can appeal to the ethics of another person so long as both have relatively similar access to institutional representation and economic equity. For example, persons of the same racial, sex, gender, and class categories can generally appeal to one another, but as institutionalized discrimination

historically codes persons as more or less “valuable” due to such factors, oppression clouds ethical judgments. In a patriarchal society, for instance, men may appeal to other men as ethical subjects but men as an ethically enfranchised (subjectified) class do not generally consider women as subjects, only as objects/objectified. Yes, men may afford women some measure of ethical regard, however partial or contingent ethical evaluation counts for little more than a “separate but equal” moral code.

Systematic oppression does not necessarily eradicate ethical reasoning and evaluations wholesale, but oppression does place such intractable limits on the uses of ethics as a resource for oppressed groups who intend to challenge and dismantle oppression.^{39,40} However, it is to liberation, praxis and theory, that the oppressed turn when dominant conceptions of morality and justice provide reasoned arguments about “good” and “fair,” “bad and “partial,” and yet at the same time moral and political praxis and theory cannot effectively respond to questions of institutionalized discrimination, cultural hegemony, and patterned economic subversion. That is, many of the cruelest and most pervasive forms of oppression operate within, and remain entrenched by moral norms and political justifications that might work in egalitarian circumstances; however, to the oppressed, moral and political reasoning and praxis can do only so much to challenge oppression. Thus, the turn to liberation as both complementary to and insubordinate to ethics and politics. Once we treat liberation not as a subset of moral and political thought, but as a form of praxis and social epistemology in its own right, we can raise new questions about a broad range of concerns, including pedagogy, critical thinking, and similar topics.

Major constituents of liberation

To understand a process of liberation we must first consider the relationship between oppressor and oppressed. The oppressor has the tendency to reproduce the status quo and neglect the very right of people, freedom.⁴¹ Oppressors try to convince the oppressed, poor, women, ethnic, political, or religious minorities, or people with disability, that the world is fixed, and that the status quo represents both the best option, and what has evolved over time. Oppressions, racism, sexism, heterosexism, and so on, all come from the same source and when exists, it comes independent of regard for races, sexes, shapes, and sexualities, etc. “There is no hierarchy of

oppressions,” and oppressors will foster exploitation in any ways that successfully transfer society’s burdens onto marginalized groups in increasing measure with the transfer of society’s benefits to the oppressor’s own group or, put differently, to a society’s “dominant paradigm.”⁴²

To change the status quo, the oppressed need to recognize and acknowledge that they are oppressed, systematically and persistently. We call this important constituent of liberation struggle “understanding” (a mere translation of what Paulo Freire, perhaps the most well-known progenitor of liberatory pedagogy, called “conscientization”).⁴³ The oppressed need to look at themselves from the window outside of their constraints and critically seek to comprehend and then theoretically model the causes of oppression. Freire emphasizes the necessity of getting objective distance from the world in order to be “with” the world. Gaining this sort of required self-knowledge and knowledge of the world helps one question and reflect on her relationship with the world.⁴³ Marilyn Frye, a prominent feminist scholar, proposes the birdcage model to illustrate the systematic invisible oppression of women, as a group, in a cage.⁴⁴ Once the oppressed see themselves from the outside and understand the causes of the current state, the oppressed are not “things” anymore; they are the subject in the struggle for liberation. As a result, the oppressed may find out who they really are, how oppressors use and abuse the oppressed and, arguably, how to begin imagining and planning alternatives to oppression.

