Critical Education

Packaging Girls for STEM or STEM for Girls?
A critique on the perceived crisis of increasing female representation in STEM education

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Abstract

This critical essay considers the "problem" of girls, STEM, and visual media to critique how their intersections shape discourses surrounding public perceptions of neoliberal STEM education reforms. We ground this essay with a brief discussion of recruiting girls into STEM as discussed in federal education policy documents, and address the roles the mass media play in shaping and conveying issues concerning education. We then discuss visual imagery to consider the role they might play in shaping one's understanding of STEM education, provide examples of STEM imagery, and consider how they complement or complicate textual narratives by foregrounding or masking different aspects of STEM. We highlight how the composite nature of many images associated with girls and STEM reinforce gender-normative and hetero-patriarchal assumptions. Finally, we discuss how such images normalize and truncate the discussion about and implementation of programs for girls and women in STEM.

Keywords: STEM Education, Media, Visual Imagery, Women/girls

Introduction

Like many neoliberal school reform discourses, STEM discourses and policies employ a language of urgency and crisis in regard to addressing the needs of children and youth in a global society (Drew, 2011; Educate to Innovate, 2009). They are presented as a means for the United States to maintain economic and technological competitiveness in an era of increased global competition. At the same time, such discourses are touted as a means to address inequities in income and education, particularly for women and minorities (Drew, 2011; *Educate to Innovate*, 2009). In response, education researchers have turned their attention to how the discourses surrounding global competition and economic crisis have been used to justify school reform practices like the closure of public schools and reopening them as ostensibly public charter schools under private control, diminishing employee rights and eliminating pensions and benefits, and the narrowing of the school curriculum to cover only those subjects beneficial to competition in a capitalist society are reflected in news media reports to largely and uncritically support neoliberal education reforms (Hursh, 2015; Lipman, 2011; Peck, 2015).

This critical essay considers the "problem" of girls, STEM, and visual media to critique how their intersections shape discourses surrounding public perceptions of neoliberal STEM education reforms. We problematize rarely examined visual imagery about STEM and women/girls in order to understand 1) what messages might be disseminated broadly about girls and STEM and, 2) what the public at large might come to understand by consuming them. Employing visual exemplars from visual media including ClipArt, advertisements, and popular products marketed for girls, we highlight a persistent disconnect between official STEM discourses, extant visual imagery, and what it means to be *woman* in STEM. This disconnect masks deeper, more entrenched structural, institutional, and ideological barriers that persist for women.

We ground this essay with a brief discussion of recruiting girls into STEM as discussed in federal education policy documents, and address the roles the mass media play in shaping and conveying issues concerning education. We then discuss visual imagery to consider the role they might play in shaping one's understanding of STEM education, provide examples of STEM imagery, and consider how they complement or complicate textual narratives by foregrounding or masking different aspects of STEM. We highlight how the composite nature of many images associated with girls and STEM reinforce gender-normative and hetero-patriarchal assumptions. Finally, we discuss how such images normalize and truncate the discussion about and implementation of programs for girls and women in STEM.

Girls and/in STEM:
A new panacea for a longstanding manufactured crisis

Like all education policymaking and implementation, recent U.S. school reform efforts reflect official national and local priorities regarding the education of young people and their potential role and place in society. Power brokers, including the media, have framed one policy agenda, STEM (science, technology, engineering, and mathematics) as a means to ensure the economic, military, and intellectual domination of the United States in the global theatre. Simply put, governmental and corporate representatives have long contended, from *A Nation at Risk* (1983) to the recent reauthorization of ESEA in the form of *Every Student Succeeds Act* (ESSA, 2015), that there is too little scientific and technological expertise in the current and soon-to-be

potential workforce to maintain the United States' supremacy as a global economic, military, and political power (Mehta, 2015; Vinovskis, 2015). Among the solutions proposed was to recruit and train highly qualified workers to take employment in STEM fields, with particular focus on tapping underrepresented groups for future STEM employment.

More recently, the Obama Administration specifically targeted girls and women for STEM recruitment because they are considered an "untapped resource" that might fulfill employer needs by increasing the applicant pool of qualified STEM candidates (*Change the Equation*, 2010; *Educate to Innovate, 2009*). Women were considered a particularly good investment since already they "[made] up 46% of the total current workforce, but only [held] 24% of jobs in technical or STEM fields" (*Change the Equation*, 2010, p. 2). To move girls and women successfully into the STEM pipeline additional recommendations included (1) representing more women in STEM fields in popular culture, (2) encouraging awareness of STEM as a growing career option, (3) developing more authentic, hands-on activities highlighting real world applications and problem solving, (4) showcasing successful female STEM role models and connecting girls and young women with mentors, and lastly, (5) dramatically increasing girls and young women's *exposure* to STEM career opportunities and academic events such as fairs, conventions, museum trips, summer camps, and after school activities (Bybee, 2013, *Prepare and Inspire*, 2010).

