IMAGINEERING CRISES:
PERFORMATIVE HISTORIES OF RATIONALIZING US STEM EDUCATION REFORM

by

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Abstract

Imagineering Crises: Performative Histories of Rationalizing US STEM Education Reform explores how US STEM education reform is historically made possible as a global phenomenon that rationalizes technoscience and education as apparatuses of security that prepare for and preempt anticipated crises. It combines postcolonial science and technology studies, security studies, and performativity theory to write a curriculum history that draws attention to the discursive-material configuration of time-space in technoscientific and educational practices that produce the objects of knowing, feeling, and controlling in the post-World War II years.

The introduction (Chapter 1) focuses on the theoretical question of how to think of the present paradox of education reform through historicizing the emergence of US STEM education at the intersection of the politics of technoscience and the security regime of American Empire. Chapter 2 engages with the textual and visual materials of the contemporary US STEM education reform, unpacking the poetics and politics of the "leaky STEM pipeline" metaphor used to induce hope and fear of change. It analyzes how the global scale and common standards constructed for international comparisons are mobilized to produce both a certainty of future progress and objects of fear--the "techno-Orientals" and the domestic "diverse" population. It also discusses how STEM learning programs in the US are designed to associate STEM tightly with home security and to produce learners as the future colonizers of the unknown land. Chapter 3 and 4 focus on the historical co-construction of the global scale, the objects of fear, and the cultural imaginaries of survival crisis that are taken up to order STEM and education as powerful preemptive infrastructures. These chapters examine how US-led social/sciences (e.g., biology, experimental psychology, anthropology, ecology, systems theory, management theory) and educational practices were joined by international institutes (i.e., UNESCO, OECD, IIASA, the Club of Rome) to perform various phantasmas of crisis in the post-World War II years. As this research argues, by abstracting and substituting different scales of lives, including the biological laboratory bottle, the urban "slum," and the global Earth, these phantasmas of crisis (e.g., "the struggle for existence," "the culture of poverty", and "the spaceship earth") not only differentially included the "crowds" as unwanted threats to the whole, but also authorized a technoscientific vision and calculation of time-space as a universal means of survival to orient learning and curriculum.

This research provides a different way for scholars in educational and social sciences to be aware of and accountable to the conditions of their intervention of social change that is oftentimes justified in the name of progress and justice. It reveals and problematizes the politics of constructing the problems and crises that education reforms are presumed to resolve and for which particular kinds of population are constructed to be responsible. By interrogating the historical entanglement of technoscientific innovation, social governance, and international development in US STEM education reform, this dissertation also attempts to address broader socio-cultural-political issues regarding the paradox of change and stability, crisis and security, empowerment and control, and also, fertility and infertility of imagination of the unknown lives and the unknown futures.

Chapter I. Introduction

1. The Cruel Optimism of Curriculum: Routine + Crisis = Reform

In the US (and many other countries), there is a prevalent anxiety with schooling. Paranoid education reforms push children, parents, and teachers into a race-course—the Latin root of curriculum—where everyone is running towards (almost) the same end. Children are evaluated by the timekeeper, by the starting line and finishing line that they cross, by the medals that they could acquire. And you might say, well, haven't people always been like that, at least from the time when (social) Darwinism began to be accepted as the (Modern) Truth? Yes and no. Several things have changed. The track has been extended, the child has been "dismembered" into more "pieces," and the time has been measured on a much smaller scale.

For many "stake-holders" the goal is not just running forward to win but also running away to not run in the future, to no longer hold any "stake." Here and now is seen as the most insecure place and time and running faster is taken as the only way to make the desired place and time appear sooner. The paradox is that the racecourse could always extend itself by projecting a future invested with both hope and fear to keep people running on it. For example, PISA 2009 reports recited Darling-Hammond et al. (2008)'s claim that there were daunting challenges that were brought by the changes that had "not-yet" happened—jobs that had not yet been created, technologies that had not yet been invented and economic and social challenges that we did not yet know would arise. If individuals and countries wanted to constantly improve themselves and thus had a sustainable future, they had to be lifelong learners who successfully prepared for these "not-yets" and thus be "swift to adapt, slow to

complain and open to change" (OECD, 2010). The future is simultaneously imagined and thought to go beyond imagination in the education reform discourse and the present becomes a "presence of the future", a site of immediate intervention, a constant rehearsal of the whole-life span to prepare for and preempt the possible risks that the future might bring (Anderson, 2010).

In the name of quality and equality, education reforms repetitively create a sensitivity[1] of crisis and a desire for survival to extend the racecourse. The endless racecourse produces the feeling of precariousness and certainty at the same time. It enacts an internment that promises freedom to paradoxically capture people and their desire for another line of flight (Deleuze and Guatarri, 1987). Education reform as such embodies a relation of, what Lauren Berlant (2011) calls, cruel optimism as it "draws your attachment actively impedes the aim that brought you to it initially" (p.1).

Inspired by Wendy Chun (2016)'s theorization of the development of new media,[2] I put this cruel optimism of education reform also into a formula: Routine + Event/Crisis = Reform. We can find this formula has been used to rationalize "how changes are made or should be made" not only in education but also in other fields that are entangled in and through education, such as techno-scientific innovation, social reforms, and international development. This formula is a loop as a reform very soon becomes routinized and obsolete

[1] Throughout writing this dissertation, I came across many works that deal with affects in different ways. Share with these scholars that I draw upon (e.g., Halpern, Chun, Berlant, Sedgewick), I am not interested in theorizing affect or providing any evidence to approve or dispute certain theories. Rather, we pay particular attention to different aesthetic and material forms through which affects get manifested and distributed to orient action.

[2] Chun (2014) theorizes new media as embodiment of an ontological assumption that to be is to be updated," which she expresses in a formula: habit + crisis=update.

and for a new reform to come up, crisis becomes indispensable. Crisis is what a system aims to eliminate and also what it perpetuates (Chun, 2016, p.69). In this case, crisis becomes ordinary while security and phantasmatic and survival become a moving target of reform that can never be fully achieved.

In an era of Reform, which I capitalize not to indicate reform didn't happen before but to highlight reform is referring back to itself across time and space, what could curriculum theorists do? Do we, or can we, simply run away from the reformania to make a difference? How can we make a rupture of this formula of crisis without re-inscribing a moment of crisis? This dissertation project attempts to answer this question by historically re-accounting for "crises." It interrogates the specific forms in which crises become constitutive of the habitual repetition of social and educational reforms that are "attached to unachievable fantasies of the good life" (Berlant, 2011) and "make children who are not only under siege but preparing for siege themselves" (Nguyen, 2016). The ethopolitics (Rose, 2001) of crisis is unpacked historically as an entangled effect of technoscientific governance of the present/presence of the Other—the domestic and international "deprived"—to securitize the future of the American empire.

2. Education in a Technological Society: The Paradox of Empowering and Controlling

Routine + Crisis = Reform has been taken up as a technological formula of social change. It is both produced by and constitutive of a technological society where, as defined by Andrew Barry (2001), "specific technologies dominate our sense of the kinds of problems

that government and politics must address, and the solutions that we must adopt" (p.2) to form "the kind of person who can exist, manage, compete, experiment, discover, invent and make choices in a technological society" (p.31). The self-reflexiveness (Hayles, 1999) of technoscientific governance is well performed by the "STEM pipeline" metaphor: to engineer education through teachers-as-engineers to produce students-as-becoming-engineers who can construct future infrastructures.

The "STEM pipeline" is merely one of a series of metaphors between education reform and infrastructure engineering. Educational research and reform documents in the US and other OECD countries have been using "bridge" "pipeline" "pathway" and "highway" to discuss how schooling can "empower" students in life and work (see, e.g., Mourshed, Chijioke, & Barber, 2013), and in post-socialism countries like China, teachers have been "elevated" to be the "engineer of the human soul" for more than half a century (Liu, 2016). These metaphors between education and infrastructures subsume human and machine into one category and manifest the politics of education as part of the politics of technoscience[3], "which claimed to bring the expertise of modern engineering, technology, and social science to improve the defects of nature, to transform peasant agriculture, to repair the ills of society, and to fix the economy" (Mitchell, 2002, p.15). In another word, education and population are metamorphosized (Deleuze & Guatarri, 1987) through the cultural figures of engineers and infrastructures as well as the pedagogico-political language they speak, such as

[3] The term "technoscience" has been commonly used in Science and Technology Studies to indicate the mutual embeddedness of scientific knowledge and technological application. In many cases that have been examined by scholars (e.g., Haraway, Latour), the hybrid of technoscience also involves the military and industrial invention and intervention.

integration, freedom, progress. Ignored is how these figures and their language are produced and how power is attached to technology and engineering. To understand whether STEM can empower students and the nation-state, we first need to interrogate the invisible presence that constitutes the technological metaphor of education and acts upon the present movement of producing STEM-empowered citizens and nation-states.

Critical infrastructure studies and science & technology studies have provided thoughtful discussions of the historical practices that make possible infrastructure—including its engineering process and technological product—to work as the material-conceptual means and targets of government to constitute the desire and (im)possibility of the Moderns. As this literature demonstrates, the construction of infrastructure has never merely been an industrial project or a neutral provision of service (Von Schnitzler, 2013). Instead, it has been used to stabilize and manifest the economic-political power of the rulers, such as English colonizers in Ireland (Carroll, 2006, from Mukerji, 2010) and the postcolonial government in Egypt that constructed dams (Mitchell, 2002).

The project of social integration that is delegated to technology and engineering—for example, increasing the access to infrastructure—simultaneously includes and excludes. The inauguration of new canals, railroads, bridges, and buildings on July Fourth starting from the early 19th century was to elevate the moral character of American citizens (Nye, 1994, p.42). The gas connection was enabled to integrate Londoners as healthy and reasonable citizens in the late 19th century (Von Schnitzler, 2013) and the technological network connected European regions as a unity in the contemporary era (Barry, 2001; Folkers, 2017). In these and other similar cases, e.g., post-soviet city building (Collier, 2011) or smart city projects

led by Cisco and MIT (Gabrys, 2014), the social membership is registered through a proper use of civil infrastructure that is supposed to guide the users-qua-citizens to cultivate certain desired habits and attitudes. A collective life is also created through abjection of those whose use of infrastructure is seen as “unruly” or not “culturally appropriate” (Lea & Pholerus, 2010; Barry 2001; Mrázek, 2002). The modern infrastructure speaks. It speaks a language that the “unmodern” need to learn. As Mrázek (2002) shows in his book *Engineers of Happy Land*, the body of the late-colonial Indonesians and their land were read by the colonizers as carrying softness that threatened or even ruined the language of the modern road, which was clean, hard, and orderly. Their unexpectedly calm acceptance of the modern technology was taken as a breakdown of an ideal plan, an invasion of physicality, and destruction of the asphalt. Their bodies were abjected for its racing impeded the smoothness; and the tropical land was abjected for its muddiness made the modern road “sick.” The smoothness, or the freedom of the “coming and going” technology is the new common language that ‘is made to "abstract the world from its social conditions," to make it appear as if it is, technologically, suspended in the air’ (Mrázek, 2002, p.28).Techno-scientific discoveries conceal the violence of removing the indigenous as the condition of producing the “empowering” capacity of the modern infrastructure.

While smoothing out the wrinkles of the local and the past, infrastructure draws a frontier between wildness and civilization. To move the frontier forward, nature, of both land and human body in Indonesia, for example, were turned into inert and costless resources that should be “released” and “redistributed” for both colonial transportation projects in the late 19th to early 20th centuries (Mrázek, 2002) and transnational logging and mining corporation

in the late 20th century (Tsing, 2005). As Anna Tsing observes, to discover and extract resources, a wild and empty landscape that does not exist has to be made visible by "[t]he lonely prospector [that] replaces swarming migrants and residents" (p.68). Through reimaging and remaking the landscape, the preservation of nature and the exploitation of nature were conflated, and the technological sublime became identical with the natural sublime (Nye, 1994).

The "coming and going" technology does not only remove the condition of its production and normalize the flow that it extracts, but also mobilizes and organizes the flow to move with the same rhythm. To "free" time and space is simultaneously to enable controlling how "to work, play, and sleep on schedules we design, to communicate instantaneously with others almost regardless of their physical location, and to go wherever we want at speeds far beyond the human body's walking pace" (Paul Edward, 2003). As Barry (2001) contends, "in so far as they have been formed in roughly the same mold, it simply should not matter which bureaucrat performs the task entrusted to them" (p.13). Standardization of infrastructure becomes the guarantee of stability of life when human actors are no longer treated as reliable (Daston and Galison, 2010). Infrastructure acts as an "impersonal rule" (Mukerji, 2010; Deleuze & Guatarri, 1987) which "seems to lie outside of political dispute, and thus can seem as inevitable as the natural order" (Mukerji, 2010).

Beyond the explicit articulation and enactment of in/exclusion through disciplining how infrastructure is constructed and used, infrastructure also works within movement (Amoore, 2011; Lentzos and Rose, 2009; Barry, 2001) to create a milieu that is eliminating its dangerous elements, making a division between good and bad circulation, and maximizing

the good circulation by diminishing the bad" (Foucault, 2007, p.34). As Folkers (2017) argues, "both the effectiveness and the legitimacy of modern biopower reside in the increasing infrastructurization of modern forms of life," which is "understood as connecting the population to infrastructural services or switching them off." Information and communication technologies (Gabrys, 2014; Halpern, 2014) create an environment of government (Foucault, 2008) that re-operationalizes the actions of multiple bodies through constantly calculating the causality and/or correlation among these bodies.

As the foundation of "establishing a functioning 'effective living space'" (Folkers, 2017), infrastructure becomes simultaneously a vital and vulnerable apparatus of security, in both its literal and Foucauldian sense. The genealogy of infrastructure as a security problem can be traced back to the rise of "total war" in the 19th and early 20th centuries when "the traditional distinction between the military and civilian spheres – at least in wartime – was eroded in a variety of ways" (Collier and Lakoff, 2008). US Civil Defense during the Cold War era took up the logic of US military attack in wartime—the vital notes of enemies' industrial infrastructure were the vital targets of bombing—to achieve "total preparedness" for nuclear attack (Collier and Lakoff, 2008). In the post-cold war world, due to the growing sense of fear and uncertainty over the nature and location of threats and enemies, the national vulnerability is seen as not only stemming from the threat of foreign enemies but, perhaps more importantly, the fragility and interdependency of Critical Infrastructure systems (CIs) that support the collective daily life of the nation (Folkers, 2017; Lundborg and Vaughan-William, 2011).To preempt and prepare for any unpredictable attack from literally anyone, US Department of Homeland Security attempts to create an ecosystem—'system of system.'

Within such an ecosystem, "the capacity of all CIs, their individual components, and the interplay between them" are supposed to be resilient, "through which liberal rule secures the way of life it needs to reproduce its vision of ''correct living'' (Lundborg and Vaughan-Williams, 2011). CIs work as an apparatus of security (Foucault, 2007) that acts upon the unfolding futures of a series of mobile elements, events, and accumulating units by an estimate of probabilities (p.35).

In sum, technology and engineering are not naturally powerful but empowered through actualizing socio-political cohesion and abjection, moral imperatives, displacement of nature, suspension of the local condition, abstraction and calculation of human bodies, and preemption of the unknown threats. The power attached to them are historically produced by and productive of an assemblage of colonial, developmental, and security projects to govern the commons. While being used as a metaphor of a particular kind of knowledge-making, infrastructure first of all works as the material buttress and product of it. Michelle Murphy coins the term "epistemic infrastructures" to indicate the entanglement of knowledge and its discursive-material conditions and effects. This research attends to how specific epistemic infrastructures of US schooling and social science research are historically produced and consolidated to imagineer[4]—to imagine and engineer—problems of learning and living (Kliebard, 1975; Pauly, 1987; Noble, 1989; Tyack & Cuban, 1995; Derksen, 2017) and at the same time "empower" themselves. In doing so, it denaturalizes the power associated with technology and engineering that STEM education reform prioritizes to solve daily, national,

[4] The term is borrowed from the book *The Imagineers of War*: *The Untold Story of DARPA, the Pentagon Agency That Changed the World* (Weinberger, 2017). It also "accidentally" coincides with Walter Disney's *Imagineering the Future*.

and global problems (see e.g., NGSS Lead States, 2013; NRC, 2011; United States Congress, 2007).

3. Securitizing American Empire through Making the Domestic and International Objects of Fear

US education reform, once again, is closely linked to national security to cultivate a fear of a loss of its superior power in the "flat world" and an aspiration for technoscientific advancement to retain the control of those who are "different" at home and abroad. US innovation agenda (e.g., *American Competitiveness Initiative, 2006; Rising Above the Gathering Storm,* 2010; *Opportunity Equation*, 2016; *Benchmarking for Success*, 2008) that initiated and advocated STEM education reform are explicitly concerned with threats the "flat world" brings to the values that the US is thought to inherit. The threats identified in this literature cover across the spectrum from external ones (e.g., terrorism, the growing economic and technological power of China and India, environmental catastrophe, energy crisis, cyber-attack) to intrinsic vulnerability of the national system (e.g., a lack of scientific-literate citizens and STEM workforce in women, African Americans, and Latinx; increasing dependence on international students and workers to fuel national economy).

Social and educational reform discourse takes 9-11 and the global war on terror as a second Sputnik moment to claim the nation re-enters a state of emergency and can only be defended through STEM. However, as many scholars have well observed, 9-11 merely provides an opportunity for the state to justify and strengthen the construction of American Empire through both national and global security systems (Smith, 2003; Massumi, 2009;

Amoore, 2011). Drawing upon Ann Stoler (2016) 's conceptual intervention of (post)colonial studies, I take up "American empire" not as an already enclosed territory but an ongoing imperial formation of the US through "decimation, displacement, and reclamation that endure beyond the formal exclusions that legislate against equal opportunity, commensurate dignities, and equal rights" (P.56). The paradigm of Security is not seen as merely a present form of governance but "the conceptual and political nexus of the expulsions and containments in which imperial formations (have) invested" for a long time (p.31).

While STEM education reformers acknowledge Thomas Friedman (2005)'s warning that Americans are facing a slow crisis in a world that was flattened by information and communication technologies, they dismiss the uneven epistemic and material relations that the US produced to construct the flat world and promote a smoothing-out global flow (Domosh, 2010). The fear of falling off the flat world (see the cover image of Friedman's book, shown in Fig 1) reiterated the "American Jeremiad," which controls the "frame-story—a mythic beginning and end that molded the shifting midway stories (tales of a nation in process) into a master narrative called America" (Bercovitch, 2012). The rhetoric of jeremiad contains both the hope of growth and the fear of captivity of mankind that "America" is thought to exceptionally embody.

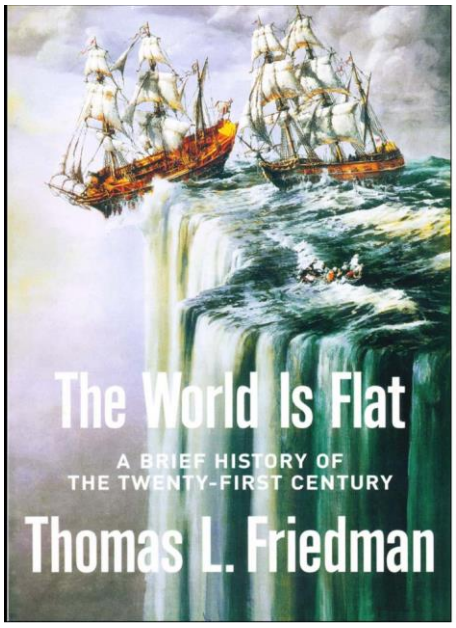


Figure 1 The cover image of The World is Flat

However, historically, the American "dream"—of freedom, autonomy, progress, and prosperity—has been taken to justify US imperial practices of producing, containing, expelling and even extinguishing its objects of fear to, paradoxically, realize its "dream." These objects of fear include both the national and the international Others. They are produced with the technologies that identify and govern them. As McKeown (2005) demonstrates, the universal albeit vague idea(l) of "civilization" was used to differentiate who were the autonomous and free migrants—"part of the global engine of intercourse"—and who were the undesirable migrants—"a potential threat or dead weight" (pp.11-12). While the rhetoric of freedom was taken up by abolitionists as an eulogy of a new form of imperial governance—indentured labor system (Lowe, 2015), the rhetoric of self-rule and egalitarianism that Asians (and particularly Chinese) were accused of not having were used to justify both the exclusion of Asians from the US and European-American extraterritoriality in Asia after the mid-19th century. The exclusion was obscured and neutralized by procedures

that were invented to subtract migrants out of their informal social networks and insert them into standardized categories and cross-reference files in order to select and protect the "free" migrants. Technologies that have been naturalized for international border control today such as passports were nonetheless born out of states' suppression of local mobility and later encouraged more domestic centralization and regulation of citizenship in the 19th century US (McKeown, 2005, pp. 102-105). The domestic and foreign Others are created based on the same epistemological and juridical principles of "human" freedom and independence, which differentiate the "self" as the autonomous subject who can move freely while the "other" as unfamiliar and irrational threats who need to be known in order to be controlled.

In the post-colonial era, US international development practices are also shaped by and mobilized between the governance and abjection of both the "American South" and the "Global South." As Domosh (2015) illustrates, US agricultural extension service that intervened the domestic life of African American women in the South in the early 20th century was "replicated" in the postwar US intervention of homemaking in the "underdeveloped" regions. While the former practices were to keep more African American alive as the source of labor and thus less "dangerous to the interest of the states," the latter was to solve the "overpopulation" problem which was deemed as another threat to the empire.

As Jerry Sanders' Peddlers of Crisis (1983) and others have warned against those who warned Americans against others, US military intervention of Korea and Vietnam would have not been possible without American colonization and militarization of Philippines, Guam and other pacific islands and a domestic scare campaign that produced and oversold fear about

the Soviet and its communist partners. As the residues of these hot wars during and after the so-called cold war era, the bodies of refugees and immigrants were nonetheless transformed into the unwanted, displaced burden of the white Americans who positioned themselves as the saviors who granted "gift of freedom." (Espiritu, 2014)

Drawing upon the existing security studies, this research considers technologies of controlling crises to be material-conceptually entangled with technologies that construct crises. Its analysis focuses on how social and educational reforms for socio-economic development were produced through and as apparatuses of security to create the subjects of hope—the survivors, act upon the objects of fear—the internal and external others/threats, and distribute differential pasts, presents, and futures of the world.

4. Writing Performative Curriculum Histories: A Reparative Writing

Performative curriculum history is concerned with what knowledge does, what the world does, and what history does. It is a reparative writing of the cruel optimism of curriculum by detaching what is seemingly undetachable, relating what is seemingly unrelated, and re-accounting for how accountability is unevenly distributed. It aims to queer and defamiliarize what is taken as "natural" in the present by stressing the contingency of its production and it is also to demythologize the "present" by mapping out its historical formation. Performativity as a perspective allows us to revision and repair the paranoid re/production of knowledge-subject-power. As Eve Sedgwick (2003) reminds us,

> *"The dogged, defensive narrative stiffness of a paranoid temporality, after all, in which yesterday can't be allowed to have differed from today and tomorrow must be even more so, takes its shape from a generational narrative that's characterized by a distinctly Oedipal regularity and*

> *repetitiveness: it happened to my father's father, it happened to my father, it is happening to me, it will happen to my son, and it will happen to my son's son. But isn't it a feature of queer possibility—only a contingent feature, but a real one, and one that in turn strengthens the force of contingency itself—that our generational relations don't always proceed in this lockstep?"*
> (p.147)

Following that, we can also ask, what makes us feel we are so trapped in such a lockstep of change as if it is inevitable and eternal? How can we account for the making and doing of knowledge, the world, and history in a way that allows us to see the invisible constitution of the imagined lockstep and thereby to feel and act differently?