Even though the oppressed may “understand” and “discover” that they are oppressed, they can’t necessarily reflect on a current state of oppression due to systematic undermining of their core values. That is, it takes persistent effort to believe oneself worthy of dignity and a share of social influence when systems of oppression convince the oppressed to believe the contrary, that they do not matter or deserve regard.⁴⁵

Moreover, the oppressed need to overcome the fear of change and get empowered with deep love and respect for of their own values, culture, and intellectual abilities. Fanon describes the notion of inferior feeling in which the oppressed feels the lack of values or, in the extreme case, present the negation of values.⁴⁶ Freire pointed out the very same issue. In describing “cultural invasion,” Freire explained that the oppressed might become convinced of their intrinsic inferiority.⁴⁷ Likewise, Steven Biko, a South African anti-apartheid activist, uses the phrase

“spiritual poverty,” which can result from the dehumanization process followed by the oppressor.⁴⁸ Suzanne Pharr, a grassroots organizer in the U.S., uses the notion of “internalized oppression” in which the oppressed receive the negative message as practice in society and internalize it in the form of self-hate and self-blaming.⁴⁹ Pharr also calls attention to “horizontal hostility” in connection with internalized oppression. Acting on the interaction of internalized oppression and horizontal hostility, the oppressed, while believing in the lack of value and capability, begin blaming each other versus working together in coalitions to critique and resist against systems of oppression.⁴⁹

The Black Consciousness and Black Internationalism Movements, as proposed by Biko and Jane Nardal respectively, have leveraged the importance of respecting and fostering deep regard for one’s own values.^{48,50} The movements Nardal and Biko helped to influence continue in present-day contexts to follow their lead. Pan-African diaspora movements aim to bolster the importance of learning about and respecting various African traditions and heritages as a source of value, dignity, and shared understanding amid a broad diversity of cultures that can serve as a means for getting the oppressed ready for liberatory movement. In general, liberationists tend to share this key proposition: one must believe oneself worthy of liberating as a necessary precursor to anyone pursuing any further useful reflection, praxis, or theory of liberation.

When the oppressed get to the process of discovery of themselves, who they are, and eventually what reality is, they are able to modify what surrounds them. The conscious comprehension of the circumstances of oppression, and then acting upon reality to bring about social justice are two interconnected constituents of a liberation movement. The feasibility of acting in the interest of liberation requires, first, at least some coherent comprehension of the conditions of oppression one faces. And not merely a sense of oppression, a feeling, nor simply a list of details about some difficulties one faces; but a functional wisdom that one uses to begin systematically questioning the maldistribution of equity, dignity, resources, etc.

But how best to bring about that sort of understanding? What catalyzes the shift from accepting oppressive conditions as naturalized to then question oppression as systematized? By acting upon reality, the oppressed participate in a meaningful transformation of reality. Audre Lorde,

for instance, emphasized eroticism as an internal source of power for women, by which they can overcome the fear resulting from systematic suppression. The erotic, Lorde argues, provides energy for liberatory change and movement.⁵¹

Solidarity is another crucial constituent of liberation. The process of liberation cannot happen in isolation. There is a need to move from the notion of individualism to one that enjoins the oppressed to labor together, fostering new and resilient relationships in the liberation struggle.⁴⁷ Dussel criticizes European philosophy in relation to the notion of “master-servant domination” and emphasized the importance of person-person relationships in the process of discovering reality in liberation struggle.⁵² In a similar way, disabilities and queer liberation activist Eli Clare highlights the importance of making relationships and creating dialogue for noticing and understanding disabilities. Clare argues that disability should be seen not as a personal problem that needs charity, but as a systemic issue of exploitation of people as a result of elements of racism and ableism to maintain power structure.⁵³

Liberation strategies

Scholars promote a spectrum of views in liberation regarding different means and strategies. On one end, scholars such as Fanon have prioritised taking control of land.⁴⁶ On Fanon’s account, the oppressed need to engage in the process of full decolonization and transformation, which is not non-violent, necessarily. Violence, according to Fanon, is a plausible element in liberatory struggle. Hence, liberation is really beyond of “rational confrontation of viewpoints”⁴⁶ (p. 6). Fanon does not clearly discuss the possibility of the danger of becoming a new oppressor through the use of violent measures when destroying the colonial world. However, it remains unclear whether Fanon merely wished to raise the specter of violence as a predictable and eventual outcome when oppressors refuse to retreat or surrender or, alternatively, whether Fanon advocated violence as a necessary and justifiable strategy.⁵⁴ This, the matter of violence and non-violence, is the very issue Freire noticed in describing oppressor-oppressed contradiction. Biko also does not guarantee the efficacy of non-violent movements, although he clarifies that violence is against unity, which is an important factor in liberatory struggle. Thus, violence can change the nature of actions and programs, but liberation does not necessarily require violent means.⁴⁸