Since then, a number of STEM initiatives, including opening charters schools with a STEM focus, infusing more STEM content into K-12 public school curricula, afterschool programs, increased focus on STEM in higher education, programs designed to recruit girls and minorities into STEM, teacher education programs in STEM preparation, and others have been explored and implemented, with varying results (National Research Council, 2015). What the public learns about STEM educational reforms like those listed above, however, is often based anecdotal evidence, personal experience, and in large part, media production across multiple platforms (Franklin, 2004; Goldstein, 2010; Tollefson, 2015). They learn about STEM reforms because a family member or acquaintance is enrolled in a particular program, or they themselves engage in STEM-related activities or professions. They are exposed to STEM careers via popular culture like Bill Nye, The Science Guy, *Big Bang Theory*, or other programming (Kohlenberger, 2015). For many, their daily dose of news via social media networks might shape their thinking about the latest policy debate over math education (a part of STEM), were they to come across discussion (see, for instance, Kümpel, Karnowski, & Keyling, 2015; Lange & Meaney, 2018; Pense, Freeburg, and Clemons, 2015; Perrin, 2015). Given the ubiquity of the media as a system of mass communications, examining how the media "package" information about STEM—for our purposes, how they *frame* girls and STEM—helps those concerned about education to better understand the complex processes that shape community perceptions about *whom STEM is for* (Matthes, 2011).

Applying a Lens to Media for Social-Political Critique

21st century media systems help to compress distance and democratize who controls, produces, and shares different media forms by presenting those who consume media with a torrent of images and messages that one must parse (Gitlin, 2007; Hay & Couldry, 2011; Jenkins, Ford, & Green, 2013). Media also operate as contested sites for identity construction and meaning making with their own culture and practices that help to construct reality (Bourdieu, 1993; Couldry, 2008; Jenkins, 2006). Digital technologies make the global appear local, and

bring news, people, and stories from all over the world into one's locale. Thus, media sources not only function as part of the policy enactment process by clarifying the processes and official arguments, they also narrow the way in which the public comes to think about school reform issues, their problems, stakeholders, and solutions (Baroutsis, 2016; Baroutsis & Lingard, 2017). In other words, media sources like ClipArt, Getty Images, advertisements, social media, and others help to frame (e.g., organize) what it is that people think about policy initiatives like STEM, as well as how they think about them, because how an issue is framed "not only defines the issue, but it also suggests the solution" (Menashe & Siegel, 1998, p. 301).

Further, media are an important site for exploration and critical commentary on neoliberal education policies like STEM. First, the policies, news reports, and their concomitant media prominently present STEM school reform initiatives as a means to achieve more equitable schooling outcomes for underrepresented students, including girls and other minorities. Even so these same policies fail to consider the lived realities of students in the classroom and beyond (Gutstein, 2010; Martin, 2013). Second, media play a significant role in shaping public perception about policies, educational initiatives and discourses, thereby playing an influential role in cultural production (Bourdieu, 1993; Lingard and Rawolle, 2004); Last, while media play a vital role in a vibrant democracy (Habermas, 1991), how problems and solutions are framed often simplifies debates and masks conflicting viewpoints (Haas, 2007; Kumashiro, 2008; Levin, 2004; Opfer, 2008). Finally, while journalists and other policy communicators themselves may not ascribe to neoliberal perspectives, the structures and institutions in which they work privilege the ascendancy of neoliberal logic as a system of meaning which permeates all aspects of mediated life (Brown, 2015; Couldry, 2008; Fenton, 2010; McChesney, 2001).

A growing body of literature has explored how media frame educational issues and decision making for consumers (Coe & Kuttner, 2018). Among the topics of study have included teachers and unions; different school reform efforts; cartoons about teachers, schools, and students; standardized tests; the role the media play in education policy debates and decision making, and others (see, for instance, Baroutis, 2016; Feuerstein, 2014; Franklin, 2004; Goldstein, 2010; Lingard & Rowelle, 2004; Stack, 2007; Ulmer, 2016). Researchers have also studied images of teachers, teaching, students, and schools in popular film, television programming, and most recently, on social media (see, for instance, Beyerbach, 2005; Chang-Kredl & Colannino, 2017; Dahlgren, 2017; Schiller, 2015). Finally, research considering media portrayals of math and mathematicians, and scientists and their scientific disciplines has focused on a number of issues including stereotyping in popular film (Kirby, 2011, 2014, 2017), how scientists and science have become "cool" (Kohlenberger, 2015), popular television programs with science themes (Weitekamp, 2017), and gender and race representations of scientists in children's magazines (Previs, 2016). Such research has utilized various methodological and theoretical lenses. In the next section, we discuss these methodologies and explain the processes in which we engaged to make sense of the visual imagery we encountered.

An Ode to an Analytic Frame: From the Textual to the Visual

We bring to this critical essay collaboratively, with each other and other scholars, over ten years of investigating and writing about how school reform, broadly speaking, has been discussed in and across different media formats, including press releases and major policy documents (Goldstein & Beutel, 2008, 2009), discursive and visual constructions of teachers, unions, and school reform in selected news outlets (Goldstein, 2011), the mediatization of

neoliberal school reforms (Goldstein & Chesky, 2011), STEM policy, practice, and instruction (Chesky & Wolfmeyer, 2015, issues of equity and social justice, Obama Administration STEM education policies, and news media reporting (Goldstein, Macrine, & Chesky, 2014) and direct voices of girls discussing their STEM experiences in newspapers (Chesky & Goldstein, 2016). In much of this research and scholarship, we focused primarily on the uncovering the discourses of textual materials available in different media formats, with the goal of understanding how education information is framed for public consumption. In other words, we have sought to uncover the normative discourses present in media texts to make sense of the ways in which such media discourses help to construct a "reality" about education in the United States and globally.