4.1 Performativity of knowledge and the "real"

Performativity is defined here as discursive-material arrangement of time-space that constitutes the subject by enabling words, images, numbers and other artefacts to do things upon bodies. To approach knowledge as performative is a direct countermove of representationalism which pursues a correspondence between subject and object and assumes agency as a transcendental property of individual entities. Historians of science have been doing so by adopting historical epistemology to understand not only the changing ways in which things are made into objects of knowledge (Rheinberger, 2010) but also how new models of knowing and knowers appear at "irregular intervals" and become widely accepted epistemic virtues (Daston & Galison, 2010, pp.375-376). Scholars in humanistic social sciences have combined historical epistemology with the analytics of governmentality (Foucault, 2008) to examine how knowledge, population, and power work as media, targets, and effects of each other. For example, human geographer Ben Anderson (2017) interrogates how affects—such as morale or 'debility, dependency, dread" are turned into objects of knowledge via various techniques to intervene in environments and bodies (p.20). And in

curriculum studies, there has been a trend of countering the epistemicide in this field through attending to the politics of truth since the 1970s (Paraskeva, 2016; Baker, 2009). Part of it is to examine how particular subject/object of knowledge-action is historically formulated as part of governmental practices, such as the mind and body of children and adolescents (see e.g., Popkewitz, 2013; Baker, 2013) or a particular kind of STEM citizens (see e.g., Bazzul & Cater, 2017; Hoeg & Bencze, 2017).

Posthumanist performative approach in Science and Technology Studies offers another kind of conceptual intervention to the notion of "agency" and "causality." Karen Barad (2003, 2007) tactically displaces "interaction" with "intra-action" to highlight that a correspondence or a causality between A and B is an effect of an "agential cut" (in contrast to the Cartesian cut) that a specific discursive-material apparatus—e.g., the measurement instrument—enacts to separate A and B *within* the making of spacetime. From this perspective, the (over) examination of "interaction" between, e.g., the global and the national, science and society, the self and the other, the known and the unknown, the present and the future, and the threat and the savior, can be seen as the entangled effect of discursive apparatuses that are constructed to separate them at the first place.

To repeat what I previously discussed about epistemic infrastructure, this dissertation research revisions social scientific knowledge by interrogating how the historical conditions where this knowledge was produced were entangled with the causal relations it constructed and the historical effects the constructed causality brought about.

4.2 Performativity of the world

Performativity is an approach to understanding not only knowledge but also the world. It shifts the concern from epistemological uncertainties to ontological indeterminacies to challenge anthropocentrism and make both science and social policy more responsible. As Astrid Schrader (2010) argues, “the very idea of an epistemological uncertainty presupposes an a priori separation of the epistemological question of 'how we know' from the ontological status of 'what we know', where only the former, that is, our knowledge is allowed to vary.”

The world is no longer taken as an immutable container of space-time “from” or “to” which actors move but a volatile apparatus that constantly re-configures space-time and produces a particular subject within it. To know the world is to re-make the world within the world. As a conceptual-material apparatus, the world is “perpetually open to rearrangements, rearticulations, and other reworkings” (Barad, 2003). Each repetition engages with and produces differences. Each universal is a singular one while the singulars are delocalized to look like general. Discourses of the “universal” and the “global” travel, translate and transform. They contribute to their own materialization and make demands on us to be accounted for (Schrader, 2010). Contemporary historico-ethnographic studies have made these philosophical statements more concrete and grounded: the transfer of the operationalization of American neoliberal economic theories into Russia to build the post-Soviet cities (Collier, 2011); the reworking of universalizing rhetoric of rights and justice by the Indonesian democratic movement of the 1980s and 1990s (Tsing, 2005); the transformation of economics into a global form of knowledge through colonial government, the colleges of the East India Company, American academic visitor programs, metropolitan

universities, intergovernmental organizations, the Ford Foundation, and other agencies (Mitchell, 2002). As Tsing (2005) notes, "abstract claims about the globe can be studied as they operate in the world. We might thus ask about universals not as truths or lies but as sticky engagements" (pp.5-6).

With a performative perspective, the world in social science practices is phantom-like but nonetheless "agentially real." It is a kind of phantasmagram, as Murphy (2017) terms, which invests affects and produces imaginaries through discursive-material arrangement of space-time.[5] Inspired by the existing work on the phantasmagrams produced in and about the cold war/post-colonial world (see Murhphy, 2017; Masco, 2014; Orr, 2006; Erickson et al., 2013), this dissertation research will explore how epistemic infrastructures (such as simulation, modeling, diagrams, analogies, and scenarios) of the real-world change were built after WWII to imagineer collective imaginaries of crises and conflicts and operate metaphoric performances that re-configure the world and re-orient actions. Imagineering is defined here as an act of imagination that transforms the unknown (world and future) into the object of knowledge and control. Metaphors are performative as they do not only conjure a projection of the world through discursive-material apparatuses that are particularly invented, but their projection also produces specific order of how to feel, to know, and to act upon/in the world. As Aradau & Van Munster (2011)'s research points out, imagination and aesthetics have

[5] In her book on the economization of life, Murphy (2017) discusses how the demographic transition model and calculations of averted birth as phantasmagrams of population was both constituted by and productive of imaginaries and feelings that animated numbers and oriented facticity while they at the same time tended to erase their own conditions of creation.

worked as modes of knowledge to access the unknown futures as catastrophe and foster particular subjects of a catastrophic future.

What matters in this research is less about whether we should or not "imagine" or use aesthetic approaches such as metaphors in intellectual work than how to assess the effects of the imaginaries that are produced and consolidated as real through various apparatuses of knowing. As Berlant (2011) argues, aesthetics "provides metrics for understanding how we pace and space our encounters with things, how we manage the too closeness of the world and also the desire to have an impact on it that has some relation to its impact on us" (p.12).

4.3 Performativity of history

Genealogy or history of the present deals with history as performative. The performativity of history is not about how things repeat themselves across time. Rather, the past is seen as a spatial coeval of the present. It is part of the discursive-material surrounding that makes the present statement intelligible and legitimate. While Judith Butler (1993) examines how temporal repetition of discourses produces the normal body and its constitutive other, Sedgwick (2003)'s queer reading of the marriage example provided by J.L Austin (1962) invites us to think about how spatial relations condition the effectiveness of a given statement of subjectivity: the efficacy of 'I do' does not come from the act of the first-person subject but the surrounding cross-gender 'witnesses' through the presence of whom the subject 'I' gets constituted (pp.71-72). It is the multiple tenses and layers of what the present occurs "with" "beside" and "through" that work as the coordinates of meaning and action. To distinguish "colonial presence" with "colonial present," Stoler (2016) argues that "colonial sensibilities, distinctions, and discriminations are not just leftovers, reappointed to

other time and place. Nor are they abstract "legacies." Colonial presence is an effort to make room for the complex ways in which people can inhabit enduring colonial conditions that are intimately interlaced with a "postcolonial condition" that speaks in the language of rights, recognitions, and choices that enter and recede from the conditions of duress that shape the life worlds we differently inhabit" (p.33).

In this research, to examine US STEM education reform historically is not to trace or compare how similar practices emerged at different places and times. Rather, it attends to certain historical practices that set up the conceptual-material infrastructures that not only support the rationalization of STEM education reform but also become consolidated through it. Focus is given to the years between 1960s and late 1980s when "post" began to be used to conclude that wars and colonialism were over. It might sound like a cliché choice since many scholars have noticed US STEM education reform is echoing the Sputnik moment and the National Defense Education Act (NDEA) in terms of encouraging more students to become scientists and engineers to secure the nation's position in the technoscientific and economic race. However, this research neither intends to compare STEM education agenda and NDEA nor locates an origin of STEM education in the Sputnik moment. Rather, it interrogates how martial and colonial relations and sensibilities were refashioned and reanimated after WWII and decolonization movements by inscribing a different set of language that the current STEM education reform depends on and hardens.

This research also troubles the naturalized idea that technoscientific competition and crisis are the inherent (in contrast to fabricated) center of the cold war/early post-colonial era. It understands crisis as an object of knowledge that is co-produced with a particular way of

knowing it and a particular kind of knower who can respond to it. And the Cold War/early post-colonial era is treated as both where this co-production happened and what it constituted instead of a pre-defined "background" of crisis. Through this reconceptualization of the Cold War crisis, this research attempts to reveal how the social and educational projects during the 1960s-1980s created techniques of governance to produce and control the subject of crisis—both crisis as a subject and a subject in crisis—who are also the imagined and actualized subject of US STEM education reform. Future catastrophes, global conflicts and competition, among many other "universal things" that STEM and its education are said to solve or prepare for, are not seen as produced outside but within the reiterative articulation of science, technology, engineering, mathematics, and their relation to education, along with the changing enactment of domestic and international development.

In the process of writing the performative histories, this research project along with myself also become an epistemic infrastructure that partially intervenes and reconfigures STEM education and the world. At the same time, the constitution, the working mechanism and the associations of the epistemic infrastructures examined in this project are made, partially, visible and transformed. As a writer I am also being *within* the arrangement that these infrastructures have made and *within* the politics of anxiety and desire that have been acting upon education and those engaged bodies. Rather than seeking for a way *out*, which suggests the theme of salvation and control, I am attending to how this arrangement or internment that I am *within* is made and remade with what kind of tactics deployed and effects produced.

5. Chapter Outline

Imagineering Crises: Performative histories of Rationalizing US STEM education reform focuses on two major research questions:

1. How does US STEM education reform rationalize itself? In another word, through what epistemic infrastructures are STEM empowered to empower and securitize the nation-state and individuals?

2. How were these epistemic infrastructures discussed in the first question constructed in American social/sciences and education to perform, control and preempt crises that were performatively taken up to rationalize US STEM education reform?

The following chapters are divided into two parts. The first part (Chapter 2) engages with the textual and visual materials of the contemporary US STEM education reform to answer the first question. And the second part (Chapter 3 and Chapter 4) looks at historical experiments and performances of crises conducted in American social/sciences and international institutes during and after WWII to answer the second question.

In particular, Chapter 2 starts with questioning the "invisible present" that constitutes the "leaky STEM pipeline" metaphor and image that are circulated in policy documents and research on US STEM education reform. It argues this particular metaphor is productive of and dependent on the international and domestic objects of fear that are produced and mobilized through the discourses of the global and diversity with regards to national survival. This chapter also analyzes STEM curriculum and programs, STEM-twisted children literature, and space-theme learning media to discuss how STEM education is designed as an

apparatus of security that imagines and preempts potential threats and produces learners as the subject-in-crisis.

Chapter 3 discusses how social/sciences after WWII conjured phantasmagrams of crisis through making various “containers” of the “struggle for life,” including the biological laboratory bottle, the urban “slum,” and the global Earth. These phantasmagrams not only adjusted particular temporal and spatial scales as the “real situations” but also substituting the living subjects back and forth in these “situations” to make particular groups of people as the “problem” for the collective survival and another group as the “problem-solvers.” This chapter argues technoscientific performances of the “real problem” aka the “modern crisis” authorize technoscience and a vision of the global-future as the universal means of survival but also differentially included particular kinds of life as excessive and unwanted, as unable to help themselves, and as threats to other's survival.

Chapter 4 investigates how educational infrastructures were constructed to perform phantasms of crisis and make the goal of educational reforms as preparing students and the nation-state for survival. It examines how different models of “educational pipeline” were developed to reconceptualize education in a technical and engineering language but also necessitated the use of more computers, new media, and classroom technology to make possible self-regulated--"individualized"--learning and instruction and training more experts in mathematics and engineering to develop systems models. Following that, it discussed how “educational pipeline” was co-constructed with US international aids to educational development in the newly independent countries and US educational war on poverty that targeted at the domestic "culturally deprived children" from the 1950s to the early 1970s. The

discursive-material practices of “educational pipeline” to control the quantity and quality of students and teachers in technoscience were circulated transnationally and made possible the imaginaries of “at-risk” nations and students and the emergence of international education and assessment as a new hope for securing national survival.

Chapter II. The Nation Must be Defended: Untangling the Rationality of US STEM Education Reform

1. Can the Leaky STEM Pipeline Speak?

"With infrastructure, something both huge and hidden is conjured up—a dark and indistinct shadow of a thing that needs to function in order for it not to be thought about. … With such a subservient status, infrastructure is what allows society to hold its shape as a complex set of events that form and support a stable pattern. … Systems of domination, subjection, or repression also take place in the infrastructural, so that it is not simply a manifestation or the embodiment of preexisting systems but an intrinsic part of their configuration. -- Céline Condorelli, "Infrastructure" (Speculation, Now, 2015)

"The inadequacies of our system of research and education pose a greater threat to U.S. national security over the next quarter century than any potential conventional war that we might imagine." (Road Map for National Security: Imperative for Change, US Commission on National Security)

"The STEM pipeline is leaking badly!" The proponents of STEM education reform in the US cry about the STEM crisis this country is facing, i.e., the insufficient supply of trainees for STEM industries and research (e.g., Alper, 1993; Leboy, 2008). "Fix the hole and apply energy all the way through the pipeline!" "Start the pipeline early!" (e.g., Morgan, et al., 2016) These STEM education experts get excited as they know how to repair and improve the leaking pipeline and "such is the case for the metaphorical STEM pipeline" (Allen-Ramdial and Campbell, 2014). "Diversify the STEM pipeline!" "Make STEM their home!" These education-engineers are even more excited now as they find out that the main leaks and back-flow of the pipeline are the underrepresented minorities and women and the boosting energy comes from their social identity, sense of belonging, and motivation (e.g., Allen-Ramidial & Campbell, et al., 2014). For diversity and equity! For innovation! No doubt. No doubt?

The leaky pipeline metaphor and image (see e.g., Fig 2 and Fig 3) have been circulated widely in the US education reform discourse as a self-evident articulation of

problem in terms of both national competitiveness and security (e.g., NAS, NAE, & IM, 2007; Snyder & Dillow, 2008). Scholars have questioned this metaphor by focusing on its paradox of using a single prescribed, universal, and White male-dominant trajectory to attract women and minorities into the STEM pipeline or pathway (see e.g., Cannady et al., 2014; Lyon et al., 2012; Zeidler, 2016) while another strand of critique emphasizes that STEM education should be talents based since not all students can become scientists . Since both sides of the debates regard STEM as embodiment of power that can uplift individuals, "special" groups, and the society, they have been incorporated into the normative construction of a more diversified STEM pipeline or pathway to make girls, non-white ethnic groups, and low income youth identify themselves with the field of STEM and at the same time select those who have "special talents" into the pool of future scientists (NGSS Lead States, 2013; NRC, 2012; NAGC Math/Science Task Force). "Diversity" is made essential to securing "the United State' s role as a STEM field leader" (Allen-Ramidial & Campbell, 2014) and the effort of diversifying STEM education and workforce is often carried out in the name of empowering both individuals and the nation-state.

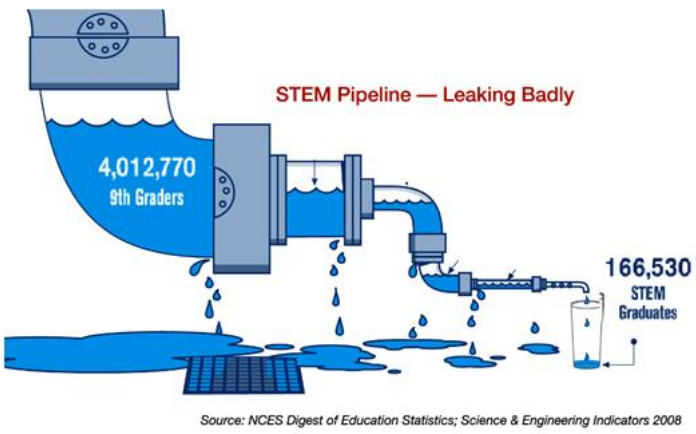
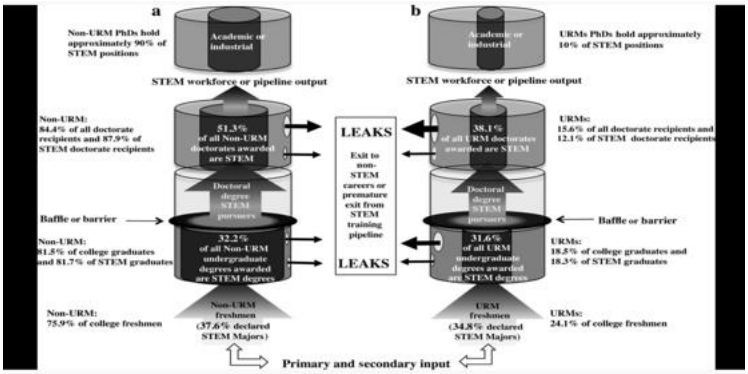


Figure 2 A horizontal "leaky STEM pipeline" (NIFA, 2016)



The reimagined science, technology, engineering, and mathematics (STEM) pipeline for US underrepresented racial and ethnic minorities (URMs) and nonminorities: the progression of non-URM and URM trainees from undergraduate to postdegree career training stages. For illustrative purposes only, the pipeline population has been divided to show the progression of non-URM and URM trainees separately. The shaded upward arrows indicate advancement through the STEM training pipeline. The baffle between the undergraduate and graduate segments of the pipeline highlights the greatest barrier to the advancement of STEM training. Gaps or discontinuities between segments illustrate that the pipeline can be discontinuous for trainees who take breaks before advancing. Leaks represents trainee attrition.

Figure 3 A vertical "leaky STEM pipeline" (Allen-Ramdial, S. A., & Campbell, A. G., 2014)

However, as René Magritte—the painter of Ceci n'est pas une pipe—puts it, "A thing which is present can be invisible, hidden by what it shows" (quoted in Lea & Pholeros, 2010). The negligible and invisible present in the "leaky STEM pipeline" (Fig 2) perverts the visible problem. See, the floor drain, where is it connected to; where and how is each pipe located; where and how is the energy extracted to install, run, and repair the pipeline; what kind of life might be destroyed and prevented by installing such a pipeline (Yes think of the pipeline struggle in the indigenous land!); and who gain the right to drink or hold the final cup of STEM "water"? By not including them in the image, we find the only visible problem is the leaks and back-flow. The pipeline is never transparent, be it material or metaphorical. The relation between the infrastructure "down there" and the emergency "above here" is not linear and causal but recursive and dispersed (Larkin, 2013).

The "leaky pipeline" familiarizes us with the water pipe in our kitchen, with the oil pipe in the Caribbean Sea, with the fear and the panic that the leaking moment induces. Very

quickly, it reminds us of the reassurance brought by the presence of the engineer who knows how to control the pipeline, with the necessity to routinely check the vulnerable parts and the linkage points that threaten the whole, and with the faith that the standardized and regulated industry can automate revision and update. The feeling of fear and security it provokes bleeds into the reality in a way that anticipates both an infrastructural crisis and its control with engineering.

What the metaphor of "leaky STEM pipeline" speaks is not only about, as some curriculum scholars have recently examined, how science-literate citizens (Ideland, 2018; Kirchgasler, 2017) and mathematically abled bodies (Yolcu & Popkewitz, 2019) are made. In addition to this scholarship that problematizes the identification of the "leaks," the feminism science studies scholar Banu Subramanjam (2009) provokes us to question sciences as a "business of laying down pipes" that are "long, dark, dingy, impenetrable tubes and masses of metal crisscrossing the terrain of industrial capital" and "that contains, constrains, limits, and cuts off the oxygen of the traveler no agency in their journey." The "leaks" are not failures but fleeing away from the suffocating journey in the pipeline. And it is this pipeline—as an epistemic infrastructure--that produces anxiety and fear along with progress and certainty that is put under scrutiny here.

This chapter will unpack how US STEM education programs and learning media are constructed as "pipelines" to imagineer—imagine, produce and control—both the objects that arouse fear of crisis and the subject-in-crisis. Although the analysis of this chapter is strategically separated into two sections that respectively focus on the making of the objects of fear and the subject-in-crisis , they are nonetheless entangled effects of the discursive

operation of the global scale, diversity, problem-solving, and the future human survival through educational practices to enact, normalize and mobilize fears. As Nicole Nguyen argues in her book *A Curriculum of Fear: Homeland Security in US Public Schools* (2016), "fear, then, is not an inherent bodily response to danger but a mediated reaction shaped by enduring cultural histories through which people come to apprehend some bodies, behaviors, and objects as fearsome" (p.42).

2. Making the Objects of Fear through the Global scale and Diversity

2.1 Mobilizing a fear of national loss through the global scale

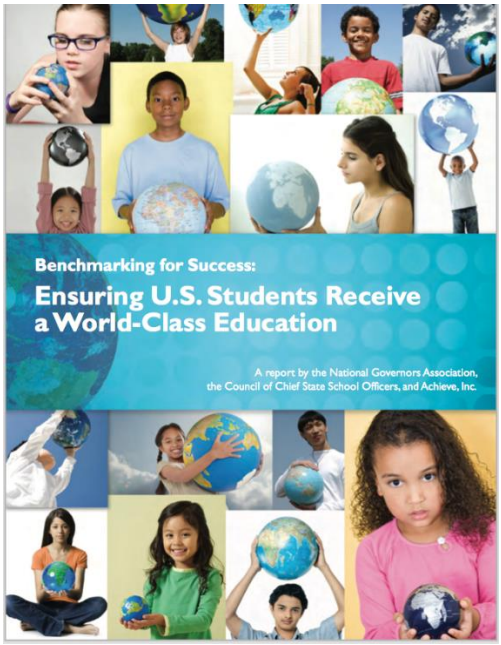


Figure 4 The cover image of Benchmarking for Success

> *"It is only through such benchmarking that countries can understand relative strengths and weaknesses of their education system and identify best practices and ways forward. The world is indifferent to tradition and past reputations, unforgiving of frailty and ignorant of custom or practice. Success will go to those individuals and countries which are swift to adapt,*

slow to com- plain, and open to change." (Andreas Schleicher, Director of PISA, quoted from Benchmarking for Success, p.19)

The unsatisfying ranking of the US in international assessment of students' performance in science, mathematics, and problem-solving (e.g., PISA, TIMSS) has been frequently cited as strong evidence for a necessity of US STEM education reform (see e.g., *Building a STEM agenda*, NGA, 2011; *the Opportunity Equation*, Carnegie-IAS, 2007; *STEM education a primer*, 2012; NGSS Lead States, 2013) . *Rising above the gathering storm: Energizing and employing America for a brighter economic future,* one of the most well-known US STEM education agenda documents, heavily draws upon Thomas Friedman's *The World is Flat* and other reports of international comparisons of national competitiveness in education, research, and economy. It highlights the "slow crisis" that the leading position of the US in global competition in scientific research and technological innovation is no longer secured and questions "whether its education system can meet the demands of the 21st century" (p.94). Hope is nonetheless manifested through, for example, the cover image (Fig 4) of *Benchmarking for Success,* which aims at providing international benchmarking for state policymakers to improve their education systems. Holding the whole Globe in one's hands is performed as the only way for students to both succeed and survive in the new world.

By participating in international assessment and aligning their own curriculum with the international benchmark that are produced and promoted by international organizations such as OECD, IEA, World Bank, countries not only naturalize and consolidate but also become dependent upon the global scale that is "indifferent to tradition" and "ignorant of

custom". The desire for autonomy and superiority in the global competition thus embodies a cruel optimism and mobilizes a national fear of loss for an imperative of US STEM education reform. The fear is doubled since the potential loss is both its control of the global world and the universal values it is assumed to inherit. This double sense of loss is well manifested in the *Opportunity Equation* report (CCNY & IAC, 2016) when it addresses the significant role of math and science in the past and future of the US:

> *"The nation's capacity to innovate for economic growth and the ability of American workers to thrive in the global economy depend on a broad foundation of math and science learning, as do our hopes for preserving a vibrant democracy and the promise of social mobility for young people that lie at the heart of the American dream."*

Although various STEM education programs, research and policies are not unanimous regarding specific pedagogical contents, strategies, and goals, we nonetheless see a consistent theme of the "global": STEM education is supposed to produce global citizens who can solve global problems and win their global competitors in the future. This global scale is a constructed epistemic infrastructure that produces both uniformity and comparability for government (in a Foucauldian sense). It proposes a transcendental unity of the world and transforms different "parts" —people, families, societies and countries—into abstract indicators of the modern development. More importantly, it makes possible to hold particular "parts" accountable for the whole world. In Chapter 3 I will historicize how the global scale was co-constituted with systems analysis in the early post-colonial era to calculate and control the world crisis and I will discuss how international education emerged with the production of the objects of fear in Chapter 4.