Taking full control of land with force is important for some liberationists. However, on the other spectrum, certain scholars demonstrate the option of leaving and giving up the land as a strategy. Marcus Garvey, the scholar-activist who helped to found Pan-Africanist movements in the early 1900s, promotes the concept of Universal Negro nationality (transnationality) and prioritized establishing a nation for a Black community; Garvey calls it, “Mother Africa.”⁵⁵ Garvey argues against the radical strategies for integrating African Americans and also the immediate meeting of all rights including political rule and economic suffrage. His strategy to “fit in the world” was to ship African Americans to Africa and have an independent nation.⁵⁵

Scholarship on liberation indicates some similarities, as well as noteworthy differences. How best to study liberation given its diverse and underrepresented history in academic research? As Matheis argues, liberatory movements may most commonly (though not always) refer to a specific priority and two objectives.³⁸ Liberatory movements take as their priority a respect (or surrender) to “alterity.” The term alterity, here, refers to the ways that unfamiliar differences deserve respect even while appearing mysterious. Despite the preferences that contemporary moral and political modes of thought have for *recognition* of differences, investigating and comprehending diversity, liberationists tend to refer to the priority of showing deference or respect for differences that remain deeply misunderstood or unintelligible due to oppression. Concurrent with the priority of respect for alterity, liberationists tend to organize in accord with two objectives: 1) challenging or questioning any dominant system of “rule”, morality, culture, governance, and economic distributions, and then 2) struggling to put any dominant system of rule in the service of reducing or eliminating systematized suffering. Supposed, then that we may also consider the priority and objectives of liberation in the context of critical thinking.

Liberatory struggle and critical thinking

The oppressed cannot change the status quo unless they can think and speak for themselves: “liberation starts with critical thought.”⁵⁶ As discussed earlier, the oppressed need to comprehend the fact of oppression and engage in collective struggles, or processes, of transformation. Once a current notion of “reality” is understood, the oppressed can reflect on that notion. Freire illustrates critical thinking as a means for perception of the reality of oppression. Freire further

clarifies that both fact and what may have resulted from it might be prejudicial to a particular person. Here, critical thinking can help to see facts “differently.”⁴⁷

Freire’s description of critical thinking cannot be satisfied by Ennis’s logic-oriented version of critical thinking. Ennis’ definition of critical thinking highlights judgment without valuing the importance of questioning systems of authority, many of which likely depend on oppression. It seems Ennis repeats the western mainstream notion of thinking as “seeking truth,” which is supposedly somewhere in an essential plane of existence (perhaps a holdover of Platonic essentialism). Freire, on the other hand, conceives of people as unfinished beings who are in the process of discovery and, also in [the consistent/repeated] processes of transforming reality. Freire warns about diffusing different beliefs that keep the oppressed unaware of the causes of oppression, and, instead, emphasizes the necessity of identifying and questioning the validity of forms of knowledge itself.⁴⁷ “Knowing,” here, is a searching process, an epistemic struggle. Freire considers knowing a permanent process of discovery that does not, contrary to Ennis, result solely in finding essential, formal facts. Knowing is not so narrowly about getting to a particular destination or conclusion. More precisely, in Freire’s praxis and theory, we find that knowledge is the matter of a journey in which one needs to interact with the world.⁵⁷

Another crucial aspect of Freire’s viewpoint on critical thinking is his strong emphasis on the importance of communication and dialogue in a social, relational context. The oppressed, when engaged in revealing reality to themselves and to one another, need to consider thinking through “true dialogue” in communication with others; in other words, thinking is meaningful in relation to others, and liberatory knowledge emerges through communication with others. For instance, the authenticity of a teacher’s thinking is meaningful only with authenticity of students’ thinking.⁴⁷