Like other researchers, we have taken note that much of the school reform discussions focus more on doing right for the economy and employers than they do on the needs of students, and when they do mention issues of equity and social justice, they focus on economic justice: the way to climb out of poverty is to get the right education for the right high-paying job, thereby reaffirming the Meritocracy Myth (Chesky & Goldstein, 2016; McNamee & Miller, 2009). By foregrounding certain policies and reforms—for instance, implementing austerity measures that strip schools of resources and teachers, charter schools, accountability measures and efficiencies like standards-based education and standardized tests, the closing and reorganizing of traditional public schools under alternate management, a renewed focus on education for workplace development, especially in STEM fields (Adamson, Astrand, & Darling-Hammond, 2016; Saltman, 2015)--our analysis revealed that the news media reports comprising our data helped to normalize neoliberalism and the construction of a neoliberal self (Brown, 2015), what many call *homo economicus* (Lazzaroto, 2009; Macrine, 2016; Peters, 2016; Read, 2009).

Our most recent work continues this exploration, but has turned its focus to how girls and women are discussed in news stories about STEM education (see, for instance, Chesky & Goldstein, 2016). This work is derived from both from previous empirical research and our continuing observations of and reflections on trends we encounter daily in news media and on social media platforms. While collecting data from academic databases like Lexis-Nexis and Proquest, and supplementing those data with online versions of those articles, we incidentally began to take note of the images associated with the content that made up our data set. These images were Getty Images, Istock images, staged and candid photos from the site of a news report, and also included embedded and targeted advertisements. We were struck by how often the images seemed to reinforce normative assumptions of femininity and what girls might like-- pink, make-up, long hair. It wasn't until Nataly pointed out the advertisements surrounding the engineering toy Goldieblox that we realized our text-based focus had blinded us to the importance of considering accompanying images as part of the overall "package of information" made available to viewers. The remainder of this critical essay calls attention to the danger of such oversight and the need to consider visual imagery as part of the discursive construction of education policies.

Studying visual imagery surrounding girls and STEM

Given that images and written narratives are cultural artifacts (e.g. Bourdieu, 1993), and "images represent photographers' and institutions' intentions, power and status" (Magno & Kirk, 2008, p. 352), we feel it is important to sensitize educational researchers to the salience of images designed to expose girls to STEM and educate the public at large. All too often, visual images are excluded from educational research (Fischman, 2001). Researchers tend to focus on

textual evidence and sources since they are easier to quantify and analyze. However, images through their composition, syntax, and use of symbols can convey complex messages and relationships, especially when accompanied by text (Bell, 2010). They can shape how people come to 'see' both the subject and themselves, and help to define the relationship between the two because their cultural relevance (Bourdieu, 1993; Christmann, 2008; Lury, 1998).

Visual analysis, a methodology that has evolved out of anthropology, communication studies, the arts, and more recently media studies, examines how visual images are put together in terms of their composition, the actors and how they are depicted in the visuals, the props and how they are used, and how the angle of view as well as other elements of visuals shape the interpretation of the viewer (Van Leeuwen and Jewitt, 2001). Indeed, how actors' work is portrayed across a series of images enables viewers to understand the ways in which images might reinforce particular identity norms over others. Researchers Rose (2016) and other have discussed ways in which the physical structure of the image--for instance whether an actor is presented in profile or face on, the clothes and physical appearance, and the angle of view--function to reinforce hegemonic relations. That is not to say that visual images can't also disrupt hegemonic, heteropatriarchal, or heteronormative messages or interpretations. Rather, how one critically engages with visual texts serves to uncover the normative, the subversive, the oppressive, and the neutral.

Studies that have focused on visual imagery generate important knowledge about a particular phenomenon or policy. For example, Schummer and Spector (2007) found that ClipArt images of science perpetuate stereotypical views of science and generalized western normative views of scientists. They noted that frequent common images about chemistry included beakers. Math was frequently associated with numbers, equations, and geometric figures. Schummer and Spector also found that ClipArt tended to identify laboratories as where science occurred, not in the classroom, the home, or in everyday interactions, and overall reinforced the notion that scientists were white men, and frequently reflective of the "mad scientist" stereotype. As Kirby (2017) and others have noted, these images are beginning to shift in some quarters, but not necessarily in all. While, studying cartoons Feuerstein (2015) analyzed how charter school reform efforts are framed in political cartoons and considered the impact of content on how viewers were sensitized to certain viewpoints about charters schools rather than others. Finally, Millburn, Carey, & Ramirez (2001) examined ClipArt in two popular computer software packages to examine if the images conveyed modern egalitarian goals or depict traditional gendered stereotypes and found the latter to be true.

Organizing images, uncovering messages, and sensemaking

Because we wanted to determine a general baseline of different images associated with STEM education, we began our inquiry with an image search across three search engines, Google, Bing, and Yahoo, because they have been the most typically used search engines in the United States (Ratcliff, 2016). We also included a Pinterest search because of Pinterest's popularity with families and teachers (Totti, Costa, Avila, Valle, Meira, & Almeida, 2014). We used the search phrases, *STEM Education, STEM Education and Students, STEM Education and Boys,* and finally, *STEM Education and Girls*. Our intention was to identify the images that appeared frequently in the image searches (see Image 1 for representative screenshots).