If the global scale produces and mobilizes fear of loss, then the common standards—or the shared agreement—of the "world best" it makes possible provides a sense of security as it prescribes what the future could be. The pursuit of security of the future enables standards to give birth to more standards. International benchmark not only sets up a standard of students' achievement but also works as a model of common language for the states and schools to identify professional norms (strategies, routines, etc.) that would make learning/teaching coherent (i.e., developing progressively), essential (i.e., commonly accepted as the most important), and equitable (i.e., high expectations for and high performances of all students regardless of social, cultural, economic factors) (NCTM, 2000; Core Practice Consortium, 2016; CCSSO, 2014; NRC, 2012) and also enable learners to solve problems in various situations (OECD, 2010; Ambitious science teaching, 2016; Jerald, 2008; NCTM, 2000). Setting up common languages and core practices are not "fashion" but "fashioned" as tools so that change can be controlled. According to *Benchmarking for Success*, the "world best" is no longer merely measured by the position one stand but the speed one run and the improvement of both the position and the speed. The universalized standard of improvement becomes a moving target and requires constant update to mobilize things and people to follow up: the "best" are those who can learn from the "best." Asian countries such as China, India and Singapore are recognized as the "exemplary learners" who quickly catch up by examining and adopting international best practices (Jerald, 2008; OECD, 2010).

These "exemplary learners" from the "East" are not taken merely as the new "reference societies" for building the common standards of (trans)national educational

reforms (Sellar & Lingard, 2013) but also the objects of fear that are constantly used to mobilize the initiatives of STEM education for the future security of the US. The increase of investment and graduates in science and engineering in China and India is portrayed as the most powerful tool for these countries to realize their ambition for dominating the world and particularly dominating "us/US"(Friedman, 2005; Sander, 2009; NAS, NAE, & IM, 2007; Hue et al., 2017; NAE & NRC, 2009). And the reliance of the US knowledge economy on international students and workers, especially those from Asian countries, is seen as the cause of national vulnerability in a new global war on mind (NAS, NAE, & IM, 2007, p.112). The rival in a war is not only to conquer but also to know. the National Academy of Sciences regards American citizen's lack of foreign cultures and foreign languages as a threat to the security of the U.S as well as its ability to compete in the global marketplace and to produce an informed citizenry (Jerald, 2008; NAS, NAE, & IM, 2007; NAE & NRC, 2009, p.31). STEM-related service learning is designed to challenge students cognitively, physically, and emotionally by asking them to venture across cultural boundaries, to interact with unfamiliar populations, and to move out of their comfort zones so that they can develop expert cognition (see e.g., Furco, 2010; Department of Education, 2016; NAS, NAE, & IM, 2007, pp.88-89). The "other" as well as the "boundaries" are made for the self to en/counter in order to gain the competences to secure and master the future.

The imaginaries of the "techno-orientals" have appeared in various media in both the "East" and "West" (e.g., BBC documentary "Are our kids tough enough," Hollywood Sci-fi movies such as *Matrix, Dr. Wonder, Cloud Atlas*). They are not to create a "new" linkage between the "East" and technoscience but, rather, to acknowledge and refashion the

historically sedimented relation between techno-scientific solutions and global problems and also between "East" and power of technoscience. These two intertwined phantasies are well manifested in the educational film *Dream Big: Engineering Our World* (2017) which celebrates the glory achievement of engineering and encourages more children to become engineers in the future. The film starts with an emerging view of the earth from the International Space Station to demonstrate that only engineers can both imagine and realize the biggest human dream—to see the real world, to solve universal and perennial problems, and to keep people safe. Embedded in the dream of the world and the hope of technoscience is the fear of vulnerability. Asia(n) and women, who are normally portrayed as more vulnerable, are given particular attention in the film as both the subject and object of engineering. For example, the first story is an autobiography of a Turkish woman engineer. She talks about how her identity was transformed from a "girly girl" to a professional engineer based in the US by an earthquake in her childhood and in order to make structure safer during earthquakes, the object of her studies is countries like Nepal that is "very poor" and where houses are built "without any engineering design."

Mythologizing the East is another means to produce fear of the unknown threat. The second story is about the Great Wall in China. It is a story of how a civilization is secured by an engineering marvel that is simply made possible by the secret of sticky rice. With the typical oriental(ized) background soundtrack, the Great Wall appears as somewhat lighthearted oriental magic. All the violence and labor that made possible this "worldly" achievement are occluded as not relevant. The picture quickly moves from ancient China to modern China, represented by Shanghai, "the most populous city in the world." The story of

the Shanghai Tower is told as if it is, again, a pure magic trick of Chinese engineers who can strike both the human-made problem—urban population density and the natural danger—typhoon. But the question of who the legible residents are to be hosted and protected by such an engineering project is elided.

2.2 Mobilizing a fear of national vulnerability through diversity

STEM education reform mobilizes fear not only through the discourse of the global Other but also its domestic twin in the name of diversity. Girls, Black and Latino students, ESL or new immigrant students, rural children, are demographic categories of diversity that are used to account for the national vulnerability—"the leak of STEM pipeline" (see e.g., *STEM 2026*). For example, *Building a STEM agenda* asserts that "because these minority youth represent an increasing share of the nation's student population, the need to close this gap and the challenge it presents to raising overall math and science scores will only grow" (pp.13-14). At the same time, "diversity" is taken up as a solution to the vulnerability that ethnically diverse students are thought to embody and cause. The "leakage" of girls and working-class youth of color from STEM pipeline has been attributed to their lack of cultural identity—expressed in terms like "interest"—with STEM disciplines (Seyranian, et al., 2018; ACT, 2014) in addition to their limited access to STEM space. Multiple STEM education programs and research encourage and/or provide particular women scientists and engineers as role models to inspire girls to "empower" themselves by constructing an identity of becoming a future engineer. By engaging with stories of these "powerful" and "successful" engineer women, girls can gain an "empowerment certificate" that is supposed to lead them to desire

and realize the promise of STEM: financial and job security, mobility and flexibility, doing cool stuff, working with talents, socio-cultural-politically neutral, and building the real world and solving the real world (see the stories and interviews provided by, e.g., EOPUS, 2013, and on the websites that promote STEM careers for girls, such as, careergirls.org; engineergirl.org).

Through various autobiographies of and interviews with women role models and self-empowerment protocols provided online, girls (of color) learn to conform to the normative values that have been attached to STEM. The embedded assumption of these "empowering" programs is women and other "diverse" bodies and minds are lack of quality for the growth of their own and the nation-state. These aesthetic tools of self-emancipation historically resemble the exemplary tales of colonial slavery that was promoted by abolitionists to prove the evolutionary development of human reason and freedom. Following her analysis of the take-up of the autobiography of Olaudah Equiano, a late-18th century African slave who gained freedom, Lisa Lowe (2015) insightfully argues, "it is a historiographical matter of which archives, events, temporalities and geographies will be privileged in the situating of Equiano's story. Moreover, it asks us to consider how liberalism requires mediation through an aesthetic form that encourages readers to understand the emancipation of the individual as if it were a collective emancipation." (P.50) Rather than empowering the minoritized students, the narratives of these STEM role models performatively reenact the colonial rationality that disempower them.

This paradox of empowerment and disempowerment is manifested by the Security-focused STEM programs that particularly target at "at-risk" American youth to not only make

them employable but also militarize their bodies and minds to make the US less vulnerable to attacks. For example, Science and Technology Academies Reinforcing Basic Aviation and Space Exploration (STARBASE) Youth Program, sponsored by the US Department of Defense, aims at "raising the interest in learning and improving the knowledge and skills of our nation's at risk youth so that we may develop a highly educated and skilled American workforce who can meet the advance technological requirements of the Department of Defense" by providing them with 25 hours of stimulating experiences at National Guard, Navy, Marine, Air Force Reserve, Army and Air Force bases across the nation. Throughout the websites of this program operated at different states, youth of color, native Americans, and girls can be found as the main participants. [6]In Maryland, a new bill has been established to fund the states' historically black colleges and Baltimore City Community College for their cyber warrior diversity programs.

"Diversity" in these programs is not a synonym of equity but an infrastructure that is central to the nation-state's needs for security and survival. Jane Harman, US congressperson and House Intelligence Committee stated in 2004: "we can no longer expect an Intelligence Community that is mostly male and mostly white to be able to monitor and infiltrate suspicious organizations or terrorist groups. We need spies that look like their targets, CIA officers who speak the dialects that terrorists use, and FBI agents who can speak to Muslim women that might be intimidated by men." (Quoted from Nguyen, 2016, p.35) The effort of recruiting "diverse" population into security-related STEM training and workforce is the product and tool of the cultural turn of the "war on terror" (Gregory, 2008).

[6] Retrieved from: https://dma.wi.gov/DMA/starbase/about-us.

The economic perspective to education also turns these minoritized "diverse" students from "deficit" to "resources" who have to be discovered or used for the "non-diverse" to gain the global competence. For example, *A Framework for K-12 Science Education* (2012) recognized that it was important to embrace diverse customs and orientations that members of different cultural communities bring to various learning contexts as a means and assets of enhancing learning. Teach Math project requires preservice student teachers to develop and enact instructional practices that capitalize on students' diverse linguistic, cultural, and community-based knowledge to support their mathematics learning through, particularly, selecting and interviewing students who are socio-culturally different from them. Core Practice Consortium also propels teachers to take students emotional, social, and intellectual resources seriously in disciplinary learning. Cultures of "others," such as Alaska Native Communities (Department of Education, 2016) and earlier Egyptian, Chinese, Greek, and Arabic cultures (NGSS Lead States, 2013) are acknowledged for their historical contribution to Western sciences rather than their own cultural value. In these cases, differences are not only particularly chosen but also objectified as capital and instrument to certify and brand those who can "experience" these differences as having competency of "inclusion." Ironically, those who embody the exclusively chosen differences are only treated as the object to be included and integrated rather than an equal subject who also live with and deal with differences.

3. Making the Subject-in-Crisis through Problem-solving

3.1 Preventing Surprises by Creating Them: From the DARPA R&D to the Education R&D

What US innovation agendas (e.g., *American Competitiveness Initiative*, 2006; *Rising Above the Gathering Storm*, 2010*; Opportunity Equation*, 2016; *Benchmarking for Success*, 2008) express is less about how essential STEM education is to innovation than "the normality of a generalized crisis environment" (Massumi, 2009) where education and STEM research are constructed as infrastructures to culturally and materially prepare for an ecosystemic crisis. Within an ecosystem—system of systems, each system is haunted by endemic threats not only specific to their own operative domains but also to their neighbors' and the relation of each system to threats is isomorphic (Massumi, 2009). As Brian Massumi (2009) observes:

> *"in a crisis-prone environment, threat is endemic, uncertainty is everywhere; a negative can never be proven. Positive military response must then be ever at the ready. The on-all-the-time, everywhere-at-the-ready of military response operatively annexes the civilian sphere to the conduct of war. Civilian life falls onto a continuum with war, permanently potentially pre-militarized, a pole on the spectrum."*

STEM and its education are taken as isotopic and unified pipelines that crisscross each other as parts of the whole national ecosystem of security.

Taking the intellectual, the industrial, and the military systems as isotope of one totalized ecosystem of crisis does not just happen as idea(l). It has been materialized through assembling knowledge, techniques, polices and money into fundamental epistemic infrastructures of both scientific R&D and military defense projects to deal with the unknown threats. More importantly, these epistemic infrastructures have also been used for the research on learning and educational technology underlying US education reform and

innovation since the 1960s. As Douglas Noble (1989) observed in the late 1980s, emergent research in computer-based education, intelligent computer-assisted instruction, and cognitive science research on artificial intelligence and learning strategies had been sponsored by military services including the Defense Advanced Research Projects Agency (DARPA) which was created in 1958 in response to the Soviet launch of Sputnik. DARPA has not stopped providing the epistemic infrastructures of US education reforms for the last three decades. The model of innovation—the term innovation is interchangeably used with R&D in these projects, based on which DARPA developed for defense research projects including the moonshot, the Internet, and GPS, is now employed by the Department of Education (ED) to direct US education reform (Shilling, 2014).

According to Russell Shilling (2014), who is a former officer at DARPA and current executive director of STEM office at ED, the DARPA model can be understood as *Pasteur's Quadrant* (Fig 5), a category invented by Donald Stokes to describe basic research that aims at solving specific and immediate problems "based on having a clear vision of success even when all of the pieces of the puzzle are not yet known." STEM education programs are created within this frame as "an engine for breakthrough innovation" (Shilling, 2014).

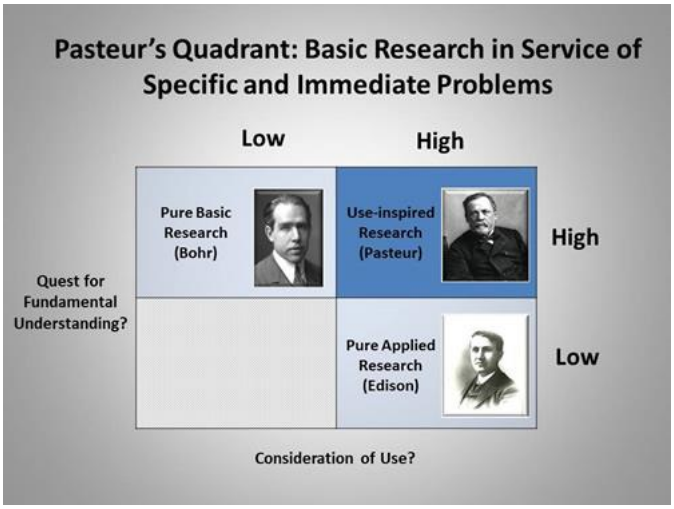


Figure 5 Pasteur's Quadrant

Pasteur's Quadrant means to avoid both the goal-less situations in pure basic research and the non-competitive products in pure applied research. It promises to achieve the DARPA mission, which is "the lesson that the U.S. government learned from the launch of *Sputnik*: The best way to prevent surprise is to create it" (Dugan and Gabriel, 2013). To create surprise, DARPA programs use fixed durations and limited tenures to stimulate a sense of urgency and keep researchers intensely focused. They also regard risk-taking and tolerance of failure as the essential elements of innovation, however, on the condition that the possible failure has been evaluated in advance to guarantee that it can generate other valuable things and the failure can be identified within a limited lifespan so any unproductive work can be ended in time (DARPA, 2016).

Moonshot, which might be one of the best examples of the DAPRA principle, has been taken up as an metaphorical approach to education reform.[7] It turns the goal of

[7] See, for example, on the following websites: https://www.brookings.edu/research/shooting-bottle-rockets-at-the-moon-overcoming-the-legacy-of-incremental-education-reform/;

education into a fixed albeit controversial one and students into the bottle rockets and weapons that are to be engineered to shoot far. The lesson that education reformers are asked to draw from moonshot is less about a success of science and engineering than how panic induced by the race for supremacy made possible revolution. This year, the Fordham Institute and the Center for American Progress initiated a joint project "A Moonshot for Kids" premised on "that the U.S. will make significant gains in real education outcomes only if it develops and deploys bold new — sizable and scalable — approaches that build on the best ideas from the private, public and nonprofit sectors."

This principle of inviting risks and failure within the goal of solving a given albeit "bold new" problem within a given situation has been enacted in STEM curriculum and learning where "setbacks, or failures, are viewed as part of the learning progression and are associated with encouragement to try again using a different approach." (Department of Education, 2016) Ignorance and failures are accepted not because they challenge the dominant ways of knowing but because taking risks are necessary for harvesting the biggest rewards.

The DARPA model not only turns uncertainty into an object of calculation but also constructs a particular kind of subjectivity by building a controlled environment of danger to provoke the sense of fear and then transform it into moderate excitement. For example, the design of STEM learning ecosystem adopts this model to nurture students' STEM identity (see in e.g., stemecosystem.org; NGSS Lead States; NRC, 2012) that involves interest,

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https://fordhaminstitute.org/national/commentary/fordham-cap-moonshot-kids-competition-now-open; https://fordhaminstitute.org/national/commentary/musings-moonshots

experience, enthusiasm, and self-perception of competence in STEM. It is supposed to make "STEM learning irresistible" (nysci.org) and make students "disappointed to hear the bell ring" (pltw.org). The DARPA model provides both epistemic and affective foundation for the "habits of mind" "engineering design process" in *Engineering in K-12* (2009) and *NGSS standards* (2013).

The following sections will examine how the DARPA model is materialized through STEM learning to create an imaginative space of potential threats and transforms students' shame and fear of failure into excitement and a spirit of risk-taking and resilience (see in e.g., NAS, NAE, & IM, 2007; DE Office of Innovation and Improvement, 2016). This part first explores how classic fairy tales in children's literatures such as *Three Little Pigs* are adapted as STEM readings (e.g., Troupe & Tejido, 2019) to incite children's interest in STEM as a critical tool to protect the independent self from the dangerous wolf/enemy. Second, it provides a visual analysis of various STEM-related learning programs and materials including Space-themed educational programs (e.g., Space Camp; NASA Space STEM education program), video games (e.g., Minecraft; Surviving Mars; Stellaris), experiential learning in museum (e.g., Beyond Spaceship Earth exhibit in Indianapolis' Children's Museum), and popular science media (e.g., National Geographic Mars Program). These programs and materials are designed in a way that makes children and adults embody the empowerment of human beings through STEM-based colonization of outer space as the "terra nullius" to make a risk-proof future. I argue that US STEM learning activities has been made as an apparatus of security and technology of self to invite risks—imagined and

actualized—in order to produce the liberal citizen-soldiers who can defend their homes—in both its literal and metaphorical sense—from anticipated threats—the unknown others.

3.2 STEMizing the Three Little Pigs and the Wolf for Survival

In general, children's literature such as fairy tales is designed intentionally to produce pure imagination in order to provoke children's excitement and curiosity of the world without a promise of resembling the real. It is nonetheless performative and constitutive of the real by creating an imaginative space for a particular subjectivity to be intelligible. However, for children's literature that is written and used particularly for reiterating certain norms, it is a performative phantasmagram that, by simulating the real world and inducing intense emotions, regulates what to know and feel and how to correctly respond to them.

The most popular fairy tales that are "twisted" for low-graders' STE(A)M learning at classrooms, public children libraries, online teaching videos, and home include *the Three Little Pigs* and *the Red Little Riding Hood*. Both stories are interestingly featured not by any direct relation to science but, rather, the confrontation between a sneaky enemy—the wolf—and a vulnerable albeit resilient self—the little girl or the little pigs, not just at any place but home! Here I will analyze the adaptation of the story of the three little pigs (3LP) in STEM curriculum and learning to explore how an interest in and power of STEM is performed and naturalized through an imaginary of the confrontation between the self and the other at home.

While an earlier adaptation of the 3LP story by Jon Scieszka and Lane Smith (1989) focuses on how the "truth" could be told and contested from different perspectives, the current "STEM-twisted" versions, such as *What's the Matter with the Three Little Pigs* (Troupe and Tejido, 2019), shifts the emphasis to the "matter." That is to say, whatever the

"truth" is—whether the wolf intentionally destroys pigs' home or he just has a bad sneeze, what matters to the little pigs is to build a stronger home to protect themselves from any danger (see e.g., STEM curriculum planning guide developed at the Dayton Regional STEM Center[8]), such as the hurricanes in Houston, Florida, the Caribbean and Central America.[9] The "twist" of this story is not simply adding more concepts and knowledge of STEM into the original story but portraying the problem and the solution—STEM—as a value-free matter of fact.

Like any children's story, saying it is value-free is no more than a white lie of the adult storyteller. It is particularly so when the story is pedagogically designed as a metaphor of the real world so that students could use what they learn from the story in their daily life. Let's review what is the invisible present in the Troupe & Tejido's version. The story starts with a crowded, noisy, chaotic scene where the pig mama is sad to ask her three eldest children to leave home so there would be more space for the family to live. All the subsequent problems these little pigs will encounter seem to stem from this overcrowded situation, which has been a historical phantasm that I will discuss further in Chapter 3. Alice, the elder sister, is the most STEM-literate child who "loved reading about how things worked. 'Matter is the stuff that's around us', she explained. 'Everything in the world is matter: you, me, mud, this house, that wolf on TV…'" Matter matters to "keep us safe from the wolf." However, Alice is not the only one who is good at STEM in the story but also the wolf. He knows how to change the states and shape of matter to achieve his goal rather than

[8] Retrieved from: http://daytonregionalstemcenter.org/wp-content/uploads/2013/08/Fractured-Fairy-Tales-Web-version.pdf
[9] Retrieved from: https://www.sadlier.com/school/sadlier-math-blog/three-little-pigs-math-stem-lesson-plan-template-grades-5-6-steam-lesson-plan-template

just huffing and puffing. The scientific wolf also appears in other versions like Fetzner & Lawhun (2000) which offers a lesson of how to use simple machines to solve problems—to get into the little pigs' home. If the wolf is upgraded with STEM so should you! A science attitude survey is provided at the end of the book. Attitude surveys, as a historical invention in the early post-war era (Murphy, 2017), is not merely an instrument to collect attitude but an epistemic infrastructure that is imbued with and at the same time redirecting and constructing affects such as aspirations and fears. Although STEM is portrayed as value-free knowledge and skills—it can be useful for both pigs and wolves, the science attitude survey nonetheless encourages students to identify themselves with the goofy and aspirant scientific wolf who can achieve whatever goals he desires by using his mind.

Students' future identity as engineers who are the safe keepers and problem-solvers is made as the starting point of other STEM learning activities that are developed based on the 3LP story (e.g., the Center for Innovation in Engineering and Science Education at Stevens Institute of Technology[10]). The Engineering Design process (NGSS Lead States, 2013) is taken as the guarantee of home security. Fans and hairdryers are used to create the wind that simulates both the big bad wolf's blow and the natural hurricane. However, it is the wolf mask[11] rather than the wind itself that brings the fear and excitement that STEM learning requires to induce children' "natural" interest in science.

3.3 Moon to Mars: Making the Mars Generation, or the Future Colonizers?

While 3LP are reiterated as STEM-literate citizens who can protect themselves from danger, Curious George, as an American cultural icon, "has become an educator of STEM-

[10] Retrieved from: http://ciese.org/curriculum/engineering/three_little_pigs.html

[11] Retrieved from: http://www.sweetsoundsofkindergarten.com/2015/06/the-3-little-pigs-stem-challenge.html

based curiosity" through the Google Nexus advertisement, PBS programs , and national travelling children's museum exhibits (Schwartz-Dupre & Parmett, 2018). The little curious explorer who discovers the world by taking risks and making troubles is now equipped with science and technology. It embodies and re-enacts the frontier narrative that has been circulated to rationalize colonial and neo-colonial practices. As Schwarts-Durpre (2018) argues, "if children are taught to learn from George's curiosity it would be fair to assume that the means they employ to be curious are without consequence as long as they justify a positive desire to learn about the unknown."

Danger is not taken for considering consequence or suffering of the land that is "discovered" or "explored" but merely as means to produce the future space colonizers. Spending $999 for a course, participants of Space Camp hosted by the US Space and Rocket Center are trained to become "the next generation of explorers" who are "engaged in STEM careers" by "overcom [ing] 'anomalies,' obstacles and self-doubt" (quoted from Dr. Deborah Barnhart, the CEO of Space Camp 2019 program). Similarly, in the Beyond Spaceship Earth exhibit hosted by the Children's Museum of Indianapolis (see Fig 6), simulation of dangerous scenarios in space was used to arouse children and adult's excitement about space exploration and STEM. And the Mars Society set up an Education Department to instill curiosity and braveness that "our civilization lost" into young people to realize the human exploration and settlement of Mars, "an event that would change human history." Unfortunately, this "civilization" that is built upon dispossession through technoscience has never been lost and the end of "human history" it attempts to record has also not changed, but, rather, become

even more extensive and deeply entrenched through the new technology of virtual media used for simulation of space exploration.