How do the oppressed bridge the gap between the derogation and cruelties of oppression to deep regard for one another, despite internalized oppression and horizontal hostility? Gloria Anzaldúa, a highly influential scholar who helped to found liberatory shifts in literature and then across the humanities, liberal arts, and social sciences, calls attention to imagination as the cornerstone for her liberatory conception, Spiritual Activism. Her strategy of liberation is both spiritual and

political. Anzaldúa introduces imagination as an important tool in the process of transformation, or what she calls, the process of healing. Here, what one's body and spirit says, what comes from feelings and emotions, matter.⁵⁸ In addition to the effective contribution in highlighting gender biases in defining the conception of critical thinking, Anzaldúa opens a revolutionary idea of encompassing imagination and emotion into the "process" of critical thinking. She argues, further, that to imagine reality differently, including imagining oneself differently, one needs to move in liminal space where there is not struggle of "us versus them." In such space, negotiation and integration of identities and cultures becomes meaningful.⁵⁸ One's history and background is connected to emotional feeling that helps people engage in the learning process, where they can contribute in the community and learn from each other. Imagination brings new breath for our participation in and with the world, where we can inspire to get engaged in the process of discovery.

Another important aspect of Anzaldúa's notion of critical thinking is "ambiguity." *Mestiza* consciousness is Anzaldúa's model of critical thinking in which there is no particular epistemological and ontological foundations; in other words, there would be state of full ambiguity.⁵⁹ For Anzaldúa, the static notion of reality has no meaning. Everything is under process: our identity, for example, is in the process of changing. There is an inherent uncertainty that is a means for questioning different beliefs and spiritualities, and constantly seeking new forms.⁶⁰ What comes behind the notion of *mestiza* is appreciation of histories and background that makes one's identity; the notion of recognition blended with an implicit notion of alterity. In the process of searching for "deep awareness," one acquires the ability to see reality in different ways, and one must also remain respectful of persistent and elusive mysteries and differences in oneself and in others.

Discussion

John Dewey describes thinking as, "Active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and the further conclusions to which it tends constitutes reflective thought"⁶¹ (p. 6). For Dewey, thinking is a reflective process of discovery and inquiry. In describing Columbus's thinking process, Dewey clarified, "even if his conclusion had finally turned out wrong, it would have been a different sort

of belief from those it antagonized, because it was reached by a different method”⁶¹ (p. 6). Dewey also valued the importance of experiencing in defining and knowing. As experience changes, reality will also change. One needs to experience things to know them, things then are “what they are experienced to be.”⁶² Here, different perspectives receive credit. Vagueness, doubtfulness, and confusion are all part of this process, and acceptable. The similar notion of thinking as process has been welcomed in Freire’s and Anzaldúa’s epistemologies.

Thayer-Bacon suggests the term “constructive thinking,” which highlights the notion of active and socially constructed thinking. Constructive thinking gives attention to a range of cognitive states, emotions, intuition, and imagination. It also highlights interactions between subjectivity and objectivity; we cannot be neutral and objective.⁶³ To address constructive thinking in the classroom, students should be seen and treated as “individuals-in-relation-with-others.”⁶⁴ In practice, instructors and learners take part in social interactions that help to develop communication skills in a safe and respectful environment. In addition, the role of body and feeling should be recognized and implemented in classroom.

To bring liberatory pedagogy into relevance for engineering educators will almost certainly require fostering a broader discussion and network of relationships among those willing to study and reconsider liberatory praxis and theory, including its contestations and challenges to conventions in the field. Put differently, relationships among engineering educators intent on studying liberation can provide the basis for any feasible, liberatory pedagogy for engineering education. While this proposition seems to follow, quite obviously, from the discussion so far, that does not deter us from suggesting some initial, tentative criteria informed by the scholarship summarized earlier. Among liberatory criteria for engineering educators, we suggest the following:

1. **Provoke and Encourage Deep Imagination:** curriculum and pedagogy stimulate broad and intricate visioning of alternative histories, past, present, and future, in which engineering can and should play a liberatory role.
2. **Balance Alterity and Recognition:** curricular content and teaching strategies promote both the respect for qualities and characteristics that appear unfamiliar, as well as a

general (though not overwhelming) curiosity to understand more about human differences.