Search Terms	Google Image Search	Bing Image Search	Yahoo Image Search
STEM and EDUCATION			
STEM EDUCATION and STUDENTS			
STEM EDUCATION and BOYS			
STEM EDUCATION and GIRLS			

Image 1: Image Searches Across Three Search Engines

We tracked and recorded images employing an Excel spreadsheet, and documented the use of color, presence or absence of actors in the images, whether actors were passive or active, presence of different commercials, toys, and advertising about after school activities and/or summer camps. Our goal was to document, broadly speaking, how the visual imagery we found presented STEM education and corresponding fields to girls and young women. We employed elements of visual analysis and a critical media analytic lens to identify common image and discursive characteristics (Altheide & Schneider, 2013; Berger, 2013; Pink, 2014; Rose, 2016; Van Leeuwen & Jewitt, 2001). Below we report on our initial analysis in order to identify preliminary findings.

Our analysis yielded three non-exclusive, but interrelated categories: *Who STEM is For*, *What STEM is Worth*, and *Why STEM and Girls*? In what follows we describe those categories and provide visual and textual examples. We first discuss *Who STEM is For*, and highlight the visual imagery we encountered for a popular toy brand. Our second, *What STEM is Worth*, encapsulates images and text that explicitly connect girls and women to the economic imperative of neoliberal agendas as expressed in visual imagery surrounding *Changing the Equation* (Sabochik, 2010) and school reform groups like Democrats for Education Reform (DFR). The last category, *Why STEM and Girls?*, addresses the essentialization of that which is *Woman*, and the feminine idealized traits of communication, collaboration, and creativity as evidenced through an interrogation of Goldieblox, a popular STEM toy targeted at girls. In what follows, we discuss how the visual media in our data set present the challenge of recruiting women into

STEM beginning with, but not limited to, encouraging young girls to consider STEM fields as a course of study for future employment. Our intent is to explicate how a "perceived reality [is made] salient in a communicating text [such as visual images or television commercials], in such a way as to promote a particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendation" (Entman, 1993, p. 52).

Who STEM is for? Sugar, Spice, and everything STEM

In this first non-exclusive category, we offer visual images and discuss a popular toy brand, that exemplify the sexualized cultural stereotypes of women in present Western society. We start with the image below (Exemplar 1), which appeared in all three search engine searches. This image included the tagline: "The Future of STEM?" and "Girls discouraged from STEM?"

Exemplar 1: http://www.inspiringscience.eu/news/girls-discouraged-stem

The image is of a very young white girl with blond hair and blue eyes gazing upward and into the distance. Around her are mathematical equations, a line graph, gears, an airplane, a giraffe, numbers, and other images. Behind her is the earth. The image evokes a sense of futurism--her gaze is one that encompasses the far-off. A surface-level reading of this image, when coupled with the tagline *The Future of STEM?* might imply to viewers that girls can locate themselves at the center of STEM, that is, that STEM is welcoming to forward-thinking girls and women. On the other hand, the tagged phase, *Girls Discouraged from STEM?* orients the viewer to the possibility that current practices and policies within STEM occupations are hostile to girls and women entering STEM fields.

A critical reading of the image requires tracking the image back to its source, Inspiring Science Education, a reform effort supported by the European Union, which focuses on helping science teachers in the EU to develop inspiring science education programs that target girls (http://www.inspiringscience.eu/). The project's homepage discusses different factors that might discourage girls from entering STEM fields. At the same time, viewers of the original image still might be compelled to ask what message regarding STEM is conveyed and to whom? STEM seems to be only available to a specific small group of girls – those with big blue eyes, light blonde wispy hair, white. In fact, a vast majority of the top images picture girls who are white, and might send the message that STEM recruitment for girls and women is only for those who

are white. Further, including simplistic scientific concepts alongside the iconic formulas of Pythagoras and Einstein, along with Darwin's giraffe, creates a contradiction by presenting an image of STEM designed to welcome (white) girls. The girl--even though she is the center of the image--is isolated from the other images, and passively looks into the future. Such a future orientation implies that school and learning is for future career aspirations and irrelevant to the present. In other words, the image, text, and intent do not match because the image obscures both the very real present challenges of being a girl in STEM classes and the future realities of being a woman in a male-dominated field.

Another prominent image from an after-school club called "STEMchicks" serves as a second example. STEMchicks, a non-profit organization, aims to engage

> girls by providing a STEM-based education designed specifically for them — empowering them to succeed in science, technology, engineering, and math. Girls participate in fun, hands-on STEM activities, have an opportunity to hear from STEM professionals, and engage in confidence boosting experiences. (http://stemchicks.org/mission/)

A perusal of the webpage introduces the viewer to many of the stock images that one finds in a Google search for STEM like those we conducted. In all the images girls wear pink STEMchicks' tee shirts and are depicted conducting various engaging science experiments such as making candy models of DNA (Exemplar 2).

Exemplar 2: http://stemchicks.org/after-school/

The tagline for STEMchicks is "Showing girls that smart is the new cool." A descriptive reading of STEMchicks suggests that the activities and curricula the organization disseminates solve the problem of recruiting girls into STEM by simply making STEM a list of activities appealing to girls. That is, all policymakers and educators need to do is make STEM fun, popular, and appeal to a "typical" girl's interests, such as makeup, candy, fashion, and fragrant body products.