Figure 6 Museum display entitled "Space isn't safe" [12]

Virtual media is not a mirror of the real world but constitutive and coextensive of the real. What it creates is not a fantasy but a phantasma that produces both possibilities and impossibilities of, for example, how to see and build the relations between technoscience, education, and the world. Microsoft has been particularly successful and active in creating such phantasmas of technology as both the means and goal of education and international development. It constructs Microsoft showcase schools, the Windows mixed reality platform, and video games such as Minecraft to "get students exposed with the challenges of industrial revolution 4.0" and "connect students' love of technology to a STEM curriculum that will prepare them for their future careers."[13]

However, when teachers and parents are celebrating how Minecraft could help engage students in learning STEM to empower their future, and when the gamers are learning lessons

[12] Retrieved from https://www.nasa.gov/offices/education/seap/Beyond-Spaceship-Earth.html

13 Retrieved from https://customers.microsoft.com/en-us/story/mrsm-edu-k12-xbox-minecraft-malaysia https://customers.microsoft.com/en-us/story/nsw-edu-minecraft-australia

about entrepreneurship through Minecraft,[14] few question the political, economic, and cultural assumptions of technological exploration and construction of the world that are embedded in the game's mechanics (Dooghan, 2019). As Lopez et al. (2019) demonstrates, the "freedom" Minecraft promises to attract teachers and learners is predicated upon employing "terra nullius" as the legal technology to explain and sustain British settlement and "Indigenous" dispossession. Moreover, Minecraft habituates the individual player not only to repetitive labor but also the belief that it is merely the freedom to work that provides security, prosperity and progress. However, as Lowe (2015) demonstrates, the colonial production of "free" Chinese laborers at the turn of the nineteenth century to end slavery in the West Indian and North American colonies was a utilitarian experiment in social engineering and industrialization in both England and its colonies and "the desire for promised freedoms came to discipline and organize varieties of social subjects" (p.46).

The paradox of learning how to tackle real-life issues through an utopia world is nonetheless resolved when the rationale of making such an utopia—the telos of human world is to make technological progress for survival and superiority—has been recursively produced, actualized, and normalized through contemporary extensions of settler colonialism. The game's emphasis on resources collection and ultimate survival on an anonymous island echoes with the early environmentalism discourses of the "resource frontiers" that are made possible by Cold War militarization of the Third World and the growing power of corporate transnationalism. As Tsing (2005) well illustrates, this frontier-making which has the legacy

14 Retrieved from https://www.player.one/minecraft-secrets-six-lessons-about-business-entrepreneurship-i-learned-playing-385174

of imperial expansion designates the wildness and the civility, the backward and the progress and thus justifies entrepreneurial “open-up” of landscape. As an unpredicted result of the early environmentalism movement, a spreading frontier culture is created. This frontier culture is first of all conjuring, linking and contesting multiple, divergent claims about temporal and spatial scales to produce a spectacular accumulation for investment, production and consumption. The term “spectacular accumulation” pinpoints how an anticipatory mechanism—accelerated time and increasingly interconnected globe—work to govern and direct people’s present action that is supported by scientists, technicians, entrepreneurs, educators, and civil servants as a community of experts in developing and using models.

Exclusion of different “others”—creepers and villagers in the game—from being not only experts of development but also legible players in Minecraft “parallels the ongoing U.S.-led ‘War on Terror’’ that serves as backdrop to the game’s release and popularity” (Doogan, 2019). These “others” become merely hostile, uncivilized threats to be removed or utilized for the “player” to build more colonies and collect more resources while the player, who is the de facto alien, could freely build and rebuild the territory without the consent from its existing inhabitants. As Dooghan (2019) argues, “the illumination–darkness dichotomy of the Minecraft makes real what is metaphorical in much conquest, both historical and contemporary. ... Hostile creatures in the game are irredeemably so—they cannot be enlightened. Their absence is not the result of explicit violence but the subtle violence of cultural shift.... Where the player brings technology and illumination, what came before can no longer exist.” Although the “others” are not legible players, they are affectively invested as indispensable condition that induces risks and death—the limits of life for the player to

confront to gain both economic rewards and a sense of freedom—or in Mbembe (2003)'s word, to become the Hegelian human subject.

"Scarcity Rules All!" The Minecraft gamer summarizes the core of the gameplay, "the real resource lesson in Minecraft isn't the existence of scarcity—the lesson is the importance of taming it."[15] Scarcity provides a clear goal to achieve within a limited time-space: the more and faster, the better and safer. To overcome the natural limit and threat to human survival through exploration, occupation, and the removal of others was taken by imperialists and colonizers in the 19th century as the necessary condition for becoming the enlightened and autonomous subject. This rationality of settler colonialism continues to be bluntly glorified, played out, and justified by the simulation of space exploration and planetary apocalypse in various sci-fi movies and video games that have been integrated into formal and informal STEM education programs in the US.

The cultural representations of interstellar voyage resonate with the previous English travel literature such as Robinson Crusoe to extend the nomos of the Earth (Schmitt, 1950, cited in Lowe, 2015) to the nomos of the unlimited space. From the Moon 2024 Education Guide to the Mars Curriculum, NASA's Office of STEM Engagement invites students to not only imagine but work on how to live on the Moon and the Mars healthily and happily on a day-to-day basis. The survival-based tasks/lessons are not only for preparing future astronauts or STEM professionals but future space colonizers for whom those challenges, such as how to balance work, recreation and sleep in very limited spaces or how to mine and process the

15 Retrieved from: https://www.player.one/minecraft-or-how-succeed-business-without-really-trying-minecraft-business-secrets-386464

ilmenite, become real-life daily problems. Through other simulation learning activities conducted in, for example, Space Camp, distant, specialized, and militarized missions for astronauts or fighter pilots are transformed into exciting albeit daily needed "21st century learning skills required in the workplace" (Space Camp 2018 program; Mars Colony STEM).

National Geographic partnered with Journeys in Film: Educating for Global Understanding to produce a film entitled MARS. The film blends a scripted drama set in the future and a number of unscripted interviews and documentary footage with today's space researchers and entrepreneurs. By mixing the future with the present, and fiction with reality, the film sets up a discursive arrangement to make intelligent and legible the idea that colonizing Mars is only feasible when the whole future generation is made to believe "it is everything" to risk their life for human's future survival. To justify colonizing Mars is for the benefits of the whole humanity, the film internationalizes MARS by suggesting all technologically advanced countries are participants of this expensive and dangerous undertaking. A Mars STEAM curriculum guide is also developed by the National Geographic based on this film to prepare students step by step for "landing, surviving, and ultimately thriving on the red planet." The imaginary of the "Challenges of the Unforgiving World" (Fig 7) that Martians must tackle in the 2030s echoes well with the game mechanics of Minecraft and re-enact the colonization plan historically carried out by European colonizers across the Pacific and the Atlantic: since our neighbor planet "remains unexplored" (Mars Global Educator Guide), our students and scientists are entitled to constantly collecting information about this "terra nullius" to increase human knowledge and terraforming it from an "enemy" to a more homelike place for our selected future colonists to settle (Mars Global Educator

Guide) . Mapping is performative. It creates and legitimates a particular kind of worlding. The visualization of the Mars colony in this curriculum not only prepares students to become the future colonizers for their own survival but also re-authorizes the linear history of human progress told by the colonizers to rationalize dispossession and exploitation.

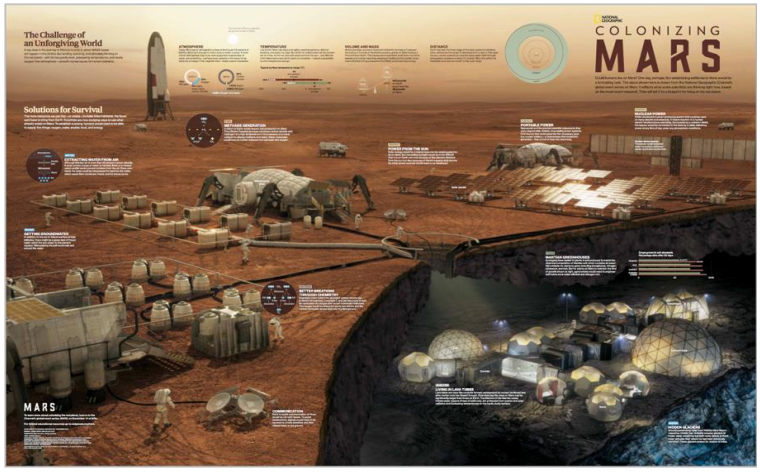


Figure 7 "Colonizing Mars: The Challenges of the Unforgiving World"

These narratives of Mars or Moon settlement in the STE(A)M curriculum can be easily found in sci-fi and sci-fi-based video games themed on space colonization. For example, the tasks of the game *Surviving Mar* that "deep dives into the actual logistics and challenges of building a colony" clearly resonates the lesson plans and learning activities in STEM curricula on Mars:

> *• Building a sustainable colony in space: Building on a planet not fit for human life challenges you to build a smart, functional colony. Bad planning isn't about traffic jams, it's about survival of your colonists.*
>
> *• Individually simulated colonists: Each colonist is a unique individual with problems and strengths that influence the needs and behavior of the other colonists.*

• Futuristic Space Dome construction: Create colonies that value science over everything else, while tired workers drink their pay away at a local bar or attempt a utopia among the stars.

• Randomized research tree: Combine static and random research through experimentation, which allows for a different experience for each journey through the game. Attain new scientific breakthroughs by exploring the uncharted terrain of Mars's surface.

• Unique retro-futuristic aesthetic: A sleek, modern take on the bright futurism of the 1960s. A time of exploration and adventure.[16]

Game, particularly strategy game and exploration game, as a mixture of reality and fiction has become an active medium for both STEM learners and US military trainees to perform real-life situations/problems/solutions/skills through constant actions—touching, wearing, pressing, steering—in simulated worlds. It enables performance of identification between the reality simulated and the reality known and lived by the player/learner/soldier. As game theorist Galloway (2006) argues,

"The time spent playing games trains the gamer to be close to the machine, to be quick and responsive, to understand interfaces, to be familiar with simulated worlds. This was Ronald Reagan's argument in the 1980s when he famously predicted that action video games were training a new generation of cyber-warriors ready to fight real foes on the real battlefield (itself computer enhanced). Today it is evident that he was right: flight simulators, Doom, and now America's Army are all realistic training tools at some level, be they skill builders in a utilitarian sense or simply instructive of a larger militaristic ideology" (Pp. 70-71).

When the player performs the roles of learner, citizen, and soldier at the same time in games that simulate war, apocalypse, and planetary colonization, as dramatized in the sci-fi movie *Ender's Game* (2013), we witness both the martialization of culture and the culturalization of war, which is termed by Gregory (2008) as the culture turn of the "war on

16 Retrieved from: https://www.paradoxplaza.com/surviving-mars/SUSM01GSK-MASTER.html

terror." The tactic of simulation that realize this culture turn of war has been taken up by the STEM learning media introduced earlier. It is to target with optical detachment that produces "an electronic disjuncture between the eye and the target" and a seamless move "from the virtual to the real to mistake the one for the other" (Gregory, 2008). The US military reduced the "enemy space"—the living space of Afghanistan and Iraq—into an abstract albeit calculative space on a display screen composed of simple objects such as poker chips, Lego bricks, and shipping containers but emptied of bodies (Gregory, 2008). By turning living targets—either human or non-human bodies—into mere objects, the violence conducted by the US military on the ground is obscured and the public is desensitized to its outcome. STEM games and learning programs that simulate space exploration and settlement normalizes both the techniques and effects of optical detachment and prepares learners affectively as future warriors who can respond spontaneously in the "mixed" reality without taking account for such mixture.

Recently, there have been curriculum scholars adopting postcolonial and biopolitical lens to look for the invisible power relations and historical conditions that make possible this link between STEM education—as well as education of each area in STEM—and empowerment. As they argue, science and STEM education practices in the US and many other western countries not only carry colonial legacy, exercise epistemic violence, and produce racialized citizens (Ideland, 2018; Kirchgasler, 2017) but also serve as technology of control that capitalizes students' life to perpetuate neoliberal economic systems (Pierce, 2013; Hoeg & Bencze, 2017; Zouda, 2016). It is not these students who are empowered but the

socio-cultural-political norms that have been attached to STEM through the historical and ongoing practices of colonizing, racializing, and economizing particular "kinds" of knowledge and life. The salvation theme embodied in the STEM promise not only depoliticizes the division and struggles those "disadvantaged" people face, but also naturalizes and thus perpetuates the exiting hierarchy and violence. The following two chapters will historize how STEM was performatively naturalized as a powerful apparatus for securing home and differentiating particular populations at home and abroad as vulnerable or potentially dangerous through technoscientific experiments and aesthetic tactics.

Chapter III. Constructing Technoscientific Phantasmagrams Of Crisis

This chapter explores how the "real world" and the crisis of life living in it were performed and imagined through social/scientific experiments and calculation. While science is often deemed as so objective—defined as impersonal and identical with reality—that it can solve the major, if not all, social problems, the miniaturization of the world by adjusting the temporal and spatial scales and substituting the living subjects back and forth in scientific experiments—in both laboratories and fields—are nonetheless constitutive and productive of cultural imaginaries that are imbued with affects to mobilize thoughts and actions. As Orr (2006) argues, "The conceptual abstractions that undergird this miniaturization are not, initially, mathematical abstractions, although they stage and will later permit quantitative and statistical analysis. The abstractions are initially founded elsewhere, in the rather commonplace symbolic operations of metaphor and analogy." (p.92) Metaphor and analogy in social/science experiments operate as phantasmagrams—the conceptual, material and affective configuration of the real that make possible albeit invisible translation, transformation, and associations. By performing the cross-species "struggle for life" with a bottle of insects, transferring a "panic crowd" into a small group competition, representing the "urban decay" with a rat hell or a "slum culture" in Mexico city, and turning the global Earth into a computer system for optimizing its operation, the circulation of a crisis of survival within a finite time-space through these social/scientific performances not only self-referentially authorized technoscience and a vision of the global-future as the universal means of survival but also differentially included particular kinds of life as excessive and unwanted, as unable to help themselves, and as threats to the survival.

1. Performing Phantasms of Crisis in the Laboratory Bottles

1.1 Biological experiments on the "struggle for existence"

We are haunted by extinction. Not only threatened by the sixth mass extinction of plants and animals, by climate change, the impoverishment of the soil, global pollution, and other environmental disasters, but also haunted. (Frédéric Neyrat,2019)

Although WWII left the catastrophic phantasm of human extinction that still perpetuates today at least in the Western societies, the ideas of species extinction (Cuvier, 2003/1813; Lyell, 1992/1830-1833) and indiscrimination between the human race and populations of animals or plants (Malthus; Darwin) had become intelligible and popularized through the development of evolutionary ideas in biology and geology during the 19th century (Sepkoski, 2016; Larson, 2002). From the early to the mid-20th century, biologists and later ecologists continued to engage themselves with demonstrating earlier theories or create new theories about "natural selection and the struggle for existence" (Pearl, Forward of Gause's dissertation, 1934). However, the younger generation of biologists at that time were pushed by other siblings disciplines such as genetics to attempt new methods—experimental and statistical approaches—to provide evidence for any "purely logical and theoretical discussion" about organisms' struggle for life (Gause, 1934). Population problem, particularly the rates of birth and death within a constrained condition, which sit on the intersection of biology and statistics, became an ideal problem for them to experiment those new quantitative methods.

The American biologist Raymond Pearl attained his fame for creating the first biological experiment of population growth in the 1920s. Pearl (1930) used a closed bottle filled with fruit flies to capture a law he proposed as "the logistic curve," also called "the S curve"—an inevitable saturation and then extinction of a population in a finite space when there was no hinderance to growth—to account for firstly the development of the US population and then the growth of all human and animal groups (Locher, 2013; Murphy, 2017).

What was transformed into an experimental object was not only human population, but also a tempo-spatial relation between the life of one homogenous population and the scale of their economic productivity that was represented by the glass bottle. Pearl's model was not only to predict the rate of birth and death but also to manage it by adjusting the scales. As Murphy (2017) correctly argues, "for Pearl, the 'business of conquest' in colonized Algeria wrought the S-curve in the births and deaths of Algerians. Here, the effect of the economic and colonial milieu on shaping human futures supplanted other 'natural' processes" (p.5).

Following Pearl's footsteps, Russian biologist Georgii Gause (1934) adopted a similar design but with mixed populations since his research interest was "in the processes of destruction and replacing of one species by another in the course of a great number of generations" (p.6). His experiment of the "struggle of existence" in a finite bottle not only calculated the relation between different groups of individuals who competed "for the utilization of a certain limited amount of energy" (p.7), but also made possible an—what later would be called—ecosystemic calculation of the relationships between each group and the total system it constituted "from the viewpoint of the movement of these groups" (p.6). The

combination of repeatable experiments and mathematical expression was taken as the guarantee of a universal and comprehensive value of such studies of population that aimed to empirically validate Darwin's evolutionary theory about competition and exclusion.

Gause's experiments included two kinds. The first one was to investigate how two similar species competed for energy within a finite space. The second kind was to investigate the interaction between the predator and the pray. The finding of the first one was that one of the two competing species could finally completely displace the other through a differential distribution of resources of energy. It was later taken up by the biologist and environmentalist Garret Hardin (1960) as "competitive exclusion principle" to validate eugenic assumptions as ecological thought that inequalities and competition were inherent in biological life and to suggest "establishing a science of ecological engineering" to account for "every instance of apparent coexistence."

In the second kind of experiment of the "struggle for existence," key variables that were introduced into a homogeneous microcosm were refuges (for the prey) and immigration at different times and sizes. The introductions of these variables made it no longer possible to "predict the course of the process of the struggle for existence" but compelled the researchers to "deal only with the probabilities of change" (Gause, 1934, Pp.115-116). Gause's introduction of migration, species abundance, population limits made possible an extended scale of seeing life. His model was adopted by paleontologists to revise the Darwinian view of extinction. Within the ecological and paleontological study of extinction and diversity during the 1950s and 1970s, a new way of reasoning emerged: an evolutionary jump will bring about the uncontrollable danger and even apocalyptic crises (Sepkoski, 2016).

Extinction was reconceptualized as sometimes catastrophic events indicated by a significant drop of diversity in a short amount of time and equilibrium was no longer seen as being permanent to nature—extinction of some would prevent extinction of the whole—but already broken and in need to be restored. This new scientific knowledge about the past extinction was entangled with political affairs, cultural values, and intense emotions to constitute the 'endangerment sensibility,' as coined by Vidal and Dias (2016, p.2).

Bottles in the biological experiments on the "struggles for life" worked as conceptual-material apparatuses of imagineering population and living environment. Competition and migration of population were naturalized as the inevitable cause of such struggles. The repetition of mathematical calculation and experimental control not only constructed crises of survival but also made itself a necessary means of identifying, predicting and preempting such crises. At the same time, the metaphoric performances of the real enacted by these laboratory bottles blurred the boundaries between scientific speculation of growth and extinction of life on a grand scale and a particular materialization of crises of survival in a finite time-space.

1.2 Psychological experiments on the "crowd behavior"[17]

The studies of social phenomenon—or the social sciences—were generally closed to experimental methodology until the 1920s when the social objects were redefined in the German pscychologist Wolfgang Moede's study of the crowd phenomenon (Danziger, 2000). Moede's study was premised on Le Bon's theory on the contrast between irrational isolated

[17] A preliminary and partial version of this section has been published in Chinese in Journal《全球教育展望》on October 2019.

behavior and rational group behavior and conceptualized “crowd” in a prototypical way that was “a collection of individual is congregated in the same place for a limited period of time” (Danziger, 2000). The American psychologist Floyd Allport drew upon Moede’s experiments and the prototype of crowd to redefine the social as “the immediate present of other people and the direct influence that this exerted on individuals” (Danziger, 2010). This definition rendered the social phenomenon decomposable and the social effects finitude in terms of time and space. With such conceptualization, social problem became experimentally manipulable by the mid-1920s.

With the introduction and spread of the epistemological concept of “situation” into social psychology and other social sciences during WWII (Erickson, 2013, Chapter 4), the object of social psychological experiments—the social—were transformed from the “interaction between individuals” to a “situation”—conceptualized as either a purely theoretical total structure (Kurt Lewin, 1939) or a purely empirical variable (Leon Festinger, 1953)—that is a spatial construction where the patterns of group behaviors can be observed and then controlled (Danziger, 2010).

Robert Free Bales was one of those pioneers devoted to experimenting on “situation” of social interaction. He invented a “special room” for observing “real-life situations” of group problem-solving. This kind of special room called “micro-classrooms” still exists in the current schools and universities and it is normally deemed as the most technologically advanced one. This special room (Fig 8) was materialized in a way that could remove all kinds of anomalies, noises, or errors that were seen as invaluable for coding human behaviors to produce a “normal situation” of social interaction where the irrational processes of group

work could be “freely” manifested, observed and discussed. Therefore, the situation was highly controlled to be “free” “natural” and “normal”, which is defined by “the full range of internal tendencies or possibilities of interaction process.” (Bales & Strodtbeck, 1951) At the same, the control was supposed to be performed by observers “typing away, not thinking at all, acting as passive instruments” to reveal a problem-solving process—or “phase movement” that occurred only under certain conditions (Bales & Strodtbeck, 1951). The experimental apparatuses—both the physical room and its design—enacted an agential cut that separated but also at the same time constructed both the observer and the observed situation.

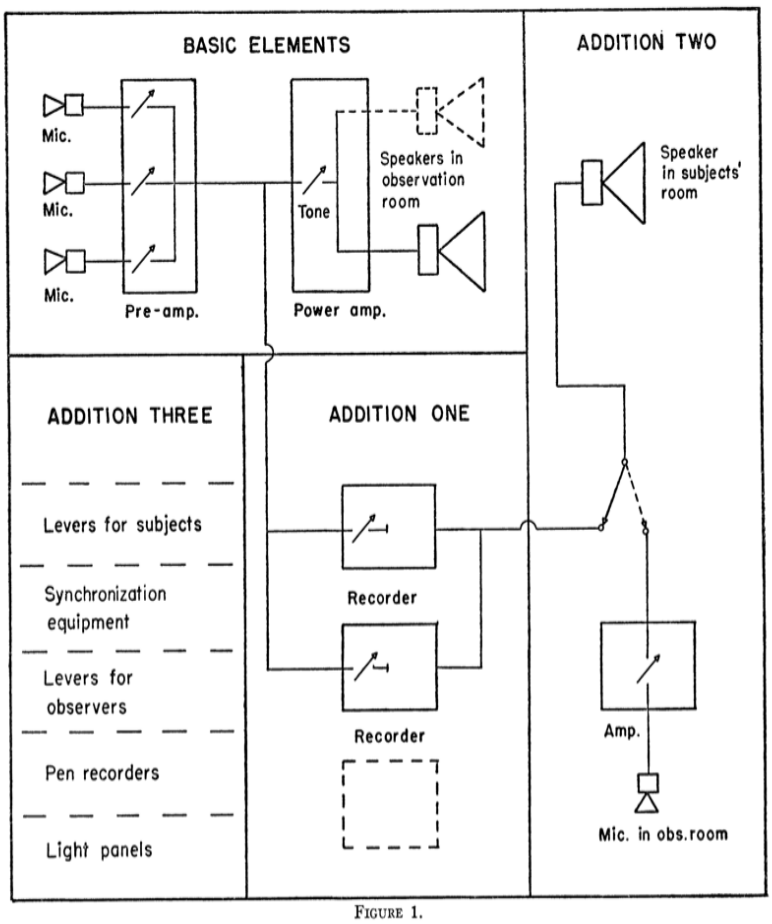


FIGURE 1.