3. **Foster Questions of Legitimacy:** students hold a general inclination to ask, “who benefits?” and to then analyze the distribution of benefits, burdens, dignity, and other key social factors.
4. **Promote Dedication to Ameliorating Systematic Suffering:** students ask, “what role does our field have in either adding to or redressing human suffering?” and then go about comprehending, explaining, and arguing for their role as either liberators or oppressors in historical, hypothetical, or actual circumstances.
5. **Encourage Communication Among Minoritized, Minimize Dictation from the Center:** students and instructors from a society’s dominant paradigm refuse to centralize themselves in the majority of conversations and, instead, promote dialogue by, for, about, and among members of historically marginalized groups.

References

1. American College Personnel Association. (1994). *The student learning imperative: Implications for Student Affairs*, Washington, DC: Author.
2. Schneider, C.J. and Miller, R. (2005). *Liberal education outcomes: A preliminary report on student achievement in college*, Association of American Colleges and Universities, Washington, DC.
3. Baxter Magolda, M.B. (2001). *Making their own way: Narratives for transforming higher education to promote self-development*. Stylus Publishing.
4. Parks Daloz, L.A., Keen, C.H., Keen, J.P. and Daloz Parks, S. (1996). *Common fire: lives of commitment in a complex world*. Beacon.
5. Paul, R. and Elder, L. (2010) *The miniature guide to critical thinking: Concepts and Tools*, Foundation for Critical Thinking Press.
6. Paul, R., Niewoehner, R. and Elder, L. (2006). *The thinker's guide to engineering reasoning*, Foundation Critical Thinking.
7. Graham, J., Welch, K.C., Hieb, J.L., and McNamara, S. (2012). Critical thinking in electrical and computer engineering. in *Proceedings American Society for Engineering Education Annual Conference and Exposition*.
8. Kaupp, J., Frank, B.M., and Chen, A.S.C. (2013). Investigating the impact of model eliciting activities on development of critical thinking. in *Proceedings American Society for Engineering Education Annual Conference and Exposition*.
9. Thompson, A., and Ralston, P.A. (2015). Using the grand challenges to foster critical thinking and awareness of the engineer's role in global community, in *Proceedings American Society for Engineering Education Annual Conference and Exposition*.
10. Thompson, A., Ralston, P.A., and Haieb, J.L. (2012). Engaging freshman engineers using the Paul-Elder model of critical thinking. in *Proceedings American Society for Engineering Education Annual Conference and Exposition*.
11. Torrejon, G.C., Husted, S., Corona, N.R., Malo, A.L., and Palou, E. (2014). Fostering the development of critical thinking in an introduction to chemical process engineering design course, in *Proceedings American Society for Engineering Education Annual Conference and Exposition*.