A critical reading dwells in the liminal space in which girls are exposed to and immersed in normative assumptions about femininity, feminine interests, and reductive discourse about girls (see for instance, Butler, 2011; Heybach & Pickup, 2017). So what if not all girls are interested in makeup, fashion, jewelry? The assumption is that these images will attract enough girls to account for losing those who are interested in other STEM-related issues like global warming, superbugs, and artificial intelligence. The fact that the word chick, a diminutive for the English term *bird* (used as a slang term for *woman* in Great Britain) is in the name of a non-

profit founded to empower women reveals the insidious ways in which sexist language permeates the everyday. While there is no way to determine if the foundation employed the term ironically, what is clear is that STEMchicks wants to sell STEM as something that is fun that girls can be "cool" doing--provided one looks feminine, pretty, enjoys talking about and doing stereotypical female activities, and of course, doesn't mind being called "honey, baby, sweetie, and chick." By reaffirming sexist, diminutive language (e.g. girls are "chicks"), the image (and the organization that produced it) reinforces that girls can have fun but need to be sexually appealing to the masculine gaze, even when they are the boss or the smartest and most qualified person in the room.

David Kirby (2014) has explored the ways in which science and scientists have been visually portrayed in popular culture. He notes that even as visuals representing science have become more positive in recent years, they persist in most frequently reflecting scientists as being white, privileged, male, and American. He comments

> Stereotypes of female scientists significantly differ from their male colleagues. Male scientist characters are far more likely than female ones to be coded as nerdy or geeky (Long et al, 2010). In fact, in most contemporary popular culture, female scientists still correspond to traditional notions of feminine beauty in appearance and dress while the pursuit of heterosexual romance remains a dominant theme (Bergman, 2012; Steinke, 2005). (Kirby, 2014; p. 294)

Coincidentally, the popular multimedia brand, "Project Mc^2," also uses the tagline *Showing Girls that Smart is the New* Cool. Project Mc^2 (https://projectmc2.mgae.com) a subsidiary of Brat Doll distributor MGA Entertainment (www.mgae.com), produces a television show, dolls, and online games. The program, showed on Netflix, highlights four girls, each with a special STEM talent, who become spies and save the world (https://www.projectmc2.com/). Similar to STEMChicks, the dolls created from Project Mc^2 (based upon the face used in many Brat Dolls^{TM}) are "cute" and fashionable. One doll (see Exemplar 3) named after one of the show's main characters, Camryn Coyle™, is proclaimed to be a "construction queen! She's known for her high IQ, but her real genius comes out in the garage. She's a firm believer that "if you can't figure it out, take it apart."

Exemplar 3: (https://www.projectmc2.com/en-us/gear/543626/camryn-coyle-3/

The Cameron doll is marketed to pre-teen girls. She wears a short skirt and bright sweater. In other outfits, she is depicted with in a belly shirt. Her hip length reddish-brown hair is controlled by a side ponytail, and she typically carries a boho purse and skateboard that she built herself. A critical perspective questions the assumption that pre-teen girls ought to aspire to be sexualized versions of themselves, who may only find worth in their intelligence and ability if, and only if, it is packaged so as to conform to societal ideals of young feminine attractiveness.

Walkerdine (1988) maintains that there is no real significance between girls and boy's mathematical ability, but rather the difference lies in the way in which girls internalize cultural and societal views, both in and outside of the classroom. Girls, while scoring as well as boys on all metrics, still report less confidence in their abilities and hence less likely to ask for help or explore a new problem with perseverance (see, for instance Ganley & Lubienski 2016). Although Project MC^2 and STEMchicks claim to inspire girls to be confident in their abilities, these businesses and the media images they produce further entrench the stereotype that girls need to maintain their place as female objects in a male dominated world. While girls' worth can be expanded past their outer appearance and bubbly personality, the prerequisite remains the same - those of western idealized versions of femininity. Hence, STEM is never marketed to girls, it never changes its position, but rather girls must add onto their list of attractive traits in order to be allowed through the STEM pipeline.

The last image we highlight is from "The Girl Code," an after-school coding and computer workshop program for girls designed to "foster diversity in STEM."

Exemplar 4: (http://www.avenuecalgary.com/City-Life/The-Girl-Code-Calgary-STEM-Technology-Diversity/http://www.avenuecalgary.com/City-Life/The-Girl-Code-Calgary-STEM-Technology-Diversity/).

The image (see Exemplar 4) includes a large computer screen prominently placed on a well-organized desk with an outline of a girl, who uses a computer mouse to manipulate the images on the screen. The image of the computer physically dwarfs her. She has no facial features, making her generic. She is passive, looking to left beyond the monitor. Once again, those responsible for producing the image have relied upon gendered imagery of girls. Her silhouette is pink. Her hair is in the perfectly messy ballet bun. She slouches. She appears physically and perhaps metaphorically overwhelmed by the technology in front of her. In other words, the images themselves reinforce a passive relationship to STEM. Any discussion of the

larger institutional barriers that have historically kept women from entering and then flourishing in STEM, such as equal pay for equal work, maternity leave, and the covert, often overt patriarchal, misogynistic culture that permits men to objectify women's bodies and minds are verboten. And, while these are specifically images constructed and produced for girls, the passivity of the girls in images like these belie the very real marginalization that persists in STEM fields.

In the book, *Toys and Tools in Pink,* Colatrella (2011) investigates how fictional literature, cinematic texts, and media represent women in STEM. Colatrella explores the way in which certain toys and tools are appropriated for girls and women and are marketed specifically to them. Sales and marketing executives might argue that such appropriation is good business in the current culture in which we live. After all, it isn't their role to change society; rather, they simply sell goods and services to meet the needs and wants of the general public. This argument might be warranted if the ends justifies the means, i.e. if these images in fact draw more girls to STEM. However, this has not been shown to be the case. Archer, DeWitt, Osborne, Dillion, and Willis, (2013) have found that visual images and practices, like all pink imagery, do not necessarily affect girls' decisions regarding studying and entering STEM fields. Perhaps, the problem is not-so-much about making STEM appealing to girls/women because it isn't a feminized field (like teaching), so much as it is about packaging girls to fit the needs of STEM fields while still maintaining binary gender expectations. As always, to understand how to solve a problem requires one to thoroughly understand the questions and the assumptions latent how that problem is perceived.