Figure 8 Bales’ design of an observation room (Bales & Flanders, 1954)

Developed with the shifting emphasis on situation in the 1950s, the "crowd," whose image was still associated with chaos, was no longer thought as merely an aggregate of irrational individuals but a panic-inducing situation. As Bankoff (2004) observes, such a research interest into how people behave under stressful conditions was inherited from the military analysis of the psychological effect of Allied air bombing on the enemy during World War two and continued with sponsor from military and government agencies to formulate emergency plans under the threat of nuclear devastation.

One of the classic experiments on the crowd behavior at this time was conducted by Alexander Mintz. Mintz' s experiment aimed to simulate how individuals could survive a panic-producing situation such as theatre fires or traffic jams with extremely limited exits. He characterized people's behavior of "blocking the exits by pushing so that individuals are burned or trampled" as non-adaptive (1951). Non-adaptive behavior meant individuals were not able to adapt themselves to their environment and following the biological law of nature selection, non-adaption would cause disorder and extinction.

Mintz rejected the then dominant explanation that non-adaptive behavior of crowd in panic-inducing situation was due to emotional excitement or those who related this idea to the ideology of fascism. He used soldiers and athletes as examples to show individuals could behave adaptively in group while being emotional at the same time. He proposed "to explain the non-adaptive character of such behavior in terms of their perception of the situation and *their expectation of what is likely to happen*." (italic added, 1951) This hypothesis not only excluded emotionality and ideology from explaining behaviors, but, more importantly, used a

time-oriented framework—anticipation of the future to account for the behavioral change in the present.

Based on this time-oriented hypothesis, the thought experiment was designed to enable a particular ordering of space-time for an anticipated problem and its solution to appear:

> *"The experiments were conducted with groups of people, 15 to 21 subjects in each group. The subjects had the task of pulling cones out of a glass bottle; each subject was given a piece of string to which a cone was attached. Cooperation on the part of the subjects was required if the cones were to come out; the physical setup made it easy for 'traffic jams' of cones to appear at the bottle neck. Only one cone could come out at a time; even a near-tie between two cones at the bottle neck prevented both from coming out." (Mintz, 1951)*

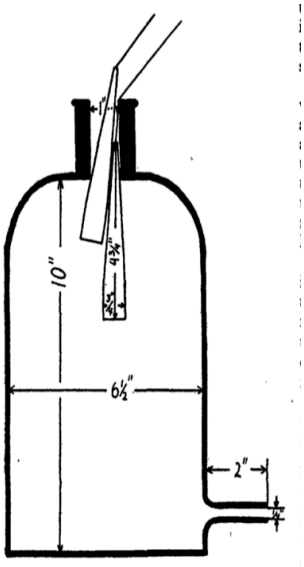


FIG. 1. CROSS-SECTION OF THE GLASS BOTTLE WITH TWO CONES SHOWN BLOCKING THE BOTTLE NECK
Main dimensions of the equipment are given.

Figure 9 Mintz's Experimental Bottle, "Non-adaptive Human Behavior" (Mintz, 1951)

The "traffic jams" were metaphorically transferred into the bottle neck (Fig 9) through materialization of the thought experiment. Th materials had to be adjusted several times until

they finally did what the thought experiment required. For example, the cone had to be aluminum not plastic (due to post-war shortages) or wood (too easy to get stuck), reducing the opening size and protecting the glass by rubber tape, using a sponge rubber pad to protect the bottom of the bottle, inserting a rubber tube to lead water, and waxing the fishing line to prevent them tangling. Therefore, the situation and problem were enacted in a specific way that was not only conditioned by researchers' hypothesis but also the physical and economic qualities of the experimental materials to make the problem-solver a particular kind.

In order to make individuals to have different perceptions of the future, Mintz used a time-based reward structure as the variable. The rewards were assumed as incentives that could turn the game of getting-out-of-the-bottle into either individual competition or cooperation for group competition. Based on the experimental results, Mintz concluded his theory that cooperation for group competition would produce more orderly action and thus solve the problem while individual competition would lead to panic and disorder or more seriously, disaster. However, as previously shown, the equivalence between cooperation and the order of solving the problem—to get one cone out at one time—were part of the conceptual-material constitution of the apparatuses in the experiment. In the conclusion of this experiment, the equivalence in the thought experiment was replaced by a causal link between anticipation of the future and an orderly behavior which led to survival in a panic-inducing crowd.

The crowd was not only taken up as a prototype of the social—i.e., the presence of others and the immediate influence of such a presence upon individuals' behaviors but also as an epitome of the social problem–i.e., the non-adaptive behavior of mass in a panic-inducing

situation. By adjusting the scales of time-space, psychological experiments constructed both the cause and the solution of the crowd problem: the material and conceptual parameters of time-space of a given population. As the following section will show, this causal link built between time-space horizone and behavioral patterns was soon adopted by urban sociologists and cultural anthropologists in the 1950s and 1960s to account for the "cultural differences" of the middle-class and the poor/lower-class in a way that economic problems could be solved through cultural means

2. Experimenting and Conjuring Phantasms of the Urban Crisis

While Mintz's experiment of the crowd simulated an emergency situation in the urban public life, the phantasm of a larger scale of crowding—or overpopulation —was reinvoked as a long-lasting problem of rapid urbanization and technological advancement in the US and the rest of the world after World War II. The social scientific modeling, experimentation and calculation of the relationships between population number, living space, and social behaviors, ironically, led to an even more widely distributed panic with an anticipated decay of American cities and an imagined threat that the "culture" of the increasing number of the "poor" would impose to the whole world

2.1 Inventing a phantasm of the "behavioral sink" in the NIMH laboratory

A living habitat had been miniaturized in the Laboratory of Psychology of the National Institute of Mental Health (NIMH) since the mid-1950s. Departing from earlier and contemporary biological experiments of population growth which focused on the factors of

predation, disease and food supply, the American social psychologist John B Calhoun (1962) who created this habitat wondered "what of vice." Calhoun's question was historically not new. As Michale Katz (1993) discusses, the 19th and early 20th centuries writers and housing reformers had attributed the immoral character of the poor to their unsanitary and congesting housing. To "set aside the moral burden" of the word "vice," Calhoun quickly translated it into a social scientific term, "social behavior," which, due to the reconceptualization of the "social" by experimental social psychology, was observable and manipulable through laboratory setting. With the help of a population of wild Norway rats, Calhoun intended to construct a pure relation between the social behavior of a species and its population density by creating a "rat utopia"—enclosing the rats with abundant food and space and without predation and disease.

When the experimental "rat utopia" gradually become a "rat hell" (Ramsden and Adams, 2009), Calhoun did not conclude with an inevitable causal relation between species extinction and exponential growth within a finite space as what Pearl and his followers suggested. Rather, what contributed to the survival crisis was a particular arrangement of space to develop what Calhoun (1962) called a "behavioral sink" (Fig 10). To create a living space that could turn rats' biological activities into social activities (see Fig 11), Calhoun connecting all pens but 1 and 4 (1 was the upper left and 2--4 were marked counter-clockwise) and using a food hopper to make "eating a lengthy activity during which one rat was likely to meet another." A behavioral sink was said to be developed when the rats associated eating with the presence of others and more and more of the rats tended to collect at one hopper as the most desirable eating place. According to Calhoun, this "togetherness"

was pathological as it created excessive social interaction and social stresses that "tended to disrupt the ordered sequences of activity involved in other vital modes of behavior: the infants were abandoned by their mothers throughout the pen and would either die or be eaten by the adults; "an estrous female would be pursued relentlessly by a pack of males" and die from disorders in pregnancy and parturition; the normal males were aggressive "to establish a position of dominance"; non-dominant males were either homosexual or pursuing females against the normal courtship ritual.

Not only did Calhoun (1962; 1970) explicitly expressed that animals' behavioral pathology was analogous to human problems, but also, the zoomorphism language he adopted—e.g., social drinkers, probers, juvenile delinquents—and the creature he chose—i.e., the rat—made it effortless and appealing for both social scientists and mass media to draw upon his publication in *Scientific American* to project an imaginary of the urban crisis and an apocalyptic future of the human race. Popular newspapers, novels and comic books used Calhoun's experiments on the rats as a scientific proof of the fact that any social environment that was arranged to render little privacy and more stresses was a source of pathological behaviors and therefore city, a family, or a community that failed to control the frequency of social contacts could be seen as a space of crisis (Ramadan and Adams, 2009).

In contrast to the public take-up of his work, Calhoun's later work focused on how to use space as a strategy for survival. At the Annual Meeting of the American Association for the Advancement of Science in 1968, Calhoun presented his solution to deferring social pathology: a conceptual space that human beings were distinctly able to develop and enlarge through technology to preemptively—Calhoun's original term was "promotion" rather than

"preemption"—limit the increasing social contacts and distribute equal access to useful information for human evolution (see Fig 12).

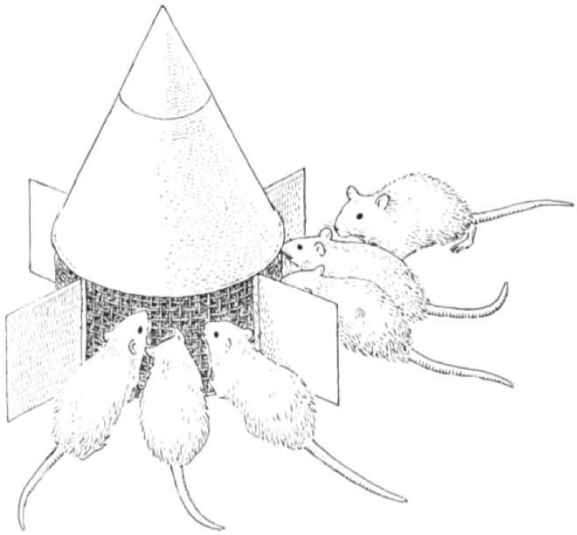
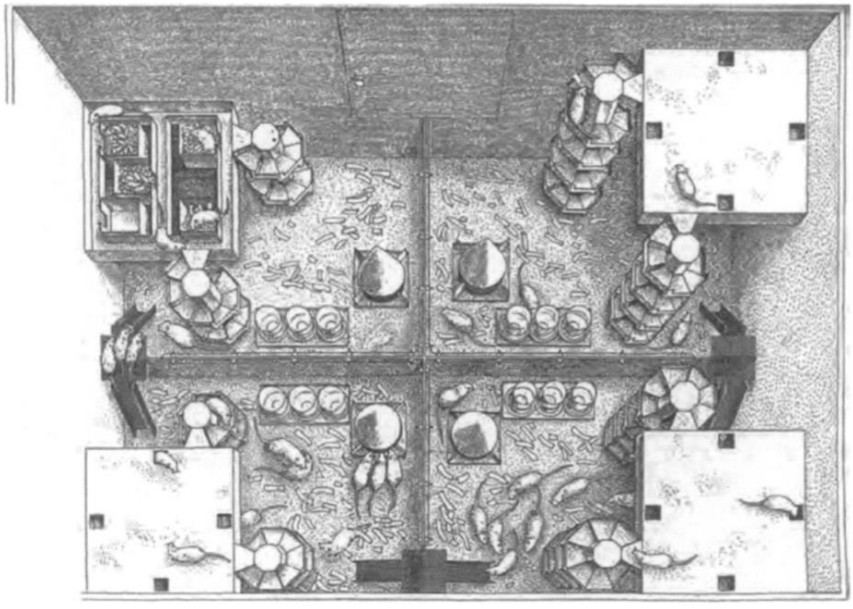


Figure 10 Calhoun's design of A food hopper for developing a "behavioral sink"



Aerial view of early rat enclosure, from Calhoun's article, "Population Density and Social Pathology," *Scientific American*, 1962.

Figure 11 Calhoun's design of a rat enclosure (Ramadan and Adams, 2009)

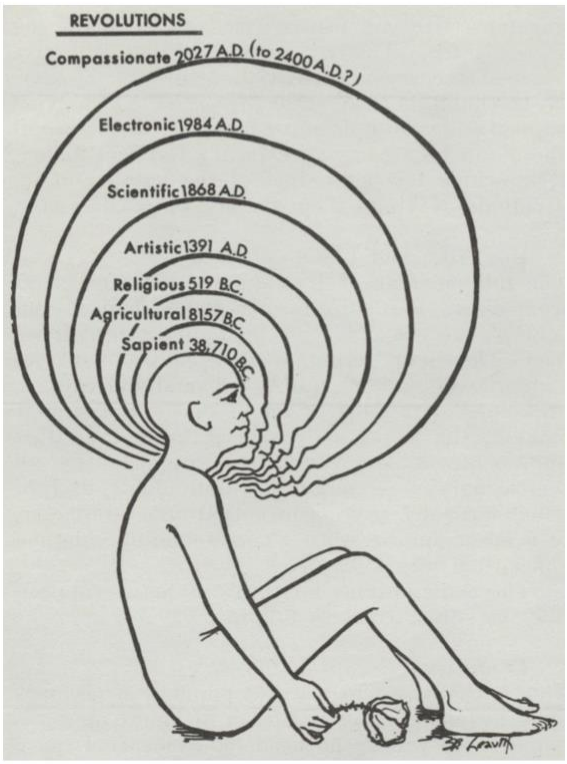


Fig. 4: The Conceptual Homunculus. The diameter of the head reflects the ability to develop and utilize concepts at the times of establishment of successive revolutions in the perspective of reality and the accompanying alterations in means of coping.

Figure 12 Human's conceptual revolution (Calhoun, 1970)

2.2 Making a phantasm of the "culture of poverty" in Vecindads of Mexico City

While Calhoun was busy experimenting with his wild rats, another phantasm of the crowd, the "culture of poverty," which shared similar characteristics of a "behavioral sink," was created by American anthropologist Oscar Lewis in his studies on vecindads and rural migrants in Mexico City. Lewis initially presented this idea in a conference seminar on urbanization problem in Latin America in 1958. The culture of poverty was said to have " its

own modalities and distinctive social and psychological consequences for its members" and cut "across regional, rural-urban, and even national boundaries" regarding "family structure, the nature of kinship ties, husband- wife relations, parent-child relations, time orientation, spending patterns, value systems, and the sense of community ." By contrasting the lifestyles in two vecindads, Lewis suggested that residents in the smaller vecindad showed "greater persistence of rural traits" as "a function of poverty and lower class membership." These "rural traits" observed and summarized by Lewis seemed to resemble Calhoun's rats: little privacy, frequent quarrels, high rate of common law marriage, male dominance, matricentered families, isolated from the rest of the city. These "traits" were less a new finding than a hypothesis that was drew from then existing characterization of the "black ghettoes" that consequentially structured Lewis' attention and analysis when he was telling the detailed life stories of the observed families.

Similar to the concept of "a behavioral sink," the "culture of poverty" was also created as a racially neutral concept to equalize characteristics of the African Americans with "slum dwellers" of Mexico City and San Juan, and Puerto Rican immigrants in New York city (Lewis, 1966). Different from Calhoun, the urban space was not miniaturized in a scientific laboratory but represented by the individuals and families in megacities. Mexico City was by no means a random choice. With the increasing interest in American urban migration and social transition studied by Chicago School of Sociology and also the mobilization of projects on urbanization by the UNESCO and the governments of the "underdeveloped" countries, big cities in Latin America became ideal candidate to know both (de Antuñano, 2018). At the same time, a phantasm of the self-perpetuating pathology that

was once associated with the Black people due to the colonial past (and present) in America was reframed with psychological language and modernization theory as a universal subculture of the poor.

In Lewis' later formulation of the "culture of poverty", he emphasized more on people's "feeling" "attitudes" and "value system" as affective effects that were caused by politico-economic conditions but inherited through family and that helped perpetuate people's social and economic status:

> *"The people in the culture of poverty have a strong feeling of marginality, of helplessness, of dependency, of not belonging. They are like aliens in their own country, convinced that the existing institutions do not serve their interests and needs. Along with this feeling of powerlessness is a widespread feeling of inferiority, of personal unworthiness. ...People with a culture of poverty have very little sense of history. They are a marginal people who know only their own troubles, their own local conditions, their own neighborhood, their own way of life. ... When the poor become class conscious or members of trade union organizations, or when they adopt an internationalist outlook on the world they are, in my view, no longer part of the culture of poverty although they may still be desperately poor." (Lewis, 1963)*

To make the subject of the poor, people who lived in the "slum-like" settlement in cities were taken out of the conditions of their own living but thrown into a universal-linear scale of timespace that was said to coordinate their thinking and feeling. This formulation differentiated people by locating "the poor/lower-class" close to the "original point"—the present and the local—and putting the "non-poor/middle-class" further from it—the future and the international—and claimed that this distinction would not be bonded by societies, countries, or racial or ethnic groups. Echoing with those social/scientific experiments discussed earlier, a vision of time-space, a sense of belonging and hope, influenced by

technology, was held accountable for an individual or a society's success in the "struggle for existence."

Despite Lewis' defense of this concept as positively recognizing the poor's successful adaptation to the city, many of his contemporaries raised serious criticism towards his work (Winter 1970; Leacock, 1971). For example, with the funds from the Temple University and the NIMH, a conference on the Culture of Poverty was held in 1969 (Winter, 1970). Most participants discussed the limitation of using this concept in different social and political contexts, questioned its negative impacts on policies of erasing poverty, begged for more scientific evaluation of its cause, or appreciated the Black characters that made them survive. Two among eight scholars, Frederick Holliday and Hylan Lewis, asked to abandon using this dangerous concept as it re-articulated racial discrimination in the name of science. They also argued the black power movement was not a proof that the poor could be imbued with middle-class values to uplift themselves but a proof that the "culture of poverty" did not actually exist. As Leacock (1971) lamented, which unfortunately still holds true today, "it is a bitter irony, therefore, that the concept of culture is now being widely applied in such a form as to be almost as pernicious in its application as biological determinist and racist views have been in the past."

However, these critiques seemed to be more a proof of the popularity of this phantasmatic concept than the opposite. The "culture of poverty" gained its cultural legitimacy as an interpretive framework to define the "urban crisis." For example, Banfield (1974), in his widely circulated and debated book *The Unheavenly City: the Nature and Future of Our Urban Crisis*, defined the "urban crisis" not as a "problem of congestion",

which for him only dealt with “the comfort convenience , and business advantage of the well-off” but as a problem of “attitudes, values, and modes of behavior” of “the poor , the Negro , and others who stand outside the charmed circle”(p.2). He reiterated the long quotes from the Commission on Population Growth and the American Future and Tocqueville’ Democracy in America to demonstrate that the “dark ghetto” constituted by African American and immigrants who were said to have less attachment and loyalty were the real threat to the future security of the US. The time horizon—"a greater or lesser ability (or desire) to provide for the future” was used as the key criteria to differentiate “class” which was defined in the same way as Lewis defined “culture.” Poverty was reframed as feelings—feeling deprived (p.141), feeling alienated (p.144), feeling restless—that could not be changed. Based on these assumptions, Banfield proposed “eugenic”—of course he would not retake up this derogatory term—solutions to eliminate the undesired people and solve the urban crisis.

Moreover, the phantasm of the “culture of poverty” has also became materialized through public policies, community action, sociological and psychological surveys, and pedagogical practices both in American cities and the “underdeveloped” countries[18] since the 1960s. Under President Johnson’s declaration of the “War on Poverty” in 1964, which was also inspired by Lewis (Lemann, 1992), mental health became one of the main targets in the “war” and the NIMH by that time was already the main funding source for research on the urban poor (O’Connor, 2001). Researchers and professionals in mental health saw they were

18. See *Encountering Development* CH 2 "the problematization of poverty: the tale of three worlds and development; Ch4 "The dispersion of power: tales of food and hunger"; Matthew Connelly, *Fatal Misconception: The Struggle to Control World Population* (Boston, 2008); John H. Perkins, *Geopolitics and the Green Revolution: Wheat, Genes, and the Cold War* (New York, 1997)Richard J. Barnet, *Intervention and Revolution: The United States in the Third World* (New York, 1968).

facing a new crisis as they were asked to not only help "anyone who was willing to strive for his own betterment" but also those "who did not try to help themselves, the paupers, the multi problem families, or the culturally deprived" (Rae-grant, et al., 1966). They proposed to re-conceptualize mental health and re-examine its strategies to achieve the new goal of the nation that was to "help those who cannot help themselves" by building their ego processes and increasing their "social and individual competency" in a "symbol-laden, rapidly moving, technological world."

Echoing with Calhoun's "strategy for life," this new therapeutic treatment for the "new client" who were "experientially deprived" put emphasis on "ego expansion." Following the suggestion given in Lewis' work, it highlighted the importance of "middle-class" ways of life in social participation, including "an orientation toward the future and the ability to plan effectively; a belief that one can sufficiently control one's own destiny so that planning is worthwhile; associated with these, an ability to delay gratification in order to attain a future goal; also some perception of how one relates to the larger social system of which one is a part; an ability to formulate problems in relatively abstract and generalizable form; the flexibility to perceive alternative solutions to most important problems, and finally, acceptance of the fact that hard and often dull work is necessary and even perhaps desirable" (Rae-grant, et al., 1966).

In this case too, the solution to the problem of "health", as well as "achievement" and "survival," was to gain a grander vision of time-space and constantly engineer the self towards the future and the larger world. It assumed that only by doing so the self could be strengthened to "cope with conflict and anxiety" better in the society. This grander vision as

social competency was said to be achieved through an ecological approach, i.e., the intervention of environment—neighborhood and families—instead of individuals, and the personnel in the front line were said to be teachers, nurses, special educators, police, judges, lawyers, physicians, clergy and indigenous workers "who carry direct responsibility for growth in intellectual and social skills"(Rae-grant, et al., 1966). Community Action, one of the official programs in the War on Poverty that stemmed from a series of community-based experiments jointly sponsored by the NIMH, the Ford Foundation and the President's Committee on Juvenile Delinquency (PCJD) was to put such a theory into practice. It provided urban planners an opportunity to experiment a comprehensive "systems reform" of the society by turning the low-income neighborhoods into a test ground of new social science knowledge and official policy, the practices of which resembled the settlement house movement in the Progressive era (O'Connor, 2001).

3. Calculating and Preempting the Global Crisis [19]

3.1 Spaceship Earth simulation: Inducing the fear of interdependence and imbalance

The phantasm of a crowd struggling for survival in a finite time-space soon went beyond the social/scientific experiments in both laboratories and urban neighborhood and transformed into a planetary imaginary of crisis. In addition to the domestic War on Poverty, the Johnson administration also declared an "International War on Hunger" in early 1966. This international war not only legitimatized and widely spread the Malthusian thinking into

[19] A preliminary and partial version of this section has been included in an Accepted Manuscript of an article published by Taylor & Francis in Journal of Discourse: Studies in the Cultural Politics of Education on July 4th 2019, available online: https://www.tandfonline.com/doi/full/10.1080/01596306.2019.1637332.

the “Third World” countries but also constructed a sticky tie between the population of these countries and US national security after WWII.

Population of “Third World” mattered to the international politics and national security of the US in two ways. On one hand, large population quantity in the “underdeveloped countries” was held accountable for not only their own economic poverty and environmental degradation but also the overconsumption of resources that were considered in the late 1940s to belong to all human beings. The concern of the scarcity of resources and interest in resource management during the wartime stretched into the postwar years. Both American environmentalists—e.g., William Vogt’s *Road to Survival* (1948) and Sierra Club’s *This is the American Earth* (1960)—and military strategists—e.g., the Paley Commission’s *Resources for Freedom*—warned that US national security required a comprehensive management of natural resources on a global scale and their suggestions included providing international aids to “Third World” with birth-control campaigns and gaining more resources from overseas (Locher, 2013; Robertson, 2008). On the other hand, with the promotion of Domino Theory for preventing the expansion of Communism camp, the large population of those newly independent countries such as India and Bangladesh became the main targets of the US relief effort for their “restless discontent” was taken by President Johnson as the largest threat to the US and peace in the world (Robertson, 2008). The control of “Third World” population was thus rationalized as the control of conflicts and restoration of peace.