12. Golanbari, M and Garlikov, R. (2008). Employing Socratic pedagogy to improve engineering students' critical reasoning skills: Teaching by asking instead of by Telling, in *Proceedings American Society for Engineering Education Annual Conference and Exposition*.
13. Shoop, B.L. (2014). Developing critical thinking, creativity and innovation skills, in *Innovations in Technology Conference*.
14. Vurkac, M. (2014). Integrating philosophy, cognitive science, and computational methods at a polytechnic institution: Experiences of interdisciplinary course designs for critical thinking, in *Proceedings American Society for Engineering Education Annual Conference and Exposition*.
15. Bayles, T.M. (2013). A reflective writing assignment to engage students in critical thinking, in *Proceedings American Society for Engineering Education Annual Conference and Exposition*.
16. Cajander, A., Daniels, M., Peters, A.K., and McDermott, R. (2014). Critical thinking, peer-writing, and the importance of feedback, in *Frontiers in Education Conference*.
17. Piergiovanni, P.R. (2014). Reflecting on engineering concepts: Effects on critical thinking, in *Frontiers in Education Conference*.
18. Hagerty, D. and Roackaway, T.D. (2012). Adapting entry level engineering courses to emphasize critical thinking, *Journal of STEM Education: Innovations and Research*, 13, 2, 25-34.
19. Kiener, M., Ahuna, K.H., and Tinnesz, C.G. (2014). Documenting critical thinking in a capstone course: moving students toward a professional disposition, *Educational Action Research*, 22, 1, 109-121.
20. Mattingly, S., Pearson, Y., Kruzic, A.P., Frost, H.L., and Rahman, Z. (2014). Critical thinking in the curriculum: Making better decisions, in *Proceedings American Society for Engineering Education Annual Conference and Exposition*.
21. Huynh, N., Caicedo, J.M., Pierce, C.E., and Gantt, J.W. (2013). Combining in-class design problems and EFFECTs to stimulate critical thinking skills, in *Proceedings American Society for Engineering Education Annual Conference and Exposition*.
22. Weiss, P., and Bazylak, J. (2014). Impact of critical thinking instruction on first year engineering students, in *IEEE International Professional Communication Conference*.
23. Gude, V.G., and Truax, D.D. (2015). Methods to Instill Critical Thinking in Environmental Engineering Students, in *Proceedings American Society for Engineering Education Annual Conference and Exposition*.

24. Paul, R. (1992). Critical thinking: What, why, and how, *New Directions for Community Colleges*, 77, 3-24.
25. Ahren, A., O'Connor, T., McRuairc, G., McNamara, M., and O'Donnell, D. (2012). Critical thinking in the university curriculum- the impact on engineering education, *European Journal of engineering Education*, 37, 2, 125-132.
26. Bumbaco, A.E., and Douglas, E.P. (2014). A thematic analysis on critical thinking in engineering undergraduates, in *Proceedings American Society for Engineering Education Annual Conference and Exposition*.
27. Bumbaco, A.E., and Douglas, E.P. (2015). A thematic analysis comparing critical thinking in engineering and humanities undergraduates, in *Proceedings American Society for Engineering Education Annual Conference and Exposition*.
28. Hicks, N., Bumbaco, A.E., and Douglas, E.P. (2014). Critical thinking, reflective practice, and adaptive expertise in engineering, in *Proceedings American Society for Engineering Education Annual Conference and Exposition*.
29. Claris, L. and Riley, D. (2012). Situation critical: Critical theory and critical thinking in engineering education, *Engineering Studies*, 4, 2, 101-120.
30. Ennis, R.H. (1962). A concept of critical thinking: A proposed research in the teaching and evaluation of critical thinking ability, *Harvard Educational Review*, 32, 1, 81-111.
31. Brell, C.D. (1990). Critical thinking as transfer: The reconstructive integration of otherwise discrete interpretation of experience, *Educational Theory*, 4,1, 53-68.
32. Ennis, R.H. (1989). Critical thinking and subject specificity: Clarification and needed research, *Educational Researcher*, 18, 3, 4-10.
33. McPeck, J. (1981). *Critical thinking and education*, St Martin's Press.
34. Weinstein, M. (1993). Critical thinking: The great debate, *Educational Theory*, 43,1, 99-117.
35. Niu, L., Behar-Horenstein, L.S., and Garvan, C.W. (2013). Do instructional interventions influence college students' critical thinking skills? A meta-analysis, *Educational Research Review*, 9, 114-128.
36. Kurfiss, J.G. (1988). Critical thinking: Theory, research, practice, and possibilities, *ASHE-ERIC Higher Education Report*, No.2. Washington D.C.