Critical scholarship illuminates how colonized frameworks of oppression are inherent in STEM discourses (Hinsdale, 2015). Further, feminist science studies depict how historical narratives of western science are entangled with gender and assumptions of masculine/feminine binary further evaporating the false belief that there is a difference in rationality or intelligence between males and females (see, for instance Harding, 1991; Keller, 1995; Lloyd, 1995). Stimson (2013) challenges the assumption that the achievement gap can be solved by girls and People of Color "catching up." He notes that discussion about the achievement gap use white, middle class males as the reference point *against which* all other groups are compared. Thus, researchers and policy makers continue to unintentionally "position mathematics [and other STEM fields] as a discipline that is first and foremost a white middle class, male domain," implying that women and People of Color really aren't cut out for STEM fields (Stimson, 2013, p. 71). Bullock (2017) further elucidates a powerful example of this argument in her case study of Memphis public schools. She theorizes and documents how urban STEM infrastructure is literally being built on top of "failing" schools that serve black communities. Even though STEM discourses and policies rhetorically address the needs of women and other minorities, it is beyond the scope of this commentary to extend our critical analysis to these intersections. Clearly, this is an area of research that should provide fertile exploration for researchers concerned about STEM reform.

What STEM is worth:
Working 9-5, Is this a way to make a living?

One thing that is particularly striking about the conversations regarding STEM and girls/women is the way in which economic and national security interests permeate the discourses surrounding them. Like other minority groups, girls and women are considered a

viable commodity for the nation's workforce, yet their subjugated position remains the same, further devastated by dwindling federal and state resources, crumbling community support networks, and the dismantling of public schools.

The image below (Exemplar 5) is a common one found on Pinterest and in social media spaces like Facebook or Twitter. It uses the iconic image of Rosie the Riveter as a visual call to duty for girls and women to do their part for the nation. Text on the visual include workforce statistics regarding the underrepresentation of women in STEM fields, as well as points out the higher earning potential of girls who pursue STEM careers. The visual also celebrates Women's History Month, though the visual is accessible year-round. In particular, the graphic highlights four ways in which the Obama Administration is prioritizing STEM education: giving preference to states and programs that address barriers to STEM careers, develop innovative programs to support girls and women, recruit 100,000 "excellent STEM teachers," and supporting the adoption of the Common Core Content Standards. In very small print in the lower right-hand corner is the source URL and the logo for Democrats for Education Reform (DFR).

Exemplar 5: https://dfer.org/better-stem-education-for-women-and-girls-we-can-do-it/
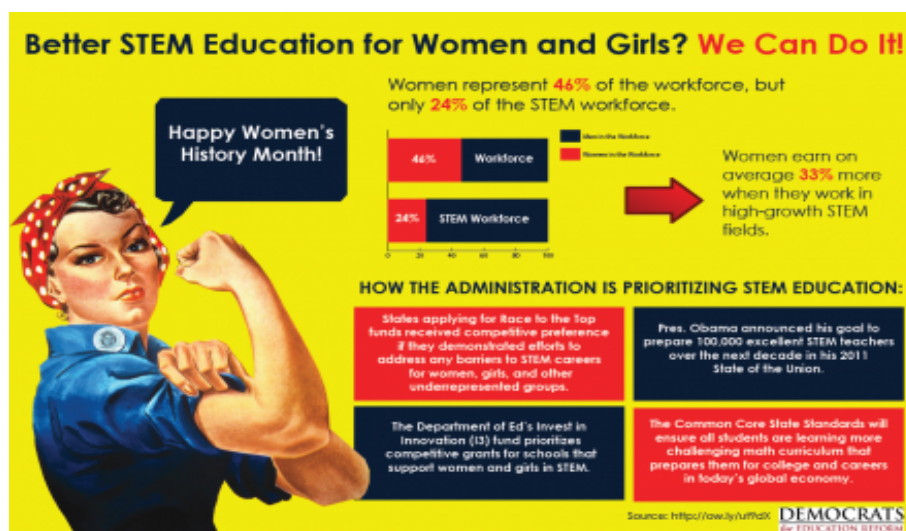
By employing Rosie in a graphic targeting girls to encourage them to study STEM, the sponsors of the graphic provide a powerful and disturbing example of how different media can frame a discussion – by not simply telling the reader what to think about, but also *how* to think about it (Haas, 2007). We continue to be struck by the association of World War Two's Rosie to today. Rosie, as a cultural icon, was the result of a concerted campaign to recruit women into the workforce during World War II, when the men who previously held factory, shipping, and other jobs joined U.S. military efforts (Honey, 1985). Rosie wasn't even real. She was an amalgam of women and came to represent all the women who worked for the war effort. It's not lost on the critical viewer that Rose the Riveter's status as a woman in the "world of men's work" was ultimately temporary. Thousands of Rosies who worked the factories to ensure the war effort kept moving, on the home-front and abroad, were expected to, and for the most part did, relinquish their jobs when the men came home, because they were expected to return to the world of women's work. Women's salaries during World War II were also significantly less than men's, and even now in 2017, women have yet to receive parity in salaries. Thus, while women are told that degrees in STEM yield higher earnings than those who pursue degrees in other

fields, that does not mean that women are being paid the same as their male colleagues. Nor does pursuing STEM serve as any guarantee that there will be ANY STEM jobs for anyone.