A conceptual foundation for making the poverty of “Third World” population an issue of national security of the US was the idea of interconnection or interdependence. From the

mid-1960s, an imaginary of a lonely, finite, intimate, and interdependent global earth began to circulate across different disciplines, i.e., economics, world history, geography, aerospace science, international relations, and formulated a discursive movement of Spaceship Earth (see e.g., Ward, 1966; Boulding, 1971; Fuller, 1969; NASA, 1968; Asimov, 1974; AFSC, 1975). In Barbara Ward's *Spaceship Earth* (1966), the first monograph written on this imaginary and later adapted into games, fictions and school curriculum, she defined human "community" by potential destruction of everyone at the same time: "If we can all be destroyed, together, in two or three act of grandiloquent incineration, then we are neighbors." Intimacy and interdependence of the planet earth were thought as conflicts/disasters-producing situations where "if somebody were to get mad or drunk in a submarine and run for the controls...If some member of human race gets dead drunk on board our spaceship, we are all in trouble." These metaphors that were used to imagine a planetary crisis of human was less about representing the real world than inducing the fear and anxiety with potential nuclear or other kinds of techno-military devastation to force intervention of the real world immediately for balance and peace.

The phantasm of Spaceship Earth performatively reiterated the phantasm of the crowd that defined the "social (problem)" as the immediate effects of the presence of the others. Ward's concern with the relation between inequality and conflicts in a finite and intimate world was reconceptualized by American biologist Garrett Hardin (1968) as the "Tragedy of the Commons." Hardin, as a Darwinian, believed in the axiom of inequality—no two things in a real world are precisely equal (Hardin, 1960) and the natural criteria of weighting value was survival. He drew upon William Foster Lloyd's image of the common pasture to argue

that freedom in a commons would bring ruin to all as each man would maximize his own interest so that the commons must be prevented from breeding by using coercive measures to control the population growth rate at zero.

Hardin's warning of unlimited growth as the cause of ecological catastrophe inspired many politicians, industrialists, and environmentalists around 1970 to think about this "tragedy" on an international and planetary scale. A larger discussion of 'common problems of advanced societies' was launched and sponsored by the Johnson administration, RAND Corporation, the Ford Foundation, and the OECD in 1967 (Levin & Winter, 1967; Read, 1967; the Club of Rome, hereafter referred as CoR, 1970). One of the proposals was made by the Club of Rome (CoR, 1970), named "the Predicament of Mankind: Quest for Structured Responses to Growing World-wide Complexities and Uncertainties." This proposal recognized "interdependence" as a new situation that was "uncertain, and, therefore, frightening"(p.4) and implied in the report that these newly independent people, who were free to act just like "us" and interact with "us," created this new situation where 'our' notions of problem and solution became wholly insufficient (p.5). Resonant with Ward, the CoR report made the notion "interdependence" a conceptual apparatus through which security as a new mode of governance of "global commons" could be enacted.

A simulation game called "Hunger on Spaceship Earth" was created by the American Friends Service Committee (1975) to simulate the "interdependence" effects under the threat of hunger crisis in "Third World. "This game aimed to "create understanding of some of the inequities present in the world social and economic situation and some of the feelings of helplessness and frustration they cause" and "bring forth both the critical danger involved and

the potential for hope and well being." In its setting, two-thirds of the members of the spaceship earth were "subject to discomfort, deprivation, danger, and other forms of stress" and travelled in the space age equivalent of steerage. They represented people from underdeveloped nations and the ghetto dwellers of the wealthy nations represented in the first-class section. The great majority of the hungry two-thirds on the spaceship had colored skins, and most of the well-fed were white. As the Committee pointed out in the preface, what to learn from the game was not about "content" but "concepts, strategic thinking, communication skills, decision-making, conflict resolution, bargaining, and the need to compromise" that survival in the real world of "interdependence" would require. As a performative play of the phantasmagram of the survival-in-bottle, this simulation game held "steerage" accountable for the imbalance of the present, the potential conflicts, and the vulnerability of the whole planet earth.

Ward's imaginary of the spaceship earth also gained its empirical proof from a set of photographs of the global earth made possible by the NASA Apollo program in the late 1960s. Although "space race" seemed to stimulate this imaginary, Western imagination and representations of the globe and the whole earth, as meticulously traced by Cosgrove (1994; 2001), had linked together power, truth and the god/man/technology that could "see" and thus "master" the global earth long before this period. However, different from previous universalist image of "one world" that coeval with the Euro-American imperial expansion, the imaginary of the spaceship earth also underscores the gloomy feelings of the astronauts—lonely, isolated, vulnerable—as the feeling of the earth. The hope of rebirth and redemption of the earth nonetheless exist in the "peace" of the outer space. The frontier of exploration

and conquest for “peace” does not disappear, but, rather, as Kenneth Boulding (1966) argues, with the image of Spaceship Earth, it is shifted from a continental one to a stellar one.

3.2 Systems analysis of the world crisis

Echoing with pervious experiments of survival, scholars in Spaceship Earth movement also found the hope of human survival in a finite earth relied upon an extended vision and technoscientific control of time-space. For the Club of Rome, the mechanical ‘eye’ that created a global view extended the scale of human vision to the entire planet to escape the predicament of what they called the rapid escalation of the world problematique. The predicament, as they argued, was due to ‘this fundamental mismatch between the situation […] and our mental and emotional attitudes […]’ (the CoR, 1970, p.5). The global ‘eye’ was treated as a critical device to emancipate the mankind from their evil self. Around the 1970, the ‘eye’ from the moon required the experts to see not only the totality of the globe but also the possible state of the future. ‘Human Perspective’ was such an expert’s vision. It was proposed in *The Limits to Growth* (D. H. Meadows, Randers, & D. L. Meadows, 1972), the first report to the CoR. Its figure (see Fig 13) showed “the larger the space and the longer the time associated with a problem, the smaller the number of people who are actually concerned with its solution” (p.18). People who fell in the upper left corner of the space-time graph like the writers themselves were argued as the most needed, as there were too few of them who were not only intellectually capable and politically neutral but also morally sound—caring about the good of humankind and its survival. The temporal and spatial scales in this figure

were created with the ‘eye’ from the moon to stratify the population regarding both its quantity and quality and to produce more ‘experts’ like the writers to foresee the crisis of the growth.

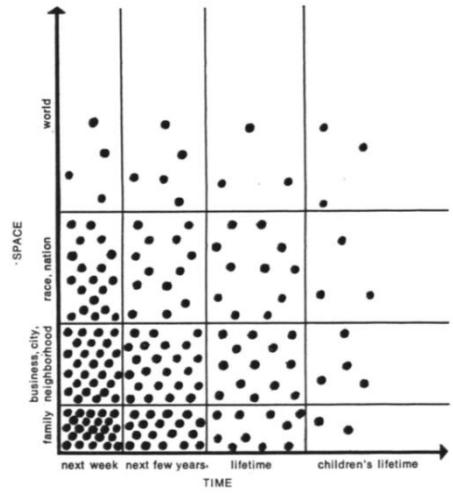


Figure 13 Human Perspectives (Meadows et al., 1972)

R. Buckminster Fuller, a navy veteran, systems theorist, and anticipatory thinker, turned himself into the captain of human beings and wrote a book called “Operating Manual for Spaceship Earth” in 1969. In the book, he took the Great Pirates as the former operator of the earth, who went global venture and mastered change by learning everything, making long-term prediction, discovering things that were previously of no “value” into resources, and connecting them together from different areas so human can share the earth equitably. Scientists and engineers—Fuller believed the great men such as Malthus, Darwin, Marx all agreed there were not enough for everyone to live—were portrayed as the servants who helped Great Pirates to discover the planet and built a world-controlling system. Fuller justified the violent conquest and robbing of those “losers” as the Great Pirate’s brightness of

using comprehensively anticipatory strategies. At the same time, Fuller claimed those "losers" were dull and helpless unless they acquired the same belief and vision as their conquerors. Although those old "heroes" were extinct, Fuller believed he found their successor: "A new, physically uncompromised, metaphysical initiative of unbiased integrity could unify the world. It could and probably will be provided by the utterly impersonal problem solutions of the computers" (p.36).

Systems theory and computers that materialized it gained their anticipated role as the world savior—the operator of Spaceship Earth—less because what they had done but their impersonal embodiment of territorial conquest. "Manichean sciences"—Peter Galison (1994) uses this name to assemble cybernetics, operations research and game theory together—were not only formulated through the warfare for strategic attack and resources management during the 1940s but also redefined the problems of the real world and the role of sciences in solving these problems in the postwar years . "Manichean" sciences also inspired scientists and social scientists in the 1960s to adopt systems analysis as a third approach—neither pure methodologies nor merely daily policy-making—to solve the common problems of the "advanced societies" and to render the "advanced societies" in the East and West benefit from learning from and cooperating with each other (Jensen, 1972; IIASA FM, 1967). Emphasized by these systems experts, systems analysis was not merely a combination of subject matters, being it economics, mathematics, or engineering, but rather "a broad research strategy — a strategy that involves the use of techniques, concepts and a scientific, systematic approach to the solution of complex problems. It is a framework of thought designed to help decision makers choose a desirable (or in some cases a 'best') course of action" (IIASA, 1974). In the

initial proposal of founding an international research center and study program for systematic analysis of the common problems of the advanced societies—it later became the International Institute for Applied Systems Analysis (IIASA), the initiators suggested making the program more methodologically oriented so it could be more scientific and independent of social structure and national values to attract system professionals, especially those from USSR, for international cooperation(IIASA FM, 1967). However, in the following experts meetings of the proposal (IIASA FM, 1969), participants showed more interest in problems rather than methodology (which they could deal with in their own institutes) and ended up with suggestion that this proposed program focus on "specific tractable aspects of universal problems" and "count on methodologists being problem oriented" and motivating "the younger problem-oriented system type." By excluding the discussions of issues like mass education as politically and culturally too complicated (IIASA FM, 1967), systems experts adopted systems analysis not only as a value-neutral approach to problems but also as a value-neutral basis to select and define these problems in advance—i.e., these problems to be solved must be substantially quantitative, having available data and techniques, intrinsically international and able to be broken down.

The CoR report "the Predicament of Mankind" pioneered in using systems theory to diagnose the world crisis and provided the very frame of reference for constructing a world system in various projects commissioned by the CoR and OECD policies after the 1970s. The predicament was said to be the fundamental gap between the world and human understanding of it and human must reconceptualize the world to emancipate themselves. The concept "ecological balance" was chosen as the value-base for constructing such a world system

model. This epistemological foundation of the world system model not only created a spatial whole as the container of time but also a differential distribution of time: balance as the normative state or equilibrium consistent with system's thought of efficiency; also thought of as either a desired future or a past that had been lost in the modern world. And, in contrast, the present was perceived as imbalanced, as evidence of system disequilibrium and as pathological, for which reason it remained outside the normative state (the CoR, 1970, p.44). More crucially, the insufficiency of human understanding of the world was thought to exacerbate the problematique irreversibly, and corrective action could only be effective within a given timespan. Time was the imperative that created affects; as the report cried out, "Act now, otherwise, N-E-V-E-R." (p.6). By accelerating time, the CoR intensified the anxieties, panic, and fear about the insufficiencies and uncertainties and necessitated the world system approach as the cure of the crisis.

As a state of exception (Agamben, 2005), the present necessitated an urgent search for a provisional approach to problem-solving. This approach to curing the pathological present was a heuristic invention of the world system. This world system model resembled the design of an electro circuit and produced a feeling of calculability and controllability. To operationalize this model, all of the component forces and phenomena were treated as "already known facts" (p.29) and reduced by the CoR to a list of indicators, with reference to the US Social Indicators developed in the 1960s. 'Balance' as the value-base was thereby transformed into a finite number of trade-offs. Combining these two transformations, a feasible function (1) of a problematic situation was created for a plan of change (p.47):

$$W = f(Ii, Oi) \qquad (1)$$

where

W = the measure of the worth of a particular action (or policy),

Ii = the input variables that control the alternative courses of action, and

Oi = the extraneous, non-controlled variables, that affect action.

The function (1) turned “ecological balance” into an algorithmic equilibrium among a limited number of variables (both controlled and uncontrolled), which defined the optimum of resources allocation as including the “unknown” or the uncontrollable inputs—"events” into calculation. In this sense, both the known past and the unknown future were made actionable in order to control the present. Ecological peace as the normative future in the post-war era was not merely a global utopia but an algorithm that rendered the world and the future collapsed and calculable in the ‘now.’

This approach to identifying ‘event’ and preventing ‘crisis,’ enacted a ‘precautionary principle’ that was characterized by the acceleration of time, the tight stringency of ex ante regulation (Hanekamp, Vera-Navas, & Verstegen, 2005), and the constant assessment of the balance between the emerging threat and the costs of (in)action in the present (B. Anderson, 2010). As Hanekamp et al. (2005) argues, “the precautionary principle impresses upon us a moral obligation to take care of the environment, of mankind, our children, and our children’s children.” It does so by making the present a constant state of exception and by instrumentalizing death to rationalize a preemptive control to transform human subject (Mbembé, 2003).

Paradoxically, the modern pursuit of certainty embodied in such a world enterprise of the human future took up heuristic algorithm as a form of techno-scientific design of problem-solving. The use of these approaches to "penetrate further into what might be real" was based upon the hypothesis that "events" were crisis-related components of a system and their dynamic relationship with other components were neither regular nor stable but "akin to evolutionary 'jumps' that creates imbalances throughout the system." The report expressed the fear of the future that once the imbalances became uncontrollable in terms of time, space, and intensity, humankind would reach its limits of existence. It signified an important change for the pursuit of certainty no longer depended on accuracy and completeness of 'facts,' but rather the 'most likely' within a limited amount of time and other expenses. Still, it embodied the belief in scientific certainty that was based on the possibility and probability of 'the negativity' of human existence—extinction—rather than the 'positive' accuracy and completeness. Consequently, the entire ecological structure and the interrelations among "those widely known problems" within it became the objects for a dynamic computerized model to reveal and experiment with.

The phantasmagrams of crisis—i.e., the performances of the "struggle for existence" in laboratory bottles and on the urban and global scales—was an entanglement of techno-scientific arrangement and control of time-space, cultural imaginaries of the "crowd," and international and domestic politics of the "poor." Aesthetic tactics, such as metaphor, analogy, simulation play, and modeling, made it possible for certain concepts—in this chapter, for example, "the behavioral sink," "the culture of poverty," and "the spaceship earth"—to become phantasmatic. These phantasmatic concepts and their materialization not only

translated the social reality into the objects of technoscientific calculation and control but also transformed technoscientific speculation and experimental results back into the cultural imaginaries of the social problems. In tendon with such performative translations and transformation were fears of the unknown others and the unknown events. An impersonal and technoscientific vision of the grandest scale of time-space was constructed as an effective and ethic salvation tool to overcome irrational feelings and restore balance and order.

Chapter IV. Constructing Educational Phantasmagrams of Crisis[20]

This chapter focuses on how phantasms of crisis were constructed through educational infrastructures and how educational reforms were formulated to prepare students and the nation-state for survival. The first section goes back to the discussion in chapter 2 on the metaphor of "educational pipeline" and examines its historical co-construction with US international aids—with expatriates, money, and programs—to educational development in the newly independent countries and US educational war on poverty that targeted at the domestic "culturally deprived children" from the 1950s to the early 1970s. Although the term "at-risk" did not become popular in social scientific research and public polices until the report "A Nation At Risk" published in 1983, a new catastrophism, as discussed in the previous chapter, had emerged and circulated in sciences and social sciences by the early 1970s and given populations had been identified as independent albeit "deprived" and even "dangerous" to the whole world if not intervened. The second section looks at how a particular perspective of the world and the future was constructed as a competency of survival in international education curriculum and adopted for developing international assessment and orienting American curriculum reforms during the 1970s to 1980s.

1. The Co-Construction of "Educational Pipeline" and At-Risk Nations and Student

[20] A preliminary and partial version of this chapter has been included in an Accepted Manuscript of an article published by Taylor & Francis in Journal of Discourse: Studies in the Cultural Politics of Education on July 4th 2019, available online: https://www.tandfonline.com/doi/full/10.1080/01596306.2019.1637332.

1.1 The epistemological travelling of "pipeline" into US education

Definition of pipeline

US Department of Defense[21]: In logistics, the channel of support or a specific portion thereof by means of which materiel or personnel flow from sources of procurement to their point of use.

Marriam-webster[22]:

1a: a line of pipe with pumps, valves, and control devices for conveying liquids, gases, or finely divided solids

b: PIPE sense 2b

2: a direct channel for information

3: a process or channel of supply an arms pipeline

4: a state of development, preparation, or production several projects in the pipeline

also: the system for such processes a strong product pipeline

5: a course of individual advancement or development especially to fill organizational needs

17 Retrieved from: https://www.militaryfactory.com/dictionary/military-terms-defined.asp?term_id=4097

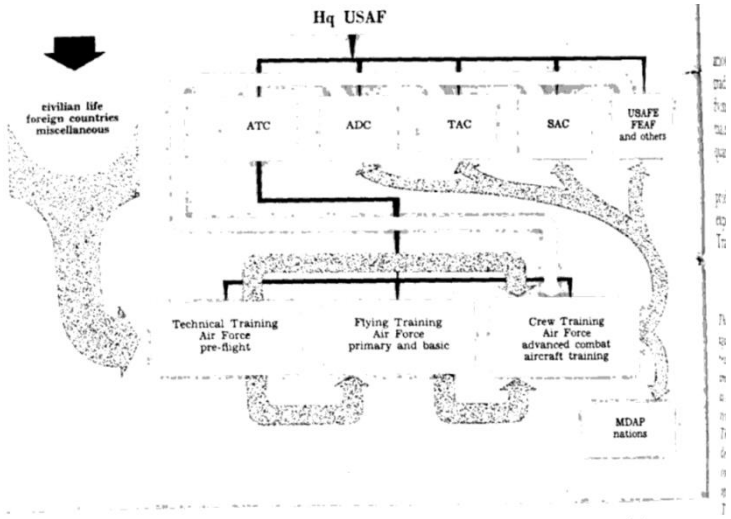
22 Retrieved from: https://www.merriam-webster.com/dictionary/pipeline#h1

The metaphor “educational pipeline” has become predominately associated with the recruitment and retention of minoritized students (girls, Hispanic Americans, and African Americans) in science, technology, engineering and mathematics since the early 1990s.[23] However, this metaphor has been long taken up as a technical language for educational policy makers and researchers to articulate both the crises that the domestic “deprived” and the international “underdeveloped” were presumed to induce and the corresponding educational solutions to these crises since the end of World War II. This borrowing of language reconceptulizes education through, interestingly, various fields that the term “pipeline” is used. According to the definition of “pipeline” given in Marriam-Webster Dictionary, the term is central to at least five fields: physical engineering, communication engineering, military supply, production management, and personnel management. There was a merge of these fields in aerial studies and air force during and after WWII as energy, machine, information and human personnel were integrated as different components into one system for optimal management and control. Consequently, “pipeline” was not only used for material supply management but also for military student training and personnel management (see in e.g., Robinson, 1944; US Congress House, 1957, p.231; *Air University Quarterly Review*, 1954-1955).

The “pipeline” model of training air force students with technical knowledge, flying operation, and combat strategies (see Fig 14) for survival became appropriated for “scientifically” managing the supply and leak of scientific and technical manpower of companies in the early 1960s (*Air University Quarterly Review*, 1955, Volume 8, p.42). For

23. It is based on the result of google scholar search of "educational pipeline."

example, the article written by the project director of General Analysis Corporation, Raoul Freeman (1960), not only echoed the Sputnik shock by emphasizing the shortage of scientists and engineers for R&D and the importance of increasing their supply for both national economic income and defense against Russia, it also suggested two points that were later successfully actualized by his contemporary educational researchers and policy makers. The first point was to identify the major cause of the "leak" in the pipeline of scientific and technical manpower as a lack of elementary and secondary education that could formulate "a love for science, a 'proper' outlook on the world, and a desire for higher education, a blossoming of innate abilities, and a counterattack to 'narrow' home education." The second suggestion was to widely distribute the "know-how" knowledge—referring to already-found solutions to already-known problems—held by military-security enterprise to "scientifically"



The student pipeline into CrewTAF flows from civilian life to Technical Training Air Force for pre-flight training and then through Flying Training Air Force for primary and basic flying training. The pipeline includes nonrated Air Force applicants for flying training as well as trainees from nations in the Mutual Defense Assistance Pact. Students also come directly from major operational air commands for transition or refresher training in the most modern combat aircraft or for training in advanced survival techniques. Selected Army, Navy, and Marine officers also attend the survival courses. CrewTAF graduates are assigned to the operational commands, and foreign students return for duty in their own military forces.

manage both material and personnel resources.

Figure 14 The "pipeline" model of training air force students

With the hindsight, we can easily find many engineering models of education in the 1960s were designed as control systems that were initially used for solving military and economic problems as proposed in Freeman's second point. An instructional quality model (see Fig 15) was constructed by mirroring business, industrial & service organizations and substituting students' behaviors for the quality of industrial product and service. The quality control was based on a routinized comparison between inspected behaviors and the predetermined behavioral goals for continuous modification (Monroe, 1966). The management of teacher supply and demand was a focus point for educational engineers. The Crisis Control model (Chapter 3.3) articulated by the Club of Rome was also taken up to designate the acceleration of the production of new teachers (see Fig 16) in developing countries when a difference between the "actual level of student-teacher ratio" and the "dangerous level" was identified (Zymelman, 1968). To build this simulation model of education, non-linearities and feedback loops were introduced with the use of analog and digital computers to not provide the " 'best' alternative" but " 'near optimal' solution" in order to "steer the whole system towards the objective. The ideal and predetermined student-teacher ratio was questioned by researchers who developed a systems approach (Fig 17) to making accurate prediction of supply versus demand (Fawcett et al., 1974). More attributes of teachers were considered in developing such a teacher pipeline regarding dropout, certification, population migration trends, birth projection, attitudes and aspiration, etc. This so-called localized approach nonetheless dismissed and excluded whatever that could not be told in social scientific language from being "local."

These models while conceptualizing education in a technical and engineering language also necessitated the use of more computers, new media, and classroom technology to make possible self-regulated—"individualized"—learning and instruction and training more experts in mathematics and engineering to develop systems models. As Theodore Porter (1995) argued in his book that the application of mathematics and sciences in US social science was not about the latter's submission to the former but rather the vulnerability of mathematics and sciences in the post-war years pushed those experts to be engaged with other fields. To distribute systems approach developed in military-economic enterprise into the field of education, mathematic technicians and engineers not only constructed a pipeline of producing and managing teachers but also self-referentially designed a pipeline of producing themselves as if it was inevitably required by the socio-economic development.