37. Paul, R. and Elder, L. Critical thinking: Ethical reasoning and fairminded thinking, Part I. (2009). *Journal of Developmental Education*, 33,1, 36-37.
38. Matheis, C. (2017). Liberatory solidarity or political solidarity? On the relational foundations of liberatory movements, Under review:
https://www.academia.edu/31961976/_Liberatory_solidarity_or_political_solidarity_On_the_relational_foundations_of_solidarity_in_liberatory_movements._
39. MacKinnon, C. A. (1989). *Toward a feminist theory of the state*. Harvard University Press.
40. Matheis, C. (2014). On various notions of ‘Relations’ in Enrique Dussel’s philosophy of liberation. *Hispanic/Latino Issues in Philosophy*, 13, 2, 9-15.
41. Matheis, C. (2015). Hegel’s reproduction issues: On identity politics, international relations, and the desire for recognition of oneself in the other. *Philosophy in the Contemporary World* 22, 2, 12-27.
42. Lorde, A. (1983). *There is no hierarchy of oppressions*, Homophobia and Education, Council on Interracial Books for Children.
43. Freire, P. (2000). Cultural action and conscientization, *Harvard Educational Review*, 40, 3, 452-477
44. Frye, M. (1983). Oppression, in *The Politics of Reality: Essays in Feminist Theory*, Crossing Press.
45. Hallie, P. (1981). *From cruelty to goodness*, The Hastings Center Report 11, 3, 23-28.
46. Fanon, F. (2004). *The Wretched of the Earth*, trans. R. Philcox, Grove Press.
47. Freire, P. (2005). *Pedagogy of the Oppressed*, trans. M.B. Ramos, Continuum International Publishing Group.
48. Biko, S. (2002). *I write what I like: Selected writings*. A. Stubbles (ed.). University of Chicago Press.
49. Pharr, S. (1996). *In the time of the right: Reflections on liberation*, Chardon Press.
50. Nardal, J. (2002) Black Internationalism, in *Negritude Women*, T.D. Sharpley-Whiting, Univ. of Minnesota Press.
51. Lorde, A. (2007). Uses of the erotic: The erotic as power, in *Sister Outsider: Essays and speeches by Audre Lorde*, Crossing Press.
52. Dussel, E. (1985). *Philosophy of liberation*, trans. A. Martinez and C. Morkovsky, Orbis Books.

53. Clare, E. (2015). *Exile and pride: Disability, queerness, and liberation*, Duke University Press.
54. Matheis, C. (2012). Political education for the furious and sick at heart: Franz Fanon's the wretched of the earth, Public Knowledge, 4.1.12.,
https://www.academia.edu/32005459/_Political_Education_for_the_Furious_and_Sick_at_Heart_Fanons_Wretched_of_the_Earth_
55. Garvey, M. (2009). Editorial Letter, in: *Pioneers of Black Liberation: Writings from the early African-American champions of civil rights and racial equality*, Red and Black Publishers.
56. Buttigieg, J. (2011). Antonio Gramsci: Liberation begins with critical thinking, in *Political philosophy in the twentieth century: Authors and arguments*, C.H. Zuckert (ed.), Cambridge University Press.
57. Roberts, P. (2000). *Education, literacy, and humanization: Exploring the work of Paulo Freire, Bergin and Garvey*, Westport.
58. Anzaldúa, G.E. (2015). *Light in the dark: Rewriting identity, spirituality, reality*, Duke University Press.
59. Torres, H.A. (2007). *Conversations with contemporary Chicana and Chicano writers*, Ch. 4, University of New Mexico Press.
60. Alvarez, A.R. (2007). *Liberation theology in Chicana/o literature: Manifestation of feminist and gay identities*, Routledge.
61. Dewey, J. (1933). *How we think*, D.C. Heath and Company.
62. Dewey, J. (1905). Psychology and scientific method: The postulate of immediate empiricism, *The Journal of Philosophy*, 2, 15, 393-399.
63. Thayer-Bacon, B. (1998). Transforming and redescribing critical thinking: Constructive thinking, *Studies in Philosophy and Education*, 17, 2, 123-148.
64. Thayer-Bacon, B.J. (2000). *Transforming critical thinking: Thinking constructively*, Ch.7, Teachers College Press.