Gutstein (2008) asks provocative questions regarding how the rhetoric of economic competitiveness translates into better material conditions for all citizens. He argues that solving the "crisis" of economic competitiveness and STEM really only benefit a small portion (approx. 1%) of the nation's population. He, too, asks if the US will have the jobs highly skilled workers (e.g., those who have STEM degrees) have been promised if they pursue STEM. Girls and women are encouraged to take a huge financial risk even though "the majority of U.S. workers in 2016 will need at most short or moderate term on the job training (not college)" (Gutstein, 2008, p. 419). Further they are blamed when the jobs never materialize.

It is also important to note that Democrats for Education Reform (DFR) is an advocacy group that seeks to "innovate" education in the United States through school reform efforts like charter schools, school choice, and attacks on teachers' unions—one of the last groups actively protecting women workers. Their rhetorical campaign masks the fact that many of their supporters are also STEM employers. DFR claims that their primary concern is for students, yet much of their school reform advocacy focuses on economic solutions and benefits. STEM policy discourses claim that women can lessen the pay disparity if they enter STEM fields; however, that disparity continues without any discussion as to how women are to go about dismantling oppressive systems and practices without support and significant structural, institutional, and cultural changes. Martin (2008) counters the claims of DFR and their fellow reformers:

> The fact is that the nation does not have the capacity, or moral commitment, to absorb all of those who would be trained in mathematics and science. Simply supply and demand would dictate that the overproduction of engineers and scientists would lead to declining wages and standards of living and would put downwards pressure on those at the lower rungs of the labor market, creating an even wider gulf between those with a high level of education and those without it (p. 394).

In other words, a glut of applicants means more profits for employers, not necessarily better salaries, benefits, and working conditions for those who work in STEM fields. The Bureau of Labor Statistics has projected that most STEM related jobs will be in the health professions, and many of them will not require advanced degrees or the advanced coursework that many STEM programs require (https://www.bls.gov/emp/ep_table_103.htm).

The disconnect between the Obama Administration's rhetoric of "STEM for all" (2016) and the reality of the current and future job market is that STEM, as framed, will continue to benefit a select few, namely the most talented and who have the most access to the economic and cultural capital to complete advanced coursework in STEM fields. Indeed, supporters of STEM initiatives have been explicit that they see recruiting girls and other minorities into STEM as an equality issue (e.g. *Educate to Innovate*, 2009; *America Competes Act*, 2007). President Obama proclaimed the need to recruit more girls into STEM:

> One of the things that I really strongly believe in is that we need to have more girls interested in math, science, and engineering. We've got half the population that is way underrepresented in those fields and that means that we've got a whole bunch of talent…not being encouraged the way they need to. (2013).

On the surface this narrative appears innocuous, but it's not. First, to focus on a few talented and lucky individuals, who happen to be at the right place at the right time, does nothing for the millions of Americans struggling to feed their families, provide adequate housing, and obtain quality health care. Second, in addition to the commodification of women's bodies, women's minds are out for bid. Last, the narrative implies that STEM related careers are a new domain for women to acclimatize themselves to, when in fact there is historical evidence that women, not men, were the revolutionaries in budding STEM fields such as computer science.

Indeed, it was a woman, Ada Lovelace, regarded as the first computer programmer, invented the first algorithm that was intended to be used in a computer. Her work enabled Charles Babbage to create the first computer in 1842 (Fuegi & Francis, 2003). Lovelace is not unique. In the 1800s Edward Charles Pickerings employed several women, dubbed "Harvard Computers," to perform clerical work said to be too tedious for men. These "computers" were also paid much less than the men they worked with. Henrietta Swan Leavitt was one such "computer" who was instrumental in the discovery of our expanding universe (Hamblin, 2005). There are countless women that played a significant role in the computer and current information age revolution. And yet, they have been removed and erased from the narrative, so that today many people see computer programming as largely a masculine domain.

To summarize, equity issues are masked behind meaningless equality discourses and imagery like Rosie. STEM images about girls' function as propaganda in order to keep capital flowing towards those few who have the most. Images like the ones we've highlighted leave little room for discussion about who is truly responsible for changing the barriers girls and women continue to face in STEM. They are exhorted to accommodate to STEM with no promise of reciprocation, like paid maternity leave, child care, fertility treatment, extended family leave, and inclusive and equitable working environments. Even more unsettling is the misconception that women are new to STEM fields and played no role in ushering society into the Internet Age.

Why girls and STEM?
Making the 21st Century Girl—the three C's—communication, collaboration and creativity

Our last non-exclusive category returns to discuss the essentialization of that which is *Woman*, and the feminine ideals of communication, collaboration, and creativity as evidenced through Goldieblox, a popular STEM toy targeted at girls. As we discuss below, girls and women are valuable to STEM not for their skills and knowledge in science, technology, engineering, mathematics, computer science, etc., but because of dispositions that are commonly associated with women and "women's ways of knowing" and being (Belenky, Clinchy, Goldberger, & Tarule, 1986; Gilligan, 1982). *The Partnership for 21st Century Skills* highlights a number of these traits, and specifies four essential skills needed to succeed in the 21st century workforce: communication, collaboration, creativity, and critical thinking (http://www.p21.org/). Women, because of their perceived strengths in these dispositions, are idealized candidates. Different programs, toys, and gaming apps are designed to appeal to girls, and are marketed as a means to convince girls to bring those strengths to STEM.