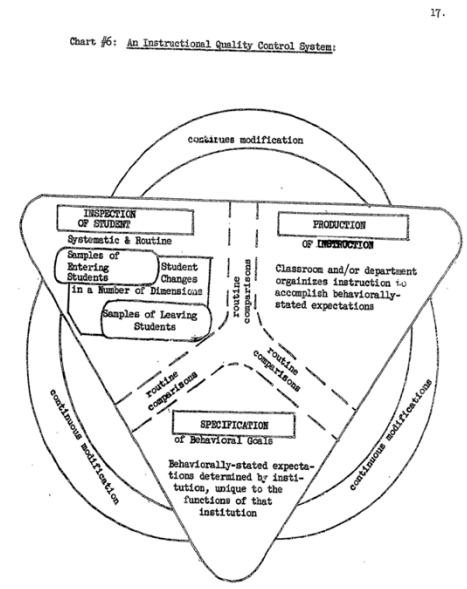


Figure 15 Instructional Quality Control Systems (Monroe, 1966)

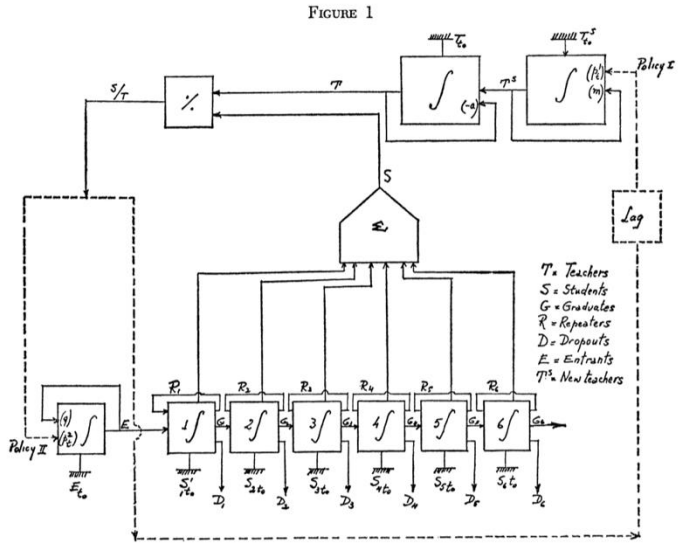


Figure 16 An Analog Simulation of an Elementary School System in a Developing Country (Zymelman, 1968)

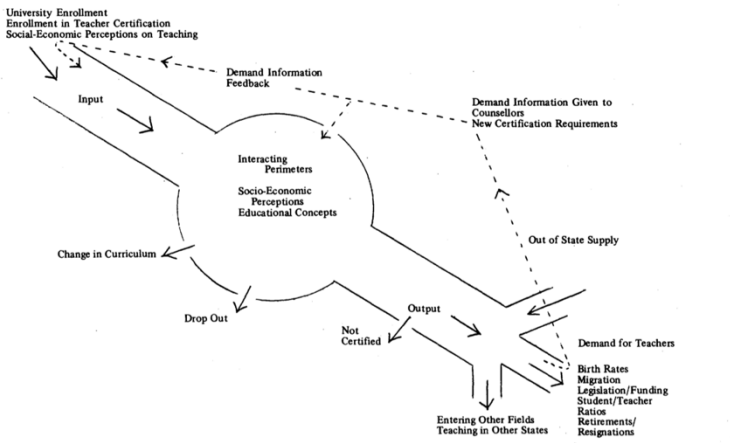


Figure 17 Modelling Prospective Flow of Teachers

(Montgomery, et al., 1974; Original source: "Phi Delta Kappa Teacher Supply/Demand Study," *Phi Delta Kappan*, September 1972, p.62)

1.2 Imagineering world educational crisis through educational infrastructures

Before entering the Sputnik era, an earlier use of “pipeline” to address the problems of education and knowledge production appeared in an article entitled “Enlightening the Japanese Mind” published in *Free World* in 1946 when the US military occupation of Japan

had been for one year. The author of this article Walter Sullivan was a navy veteran who served in the Pacific war. He argued that Japan's school system was so centralized "like a radiating series of pipelines through which crude oil is pumped from Tokyo to schoolhouses in the most remote mountain villages" and school reform was critical to preventing the resurgent militarists just as it was when the military clique took it as the best weapon to unify the youth. A jarring irony in this small commentary piece was the author's proposal of using "long-term occupation" by American army as the only possible and necessary means to reform Japan's school, de-militarize Japanese society, and make Japanese students and teachers "free" and "independent" citizens of the whole world.

This ironic paradox of "freeing" the "unenlightened mind" by controlling the educational pipeline was performatively reiterated and actualized as a guiding principle for the US, in competition with the Soviet, to intensively dispatch experts to international educational organizations and "newly independent" countries as a way to help them make educational and manpower planning throughout the 1960s. Pipeline thinking could be found in general African Studies where scholars proposed American responsibility "to secure continued freedom of the new African nations as they emerged onto "an international scene of somber and ominous crisis" and required American participation in "the training of Africa's leaders" or "high-level" manpower through constructing their "educational pipeline" and teaching "English as a second language—a scientific language" to modernize Africans (see e.g., Mildenberger, 1960; Resnick, 1967). Comparative Education scholars were interested in introducing systems thinking into the manpower and educational planning in developing countries and advocating their governments' acceptance of international academic

standards (see e.g., Zymelman, 1968). By using "pipeline" or circulating system to visualize Congolese education, Barbara Yates (1963), for example, claimed that its structural imbalance would threaten social stability and political satisfaction as "the politically aware Congolese assumes universal educational opportunity as a natural right gained with political independence." The solution she provided to make the Congo sustain itself was, paradoxically, a "slower Africanization" and a "large and sudden 'pump-priming'" of expatriates from Western countries to expand the pool of higher-level manpower and "prepare individuals to assume responsibilities in a much more technically complicated world."

Interestingly, it was US agencies rather than African countries that constructed the "educational pipelines" for such a large and sudden "pump-priming." At least three "pipelines" could be found. One was constructed by US Agency for International Development (USAID). Its educational division called for drawing upon econometrics and "engineering research" to raise the quality of educational planning in the "less developed countries" (Daniere, 1965). While emphasis seemed to be on technical and financial assistance such as offering different models of educational planning to optimize and control both quantity and quality of the manpower pipeline in LDC, the division also aimed at local attitudes of educational planning that were used to account for the failure of AID's efforts.

The second pipeline was the "Peace Corps pipeline" for producing "a new definition of citizenship," "a friendlier America," and a universal application of its experimental principle (Wofford, 1966). Rather than "top-level experts," the Peace Corps was more interested in "pumping" out a large number of "operating personnel, workers, and doers"

including teachers, technicians, and community organizers to speed up the flow of the "Peace Corps Pipeline" as these specialists were mostly demanded by the host countries. As an experiment of both peace making and a new form of education, the "Peace Corps pipeline" nonetheless naturalized "developing countries" as its experimental fields to authorize its own knowledge and power and this mechanics of self-authorization has become an underlying principle of nowadays service learning in the "global south."

The third pipeline was, rather than directly going into LDC, built through international organizations to send experts who were supposed to know and guide the world along with money to support their leadership. One of the best examples might be Mr. Philip Coombs and the International Institute for Educational Planning (IIEP) that he set up and directed in UNESCO. His advice of setting up IIEP in 1962 assumed that "recently decolonized countries had been left with few trained planners and administrators (Wanner, 2006) and the making good use of manpower was critically important to socio-economic development (UNESCO, 1963). One of his main contribution during his service time in IIEP was hosting an international conference on the World Crisis in Education that was initiated by the Johnson Government, planned by then Cornell University president James Perkins, and finally hosted by the US Department of Health, Education and Welfare and 11 foundations in 1967 (Read, 1967). The basic orientation documents of this conference were provided by Coombs and his staff at the IIEP to first analyze world's education system (Wanner, 2006). These documents were published one year later as a monograph called *The World Educational Crisis* (Coombs, 1968). This book adopted systems analysis as the lens to inscribe a world crisis based on a particular relationship constructed among education, socio-

economic development, and science and technology. The crisis it depicted and predicted was taken up by UNESCO as the very "context" of its subsequent activities in assisting the member states' educational and curricular planning.

The inscription of system analysis in the IIEP book conceptualized crisis as inefficiency. This inefficiency was defined as an imbalance and/or gap that could be identified by combining systems analysis with existing social theories of change. The first gap diagnosed between input and output was based on an endlessly extended linear Input-Process-Output (IPO) model (Coombs, 1968, pp. 11-12). The IPO model 'cut' the constantly mixed flow of people and goods into segments and relocated them as distinct, albeit consecutive, points along temporal arrows through administration. Doing so made possible diagnoses of "wrong behaviors" to account for crisis, which was indicated by disparity, mismatch, shortage, gap, and disproportion between the prospective growth of one segment and the prospective stability of its previous or subsequent one. Despite his emphasis on the shift from a linear mechanical model of education to a more dynamic system model that included interaction of different parts, the IPO model merely extended the mechanical model into a circular one to make it look more "complex."

The second gap identified between individual interests and social needs was based on using past data to forecast the 'trends' of the future. This was more than a statistical issue as it also inscribed calculable distinctions and hierarchies of labor, intelligence, gender, culture, and society of the past into the present and the future. The book argued, for example, there were too many liberal arts graduates but a shortage of manpower in the math-science-based fields (Coombs, 1968, p.75); shortages of teachers in science, mathematics, and technical

fields had been most acute and would endure because graduates in these fields would choose higher-salary and higher-status jobs (p.43); the high proportion of woman teachers compromised the education quality because they would need to attend to marriage and children (p.44); and in the developing countries, the economies were not sufficiently advanced to absorb their educational outputs such as the unemployed engineers in India (pp. 81–82).

The distinctions were calculated as (dis)proportions to indicate the contradiction between individual interests and social needs, between the part and the whole. For the decisionmakers, they had to resolve this contradiction to create a balance that was defined as efficiency. Efficiency in systems analysis of the society meant to maximize the use of individuals as a resource for social needs (Heyck, 2015). To do so, the book urged that school systems instill in students a set of attitudes, motivations, and career preferences that would meet the national needs (Coombs, 1968, pp. 95–96). Therefore, to reach balance-as-efficiency of the whole system required rationalizing the adaption of the individuals to the existing social distinction and abjection.

The third gap identified by IIEP was between the developing and the developed countries (Coombs, 1968, p.59) based on recapitulation theory that assumed the change of one particular system was analogical to the change of other systems as well as the entire world-system. What got recapitulated across different systems was the function of elements in relation to other elements in their given system. For example, it perceived educational planners to educational systems the same as doctors to human bodies, managers to department stores, generals to the military establishment (pp. 8–9). It was also believed that

although students, teachers, and materials vary in different places, a universal causal relationship could be built between the characteristics of students' enrollment and of teachers' recruitment. The inscription of systems analysis entailed a temporal order produced through the linear Input-Process-Output (IPO) model. It worked as the recapitulation theory to plan change. For example, by asking the new developing nations 'to raise their sights' to achieve a universal educational consensus (p.99), principles abstracted from education systems of the "developed" could be used to "guide" the "developing" as the former had already gone through the latter's own developmental stage (p.86).

Assuming that all the resources including time and manpower were limited in an enclosed system, which echoed with the image of the Spaceship Earth, the IIEP book treated efficiency of educational planning as prevention and transformation of "waste" of manpower. If the output of resources could not be "recycled"—that was, reused as new input—it would become 'waste' that signaled the lowest efficiency of a system. The IIEP book anticipated two kinds of waste based on this assumption: the educated unemployed and the unfinished products of education. The first kind was deemed as a problem mainly in developing countries because they imported educational forms from the developed countries that did not fit their developmental stage (p.76). To prevent this kind of waste, education systems of developing countries were asked to prepare their students for modernizing agriculture and rural life rather than modern life in the city (pp. 94–96). The second kind of waste was justified by social perception and practice that linked the finished products (i.e. those who earned certificates or degrees) with better future jobs and social status (p.65). These two kinds of waste were said to make the society anxious, the education planners guilty, and the

'waste' themselves hostile to the education systems that produced them. Since no more elements could be added to or removed from an enclosed system, the only way to recycle these 'wastes' (e.g., the unemployed Indian technicians) for balance was to ask them to 'adapt to the situation by stepping down on their "job preference scale" until they find a job they can actually get' so that they could update their jobs and make a better living (p.87). Adapting to the individual's situation was encouraged as the quality of an "educable" "lifelong learner" who could always make themselves useful' and not 'wasted.' Individual rational choice became the object of intervention to resolve the social crisis.

As the crisis indicated by imbalance of input and output was thought of as mainly a question of timing and relative rate of growth (p.26), the book suggested an immediate innovation be made by attuning people's attitudes to new changes, exchanging knowledge, and upgrading the means and content of education. Science and technology were treated as the key to all three strands of innovation. Not only were Nobel winners used to exemplify both the attitudes needed and the free exchange of knowledge, but also a self-referential relationship was built between the scientific means of education and the strengthened mathematics and science courses in the content of education.

Techno-scientific expertise was turned into a single and universal apparatus of security. Although the claim about the 'world-wide' nature of the crisis was strongly disputed by the Soviet scholars such as S. A. Tangian (1971), education experts across the Iron Curtain agreed on securing students' future by strengthening their scientific attitudes, means, and content. This consensus set up the very 'context' of the 'meeting of experts on the curriculum of general education' hosted by UNESCO in Moscow in early 1968 (The Secretariat of the

Director-General of UNESCO, 1967). To prioritize the learning of science, mathematics, and technology to secure the future, the curriculum experts in this international meeting (re-)defined these subject matters as indifferent to cultural and political value albeit representing the real world and fundamental to modern development (Morris, 1967; Bloom, 1967; Arsenyev, 1967).

Different scientific methods of curriculum making were provided in the meeting. The scientific approach suggested by the Soviet curriculum scholar M.N. Skatkin (1967) was based upon the certainty of the inherent logic of human reasoning that could be uncovered by psychological testing. American curriculum scholar Benjamin Bloom (1967) proposed another scientific approach. Although he also highlighted educational psychology, the universality he pursued relied on accumulation of experiences and the operationalization of values of education.

Regarding the disciplinary structure, the pursuit of balance of curriculum in this meeting, which was predefined by the IPO model shown previously, ironically positioned science, mathematics, and technology in the central place that was served by the teaching of humanities and aesthetics, and proposed to put subjects like general geography into “parallel schools” to unburden the regular school curriculum (The Secretariat of the Director-General of Unesco, 1967).

Four distinctive qualities of science, mathematics and technology were inscribed by the experts in this meeting to raise the proportion and the intensity of learning these subjects. First, they were “less bound up with cultural factors than other” (Morris, 1967) and thus more international in scope (Bloom, 1967). Second, they could be combined with human labor to

create high productivity in the future (Arsenyev, 1967). Third, they were the foundations of modern development and thus could realize "the genuinely humanist ideal of the free, all-round development of all members of society." (Arsenyev, 1967; Skatkin, 1967) Fourth, they were not about the past but discovering the governing law of the world (Bloom, 1967).

These attached qualities should by no means be taken as merely a representation of the hubris of scientists and technicians. By subsuming different forms of being "scientific" into a universal enterprise, the meeting rendered international cooperation of educational research necessary and possible. Defined by Lee Anderson (1969), scientific research in education was "a matter of progressively eliminating generalizations which erroneously assume either more or less commonality in our species' learning-teaching behaviors than does in fact exist." He argued that only international cooperation of comparative research could sustain such progress in education. Ironically, although it was the rigidity of science that all members trusted as the guarantor of effective solutions to modern problems, what brought them to sit together was a relative generalization of commonality.

1.3 Educational War on Poverty in America: Culturalizing economy-security through the body-mind of the "poor"

The international educational pipelines that the US constructed had their domestic twins that were also used to frame the issues regarding both the supply of "talents"—scientists and engineers (see e.g., Maul, 1953; Bueche, 1974) and the enrollment and retention of the "poor" in schools (see e.g., Schreiber, 1963; Hauser, 1966; Hensen & Astin,

1978) during the Cold War era. However, the latter became the major concern over the former in the 1960s with the rise of civil rights movement and the declaration of War on Poverty (Silver and Silver, 1991, pp.18-19). At the same time, pipeline thinking and systems approach were adopted by American social scientists to reconceptualize education as not only means of resource management but also a cultural weapon to attack domestic poverty-and-crime in order to defend against the Soviet and prove its democracy to the world (Riessman, 1962).

As discussed in the previous chapter, the "urban crisis" was increasingly conceptualized as a "cultural" problem of the "poor." This conceptualization of crisis was also conditioned by federal efforts in addressing and seeking solutions to problems of urban children and schooling. A conference on the "Impact of Urbanization on Education" was organized by the US Office of Education in 1962 to stimulate discussions of these problems. In its brief summary report, educational planning on federal, state and local levels was taken as critical measures to "make the most of these human resources." Its importance was framed in a causal chain: the concentration of the recent migrants from the rural South in city slums and their lack of "motivation, academic skills, and language sufficiencies" were used to account for "youth problems" including "higher delinquency rates" "changed labor force requirements" and "more school dropouts"; these "youth problems" were identified as the cause of high rates of youth unemployment and potential social and ideological threats. To prevent continuing production of crisis-inducing "waste" and "threats," the Office of Education suggested an unbroken line between school and job be established to first motivate and keep the potential dropouts and delinquents in school and second make them employable

after graduation. Schools were asked to assume responsibilities to prepare high school students for occupational change albeit differentially:

> Those of least ability—the mentally retarded and the reluctant learners—should be trained before they leave school for the less skilled jobs. Those who have more ability but in the past have held unskilled jobs will have to learn new skills as greater proportions of the work force are prepared for high level skilled and professional positions. An upgrading of preparation for work at all levels of ability is essential. ... The changing role of women in the work force implies the need for many vocational programs to reassess the preparation of girls and to expand their opportunities for vocational preparation. *(US DHEW, 1962, P.8)*

The dropout issue was conceptualized as "national emergency" by Kennedy administration to warrant a campaign for mounting special dropout programs for disadvantaged children with presidential fund in 1963 (Silver and Silver, 1991, p.54). There were also attempts on attacking this issue starting before this campaign. One of them was the School Dropout Project conducted by the National Education Association and directed by Daniel Schreiber. While rejecting to equate delinquency with dropouts, Schreiber (1963) nonetheless claimed that the "dropouts" were way more likely to become the delinquent than those who "quietly stay in school and graduate." He argued that what the dropout youth and the delinquent youth shared in common was not only their social and economic status but also the "threat" they posed "both to himself and to the community at large." He continued to argue that there was no *place* and no *future* in American society for the school dropouts who entailed the "greatest sin" that was "unforgivable waste and destruction of human potential, of human talents and resources." To confront "the magnitude of the problem," Schreiber (1964) recommended to use Early Childhood Programs as a preventative solution to solving dropout and delinquency since by that time American psychologists had popularized the idea

that the first six years were mostly critical to intellectual and emotional development of the young child (Silver and Silver, 1991, pp.30-32).

As discussed in chapter 3, scholars and professionals of education and health started from the late 1950s to use "class culture" and "environment" to both account for and intervene the "culture of poverty" including their vision of future and their desire of learning. These approaches were adopted by many experimental programs at that time including New York City's Higher Horizons Program in 1957 that later became a prototypical model for other city and state programs such as Ford Foundation's Great Cities Grey Areas Program. Seeing work-study programs as important albeit corrective, Schreiber (1963) advocated this new approach epitomized by Higher Horizons as "preventive" and "positive" for it exposed the "culturally deprived" children and parents to middle-class life experiences and environment which were assumed to sustain their aspiration of learning.

However, this assumption that environmental limitation would inevitably made children of the poverty drop out was questioned by the contemporary educators and psychologists including Frank Riessman whose theory on the "culturally deprived children" was widely reviewed and debated after its publication in 1962 (see e.g., Clift, 1963; B.S.M, 1963; Friedman, 1967). Riessman (1962, 1963, 1965) argued that children of poverty, opposite to popular impression, did desire education but they were prone to dropout because they were not respected in the school which only appreciated "middle-class" culture and attempted to "middle-classize" and pathologize them.[24] He called for attention to the

24. Similar critiques were also made by other scholars in the early 1960s. See e.g., Deborah Partridge Wolfe, 1962.

“positive efforts of low-income individuals to cope with their environment” and proposed to use these positive elements as guiding lines for teaching these children effectively. The agents of change of motivation and achievement was thus shifted from individuals, families and their living environment—characterized as "the crowdedness, the lack of privacy, the lack of economic security—to schools and teachers who were asked to prepare “specially” for “developing interest and excitement concerning the psychology and culture of the poor” and teaching strategies and style that matched the learning style of the disadvantaged students (1965). Riessman (1965) also emphasized that the mere exposure to the living environment and experiences of the “deprived” might reinforce stereotypes rather than the opposite so those exposure must be carefully prepared to help teachers understand “what to look and how to look at the culture of the low-income groups involved.”

To “make a kind of teacher who was most effective with the disadvantaged child” through preparing them with such a “look” and “respect” for the culture of the “poor,” Riessman (1962) nonetheless characterized the cultural norm and learning style of these children in a fixed—although not biologically inherent—and differential way. The seemingly neutral terms that he used to describe “the positive strength” of these children nonetheless embodied cultural stereotypes about their goal of education—vocational ends, future jobs—industrial workers, behavioral manners—physical and visual rather than verbal, physical preference—masculinity. These unquestioned stereotypes were used to determine what teaching strategies could help them learn best: masculinization, role playing, more use of teaching technology (as they learned through machine), programmed instruction (as they

learned like machine), problem-based skills and reality-oriented reading (as they only read about what they saw and did).

With the guidance from Riessman on differentiating the learning style of low-income children from middle-class children, specialized programs were designed to prepare teachers to work with disadvantaged students (see e.g, the Bridge Project, Downing and others, 1965; Stripling in Schreiber, 1964; Miller and others, 1967; O'Brien, 1965; Knapp, 1965). Positive attitudes towards the "poor" children and extended field experiences in lower socioeconomic schools and communities were highlighted. But at the same time the assumptions that these children were less motivated and that they needed social and academic "skills" more than academic "knowledge" were also embedded in pre-service and in-service teachers' training as a way to secure the future of the "poor" and the whole society.

2 Constructing a perspective of the global future as competency for survival [25]

While pipeline thinking and systems approach travelled from engineering and military management into US and world educational planning as cultural weapons to combat wars on poverty at home and abroad, the phantasm of a global crisis also came into US classroom and curriculum during the 1970s and 1980s to redesign learning as a way to preempt a potential apocalypse of the Earth and human beings. International education and global competency emerged as epistemological infrastructures of anticipation to prepare for the potential

[25] [25] A preliminary and partial version of this section has been published in Chinese in Journal《全球教育展望》on October 2019.

conflicts between the “have more” and the “have less,” and to secure one’s survival when facing known and unknown crisis-inducing situations.

2.1 Spaceship Earth education

From the late 1960s, the imaginary of an finite, intimate, and lonely spaceship earth (see details in Chapter 3) was promoted to work as a guiding principle to re-orient curriculum development, basic social scientific research and teacher education in the US (see e.g., Nesbitt, 1968; King, 1969; McInnis, 1970; Hawkhill, 1973; Bybee, 1979). A book entitled “International Education for Spaceship Earth” was published by the Foreign Friends Association in 1971 based on a two-year study on “An Examination of Objectives, Needs, and Priorities in International Education in US Secondary and Elementary Schools”[26] directed by Prof. James Becker, who later became known as the “father of global education.” [27] Among contributors of this study, except educational scholars, there were researchers in the fields of political science, economics, geography, international relations, and psychology, who were concerned with educational implications of the image of Spaceship Earth.

In this study, change was naturalized as a revolutionary transformation of humankind, eradication of boundaries, and decline of American isolationism and a conceptual lag, similar to Calhoun and the Club of Rome report, was said to exist between this new reality and people’s old way of perceiving it (Becker, 1969). Education was asked to respond to the transition from human separated from each other to human as part of a world-wide system

26. The final report of this study concluded in 1969 but a set of its position papers were published first in a special issue in *Social Education* in 1968.

27. Kirkwood-Tucker, T. & Goldstein E. (2007). *Father of global education: Jim Becker*.

(Harper,1968) and to change from ethnocentric to international otherwise it would cause more students unrests (Boulding, 1968). According to Boulding (1968), to avoid the conflicts between the super culture represented by universities and the folk cultures within which the school systems were embedded was to expand the "noosphere"—the sphere of cognitive structures—to get closest to "reality":

> *Under these circumstances the facts are so clear that it should not be too difficult to organize a whole curriculum around the concept of the earth as a total system, including of course a certain amount of astronomy to put earth in its setting in the solar system, the galaxy and the universe. The inputs of the earth from anything outside it except the sun are so minute — in terms of energy, though not in terms of information — that from the point of view of earth as a system we can virtually neglect them. We could continue them with geomorphology and the study of the lithosphere, the hydrosphere, and the atmosphere as total systems, always constantly moving towards an equilibrium which is equally constantly disturbed. Then of course we go on to the biosphere, which should be taught mainly from the point of view of world ecology stressing its interdependence with the other spheres but stressing also the concept of the ecosystem on both the micro and the macro scale. (Boulding, 1968)*

Boulding's theory on the system of the planet earth as a total system of systems was not only taught to new college students as introduction to the general social sciences (Boulding, et al., 1980) but was also integrated into science teaching in middle schools (see its visualization in a teaching video of Spaceship Earth produced by Hawkhill in 1973). Science educator Rodger Bybee (1979) drew upon the "noosphere" Boulding proposed to extend science education to incorporate the human issues including " problems of lifetime (conception, abortion, birth control, death with dignity); life space (pollution, crowding, urban decay); and life style (affluence, poverty, consumption, conservation)."

Looking at the earth as a total and enclosed system became a principle to organize both curriculum and education reform. The IIEP book—*The World Educational Crisis*—also

inscribed such a historical distinction to the spaceship earth discourse in its very beginning: "This is a *world* educational crisis' rather than a national one that had been the commonplace in the previous years" (Coombs, 1968, pp. 3–4). This distinction was much less a transparent consensus than an order made through the mechanical "eye" that looked at a finite and crowded globe from its outside. The book conceptualized the 'systems analysis of an educational system' as such an eye that functioned "as wide-angled lens trained on an organism so that it can be seen in its entirety, including the relationships among its parts and between the organism and its environment" (p.8). It argued an analysis that embodied a global scale could "be profitably brought to bear on the specifics of any particular educational system." (p.132) Therefore, this global scale was assumed as a self-evident justification for an urgent and universal application of systems analysis to diagnose education for its future, which (un)surprisingly rendered the catchword "world" barely visible throughout the book. As discussed in the previous chapter, the interdependence of the spaceship earth was imagined as a conflict-inducing situation and simulation games were used to create such a phantasm. Within the study on developing international education directly by Becker, Morris and King (1968) also advocated to use children as the common resources to simulate the real world and to feel the "other" by not only "stepping into another's shoes" but also playing the role of those who didn't even have shoes! The phantasm of survival-in-bottle was materialized through a particular set-up of the classroom environment. "Intimacy" and "vulnerability" were no longer conceptual abstraction but actualized through children's play with their affects induced by such a set-up. Although the simulation game might aim to make students more empathetic with the "poor," it nonetheless

produced fear towards the “poor” and hope for securing their own advantages. For example, one of the experimental programs of Spaceship Earth Curriculum was conducted in the Elementary Laboratory School at Colorado State College in 1969. It asked children to simulate their survival on a spaceship: “The children were the passengers and crew on board a spaceship. Through the use of an overhead transparency, which projected a drawing of the inside of the ship, and an audiotape, the environment was established. As the group traveled through space, the audiotape dramatized a sequence of events that *limited* the air, food, and water supply and created problems with *overcrowded* conditions, all understandable situations with which the youngsters could identify.... They talked about the complications that could develop in a *limited* environment, about the need for *cooperative* efforts among people in *close proximity* to each other or dependent on each other, about the kinds of *internal conflict which arise when people are subject to discomfort, deprivation, danger, and other forms of stress*.” (italic added; King, 1971) Resonant with the social/scientific experiments shown earlier, conflicts were naturalized as an inevitable consequence of the living environment of the “crowd.” In another Spaceship Earth Curriculum Project developed by the Center for Curriculum Design in Illinois, one article written by Noel McInnis (1970) dramatized a catastrophic human future as a consequence of any “inappropriate behavior in one component of the system.”

The prevalence of a feeling of hopelessness could also work as, according to Bybee (1979), a cause for action of change that could bring about hope. The image of earth from outer space was again taken as the beginning point of hope for it made human possible to see the limit and disorder of his growth and also engendered action to restore a global

equilibrium. Bybee (1979) concluded that “the burden for change will fall heavily on science education. ... If, after an inventory of the global situation, people are to avoid despair, there must be a repair of the broken image between science, its technology, and humankind.” He used war as an analogy to inform how to counter an ecological crisis by developing a sense of community: setting up a shared goal—survival, a shared enemy, and anticipation of victory in the near future. Problem-solving, inquiry in science, and priority of cooperation were regarded as the ideal ways to develop such a sense of community among students.

Lee Anderson (1968, 1969) took up the imaginary of Spaceship Earth to call for international cooperation of comparative educational research. Such an interest was also expressed and developed into projects by institutes affiliated with UNESCO, such as IIEP and UIE from the mid-1960s. The International Association for the Evaluation of Educational Achievement (IEA) was finally set up to make international comparisons of educational performance based on the IIEP’s recapitulation model of education system discussed previously. These comparisons through international cooperation attempted to look for a global scale expressed as statistical standard scores and to use it to measure the differences of each country based on their statistical deviation from it (see Fig 18). Therefore, the global scale paradoxically performed as an a-spatial benchmark that could be used to engineer each individual country towards it future—the right side of the deviation bar.

Figure 2. Increase in level of performance in Science from the 10-year-old level to the terminal secondary school stage

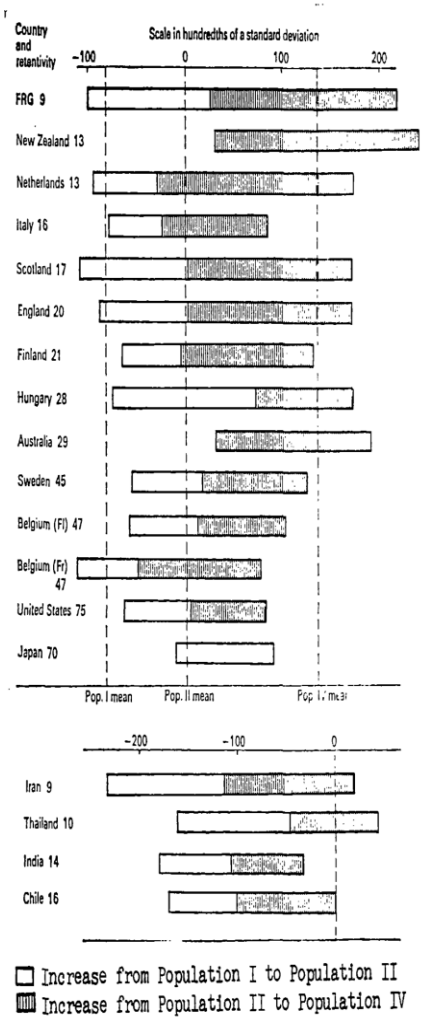


Figure 18 A selection from the overall findings of the IEA study in science, reading comprehension, literature, French as a foreign language, English as a foreign language and civic education (T. Neville Postlethwaite, 1973)

2.2 Anticipatory Learning for the Nation at Risk: The New Curriculum Reform

The change of the world that was anticipated through systems analysis very soon ordered a change of learning as means of surviving the change. While the first report to the Club of Rome, *Limits to the Growth* made the first computerized global modelling of population and capital in the MIT laboratory, the third report to the Club of Rome, *No limits to learning* (Botkin et al., 1979), applied the precautionary and anticipatory thinking to

creating human mind and culture for survival in the 1980s. Preparedness for and preemption of the future crisis for survival thus became an explicitly cultural agenda. As the authors argued, “To put human survival in the forefront as the first purpose of learning signifies that we are not discussing a metaphysical issue; instead, *learning has become a life-and-death matter, and not only* for people at the edge of subsistence.” (p.14, italic added)

Interestingly, the authors of this book directly disputed the cognitive approach to problem-solving which conceptualized human as machine—which was nonetheless considered as appropriate to teach the “culturally deprived”—and celebrated human’s distinctive autonomy that was manifested by anticipation and participation. It introduced the imaginary of the global uncertainty and the fatal shock as the new situation that requires anticipatory learning in contrast to “learning by shock,” which was designated as “a formula for disaster” (p.10).

Two general principles of anticipatory learning were proposed. One was to have an exhaustive collection of contexts and unfamiliar events to reduce the probability of shock. Two, it was also to create “new alternatives where none existed before” to ward off traumatic and costly lessons by shock (p.25). Governed by these two principles, anticipatory learning pursued a stable future no longer based on a measure of probability but on both an imagination of possibility of unknown situations that were defined as threats and a collection of already known situations. A responsible learner was defined as someone who dared to take risks, control crises, and make surprises in those situations.

The anticipation of an increasingly devastating human condition and the idea of preparing learners and schools for frequent crisis were circulated and developed further

throughout the US in the 1980s. Scholars across various disciplines in natural and social sciences were invited by Shane and Tabler (1981) to discuss how to develop curriculum for the new millennium with an anticipation of "an era of turmoil" that was reiterated through American futurist reports, e.g., *the Global 2000 Report, Through the 80's, The Crucial Years: 1986-2006*, and the like.

The "evolutionary jump" that were experimented in Pearl's bottle and simulated by MIT scientists' computers was rephrased as the "crisis of crises" by one of the panelists, biophysicist Johan Platt, with a similar imaginary of the crowd-inducing panic that Mintz's bottle materialized: "The Mayor in a large city can usually cope with emergencies such as a heavy snowfall, strikes by police or firemen, or a derailed train with chemical-filled tank cars. But if the train derails in a massive snowfall at the sometime that police and firemen are on strike, a full-blown crisis is created." (Shane & Tabler, 1981, p.41) Moreover, based on the imaginaries of a crowded spaceship earth that Ward and many others created, this discussion also reiterated that the interdependence of world resources, rising aspirations of living conditions, and "have more" and "have less" distributions would lead to rising global conflicts as "in many instances it does not matter whether the threat is real or fancied; it was how people *feel* that leads to confrontations, to picket lines, and sometimes, to battle lines." (p.6, italic original) In another word, it was the *feeling* of being threatened that were held accountable for a turbulent future. This is not an unfamiliar argument as we have heard from Banfield in the 1960s to use the "feeling of alienation" to account for the "urban crisis." The control of feeling became a matter of security.

In line with this assumption, U.S. youth and adults alike were asked to "have the courage to come to terms with nature and with their psychological, physical, and sociological environment as well as with their world peer groups" and curriculum makers were asked to help them "grasp survival concepts, understand how to use them wisely , and work with others in creating a more humane, less threatening world society." (p.31) Today's educators and policymakers might also be very familiar with these survival concepts (see Table.1) but with a different title called "21st century knowledge and skills for innovation and competitiveness." These concepts were created to make a "surprise-free" future and to "accommodate ourselves to the unexpected or the unpredictable" (p.46).

	Natural Sciences	Social Sciences
Overarching and overlapping Survival Concepts	limits, interdependence, ecocide, entropy and conservation, explosive population growth, scientific method, evolution, unity of nature, cycles in nature, human vulnerability, the need for more research, lifelong learning, information overload	

Table 4.1 Survival Concepts (Shane and Tabler, 1981)

To make students survive the uncertain future, these invited experts suggested studying and using social indicators to anticipate changes and then derive a curriculum from those images of the emerging future to make "an evolutionary educational change" (p.77). This paradigm of an anticipatory curriculum or derived curriculum (Fig 19) was developed as an application of Kuhn's paradigm shift (pp.77-78). However, the way it conceptualized changes and problems was exactly what Kuhn (1962) meant by "tradition," which validated itself by transforming the contingencies into existing categories for comprehension and

control. For example, the anticipatory/derived curriculum planning took changes as linear trends that could be reflected by social indicators and understood crisis as conflicts and survival as consensus between the old and the new without looking at whether the criteria of differentiating them was obsolete. The embedded epistemological assumption of the conventional curriculum and the innovated curriculum was the same. That was the fundamental gap between the past, the present, and the future.

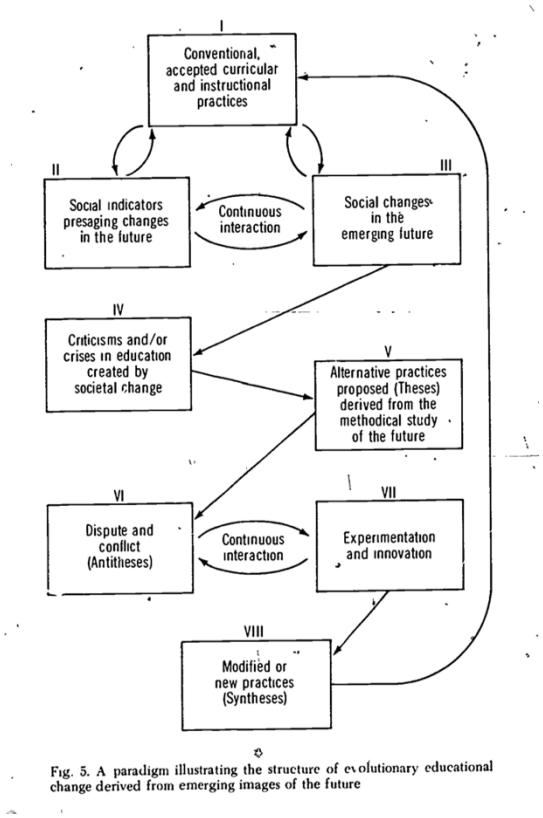


Fig. 5. A paradigm illustrating the structure of evolutionary educational change derived from emerging images of the future

Figure 19 The Anticipatory Curriculum Planning

However, the anticipatory/derived curriculum did provide US educational reformers—ironically the majority in the reform committee were not from the field of education but science, technology, engineering and business—a rationale for preempting

crises by preparing learners for anticipated images of the future. Triggered by the imaginary of a protentional falling of the nation as cried out by *A Nation at Risk* (US Department of Education, 1983), the heuristics of problem solving became not only the core content of the New Math (see e.g., NCTM, 1980; Romberg & Tufte, 1987; NSB, 1983; NCTM, 1989; Shoenfeld, 2007) but also the new goals for US education in the 1980s (et al., Picus et al., 1983; Noble, 1989). The questions of how to connect the known and the unknown and how to adapt oneself to unexpected settings stood at the heart of the pedagogy of problem-solving.

In line with the principle of anticipatory learning that I mentioned earlier, although the goal was to deal with uncertainty, routine and commonplace situations and problems were not discarded in the curriculum reform documents but seen as essential to sequentially building a repertoire of basic skills and strategies of problem-solving, particularly for lower grade students (NCTM, 1980). This repertoire of learning strategies was in essence strategies of controlling (Noble, 1989) since it could be well designed by instructors and used by learners in a multitude of familiar and unfamiliar situations.

In addition to the cognitive and visual strategies of "seeing" the future, different from Mintz's hypothesis of non-adaptive behavior, affective approaches to problem-solving was also highlighted in the New Math curriculum (Romberg, 1987). *An Agenda for Action* echoed with Fuller's boast about the Great Pirates when proposing "an open mind, an attitude of curiosity and exploration, the willingness to probe" as the foundation for problem-solving (p.3). Familiarity with situations and problems also mattered in the sense of protecting student's confidence and keeping them motivated in the process of learning (Picus et al., 1983).

Debates nonetheless existed regarding whether the approach to problem-solving should be segmental or integrative, whether the cognitive development was fixed or modifiable. For example, Romberg & Tufte (1987) argued that more abstraction and generalization would bring about more flexibility of problem-solving. However, there seemed to be a consensus from both sides on the use of various techniques of visual representation of problems as crucial to problem-solving (see NCTM, 1980; Picus et al., 1983; Romberg & Tufte, 1987). These techniques included imagery, schematic diagrams, graphic models, analogy, observation of phenomena, and simulation of real or natural settings. Researchers gave emphasis on reconceptualizing problems through visual forms with the assumption that students could not perceive problems and let alone become problem-solvers until they could "see" the problem scientifically. In another word, only problems that could be visualized in a techno-scinetific form were regarded as solvable and teachable. The technoscientific vision of the world not only defined what actually counted as problems but at the same time, as shown by the trend of Big Data today, became equivalent to the solutions to the problems it defined.

The "leaky STEM pipeline" is a historical and performative effect of the travelling of the pipeline thinking and systems approach that objectified the international and domestic "poor" as the subject to be contained and transmitted by educational infrastructures to preempt the potential threats they were imagined to the whole society. Survival concepts and simulation of the apocalypse that were developed out of techno-scientific performances of a total closed world system have still worked as organizing principle for developing the 21st century global competence through international assessment to control the unknown future

and to deal with the unknown others. The construction of technoscientific and educational phantasmagrams of crisis has performatively mobilized fear towards the unknown as threats and hope for techno-scientific control of it and thereby prevented us from imagining the unknown otherwise.

Coda

Imagineering Crises interrogates the contemporary and historical constitution of US STEM education discourses to reveal the cruel optimism of educational reforms. It continues and expands the discussions curriculum studies scholars have fostered on the cultural politics of knowledge-for-change by drawing attention to how curriculum and learning have been adopted as apparatuses of security to preempt crises and how crises have been performatively imagineered through particular epistemological infrastructures. This dissertation research particularly troubles the paradox of empowerment and control embodied in US-led techno-scientific performances of crises that not only construct the domestic and international "crowds" as the objects of fear and control but also authorize a particular techno-scientific vision of the world as the most critical knowledge and skills for survival, which provides an epistemological foundation for international institutes such as UNESCO and OECD to develop international educational planning and assessment.

Besides, this research also intends to make visible the politics of the unknown including the violence of capture, and the fear of captivity that the regime of security takes up to produce learners as life-long warriors. It refuses an apocalyptic and confrontational imaginary of the future conjured through social/scientific infrastructures; and refuses the phantasmagrams of crisis that make children subject to the "struggle for existence" within a finite time-space. It calls for an imagination in and through education that appreciates and respects the indeterminacy of life rather than seeking for a total control of it. Staying with the common troubles, acknowledging vulnerabilities of life, is not to accept violence, but on the

contrary, it counters the forces that exercise control and exclusion to achieve the promise of impeccability in the name of empowerment and protection.

Before looking at this research retrospectively, I would like to first give a brief overview of the main points of each chapter:

The introductory chapter starts with conceptualizing US STEM education reform as an epitome of a technological formula of crisis: Routine + Crisis= Reform. It situates this formula at the intersection of the politics of technoscience and the security regime of American empire. Existent postcolonial science and technology studies and security studies are reviewed to draw analytic attention of this research to the entangled relations between control and freedom and between hope and fear of change. This chapter also introduces performativity theory as a method of both discourse analysis and historiography. It is taken up to investigate the politics of making knowledge, the world, and history and to reveal the ways in which we become trapped in a lockstep of change. Key analytical concepts in this research such as phantasmagrams, epistemic infrastructures, imagineering are also explained as part of the performative approach to curriculum history.

Chapter 2 explores the poetics and politics of the “leaky STEM pipeline” metaphor that rationalizes US STEM education reform through making the objects of fear and the subject-in-crisis. The first half of this chapter analyzes how the global scale and common standards constructed for international comparisons and competition are mobilized to produce both a sense of certainty of future progress and a fear of threat that is thought to be posed by not only the “techno-Orientals” but also the domestic “diverse” students. The discourses of “diversity” “inclusion” and “empowerment”, as this chapter argues, work as

epistemic infrastructures that instrumentalize, weaponize, and capitalize the bodies and minds of those "leak" students including girls and youth of color. The second half of this chapter discusses how the DARPA model of innovation is enacted through the pedagogy of problem-solving in US STEM education programs, children literatures, and learning activities. It argues the examined pedagogical practices associate STEM tightly with securing individuals and home from potential danger and with the desire of conquering the unknown land while ignoring the conditions and consequences of such practices of securitization and exploration; virtual media (e.g., video games, sci-fi movies, and simulation of space colonization) tend to play a critical role in making students-players not only enact but also embody such a phantasma that the telos of human world is to make technological progress for survival and superiority in a finite time-space. The risk-taking problem-solver that STEM education desires to make becomes a normative figure that reauthorizes colonial dispossession and exploitation and at the same time dramatizes himself as a life-long warrior to prepare for and preempt the imagined crises.

Chapter 3 historically traces how a phantasm of survival crisis was performatively constructed on varied scales through techno-scientific arrangement and control of time-space, cultural imaginaries of the "crowd," and international and domestic politics of the "poor" after World War II. It argues that through aesthetic and metaphoric tactics, social/scientific concepts became phantasmatic as they not only translated the social reality into the objects of technoscientific calculation and control but also transformed technoscientific speculation and experimental results back into the cultural imaginaries of the problems of modernization. In tendon with such performative translations and transformation were fears of scarcity,

intimacy and uncertainty that those newly independent were imagined bringing about. The production of fear through these technoscientific performances of crisis rationalized and mobilized preemptive control of particular kinds of life. The accountability for crises was distributed by such performances to the “crowds”—in the urban slum or Third World--who were seen as excessive, unable to help themselves, narrowly-minded, lack of the ability to think and act beyond the now and here, and threatening the existence of the whole. The construction of the dangerous “crowd” performatively authorized an impersonal and technoscientific vision of the grandest scale of time-space as a cultural and ethical solution for the “crowd” to overcome their irrational feelings and restore balance and order for survival.

Chapter 4 interrogates how epistemological infrastructures such as pipeline thinking and “the spaceship earth” that imagineered crises were circulated into the field of US education and international education planning mostly during the 1960s and 1970s. It finds that education research and policies borrowed the use of "pipeline" from engineering, supply management and military personnel management to control and optimize the behaviors of teachers and students. By distributing systems approach developed in military-economic enterprise into education reforms, mathematic technicians, engineers, and economists also self-referentially designed a pipeline of producing themselves as if it was inevitably required by the socio-economic development as well as military-ideological competition. It also argues that the techno-scientific configuration of time-space that produced phantasmas of the “urban crisis” and “global crisis” necessitated learning and curriculum as cultural apparatuses of security to prepare students for both the known conflicts and disasters and the unknown

threats. As a main component of educational innovation in the 1980s, the pedagogy of problem-solving that adopted simulation of crisis-prone situations not only induced students' fear towards the unknown but also encouraged them to adopt preemptive vision and action for future survival.

The arguments of this research summarized above by no means imply that science, technology, engineering and mathematics should not be taught in the classroom because they carry a historical "sin" of conquering and manipulating time-space and life. However, it does beg serious question that how crises or problems that are used to guide pedagogy and curriculum are conceptual-material-affectively constructed in a way that turns particular knowledges and skills into legitimate and inevitable apparatuses of security to guarantee individual, national, and even planetary survival. Also important is to re-account for how and why given subjects are held accountable for crises to be solved. These are not merely research questions but also pedagogical questions when educational reforms are repeatedly driven by a sensitivity of crisis.

Writing and presenting this dissertation thesis in different countries and languages in 2019 when events and feelings of crises seem to circulate around the world as an epidemic, I gradually changed the focus and even arguments of this research. While I initially intended to investigate the transnational circulation of a universalized scientific means of reforming education and society, my analysis and observation of both the historical and contemporary events made a different conclusion that what mattered more in such circulation was a long-lasting phantasm of survival crisis that was co-constituted with American social/sciences. It is this phantasm that continues to drive anxieties about modern development and the current

polarization of the political, the socio-economic, and the cultural fields in many countries. The fear of conflicts and confrontation between the “crowd” and the “elite”, the “have more” and the “have less” is not merely an effect of such divisions but a force that actualizes and perpetuates them through techniques that substitute the real for the imaginary.

I plan to refine my analysis and arguments of this dissertation research by deepening the theoretical thinking about the theatrical and metaphoric performances of the real in techno-scientific settings. The revision will particularly focus on how these performances enabled and distributed certain models of innovation with the goal of optimizing and controlling human and non-human resources. In addition, historical literatures on social and human engineering will be supplemented to better contextualize the social/scientific experiments examined in chapter 3. Chapter 4 will be divided into two chapters. One of them will provide a more nuanced analysis of the co-constitution of educational pipelines and risks based on archival materials of US education reforms from the 1960s to 1980s. The other will focus on the connection between the techno-scientific vision of the global earth and the early development of international and comparative education, international assessment, and global competency by international institutes and scholars.

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