Goldiebox, a popular STEM construction toy, is one such example of how STEM fields are marketed specifically to girls. The creator, Debbie Sterling, claims that the toys, which include a "craft-struction box", a mansion which girls can design and build, a dunk tank like one

might find at an amusement park, a spinning machine, actions figures, and other toys, are designed to inspire girls to become engineers (see Exemplar 7). Among the products for purchase is a tee shirt with the tagline, "More than just a princess" (http://www.goldieblox.com/http://www.goldieblox.com/).

Figure 7: http://www.goldieblox.com/products/_action-figure-bundle

Goldieblox is such an award-winning multimedia phenomenon that it secured a coveted Super bowl commercial spot (https://www.youtube.com/watch?v=M0NoOtaFrEs). The commercial pictured girls in colorful construction gear, first sitting together watching television, presumably on a play date. They appear to become bored with television and turn on music by placing a vinyl record on a toy turntable. A parodied version of Beastie Boys' song, *Girls* (1986), begins to play. Using toys traditionally identified with girls, they build a Rube Goldberg machine through the house, into the backyard, down the driveway, and into the neighborhood. At the end of the spot, the viewer is shown the girls jumping on the family room couch as they watch the Rube Goldberg machine strike the television. Upon doing so the screen switches to a shot of a Goldieblox action figure completing an engineering challenge.

The commercial is appealing to parents and their kids. Parents see their kids getting off the couch and playing with their friends. The girls' Rube Goldberg machine was complex and showed evidence of the four skills highlighted by the Partnership for 21st Century Skills (www.p21.org). Girls, perhaps, see success with Goldieblox as proof they can imagine any future they want, and have fun while doing so. They can be app builders, engineers, they can build spaceships, and shouldn't be underestimated. They are the nation's future.

It is important for the critical reader to understand what the brand Goldieblox is and what it says about itself. The corporate website describes Goldieblox with the following:

> GoldieBlox is the award-winning children's multimedia company disrupting the pink aisle in toy stores globally and challenging gender stereotypes with the world's first girl engineer character. Through the integration of storytelling and STEM (Science, Technology, Engineering and Math) principles, GoldieBlox

creates toys, books, apps, videos, animation and merchandise; the tools that empower girls to build their confidence, dreams and ultimately, their futures. (https://www.goldieblox.com/pages/about)

First and foremost, the brand is not disrupting "the pink aisle." If one visits the page where Goldieblox merchandise is sold, one would expect to see that disruption: gender-neutral toys and action figures, not sexualized dolls. Instead one sees a number of toys that are (mostly) pink, and girls can build their own Barbie mansion from predetermined sets. The dolls' heads were too big the bodies, perhaps infantile in proportion. The brand explicitly sells its merchandize as a tool for empowerment, not for what girls can do with it, but rather because they (or their parents) purchase it. To be clear, we understand the popularity of the toys, and many girls are exploring STEM and finding they enjoy it. But the price point is out-of-reach for many families, advertisement is directed at upper middle class suburban families, and while the actors playing the girls were from diverse racial/ethnic backgrounds, their parents shared the same socioeconomic status.

The commercial maintains the patriarchal relationship of "Daddy's little girl," but in the new STEM world she can be a princess engineer. It also helps to normalize the unequal division of domestic labor that persists. The girls aren't only maids, but they still engage in domestic work like keeping the house clean. The revised lyrics also reflect assumptions about the value of different jobs available to women. It's great to be an engineer, not so much a housekeeper. The brand, GoldieBlox also sells a T-shirt with their tagline "More than just a princess." Why not say, "I am *not* a princess?" The very connotation of Goldieblox's slogan implies girls are essentially princesses first, before the possibility exists to become more than, such as an engineer.

21st century learning skills sit upon decades of argument about what skills, knowledge, and dispositions people need in order to thrive economically in today's highly connected world. These important theoretical arguments are reduced purely to the economic benefit STEM fields can offer future women, the businesses who will employ them, and the nation where they live. The debate is no longer about what skills ought to be valued, such as critical citizenship or mathematics literacy; rather, it is about how, most cost effectively, to harness the skills necessary for employment.

What happens to a woman in a STEM field who does not seem to "naturally" display these skills within the cultural norm? Take for instance, a woman who stands up for herself when her male colleagues take the lead and the recognition on a project for which she completed most the work herself. Will she be viewed as uncooperative or not a team player if she asserts her contribution to the work? Will her job be threatened based upon her decision to have or not have children? We engage in a very different discussion if we consider Haraway's challenge to the concept of *Woman,* which cannot exist outside of our cultural, political, sociological, and psychological co-constructed identities (1991). She proclaims:

> There is not even such a state as "being" female, itself a highly complex category constructed in contested sexual scientific discourses and other social practices. Gender, race or class consciousness is an achievement forced on us by the terrible historical experience of the contradictory social realities of patriarchy, colonialism and capitalism. (Haraway, 1991, pp. 295-296)

Discussion of findings and concluding remarks

What we have gleaned from our exploration of media imagery that depicts STEM education and the fields it represents, is that what the public comes to know about STEM remains cisgendered, apolitical, and beneficial for the country's continuing economic and national security. Equity discourses within STEM policy initiatives have primarily been rhetorical, masking social and political issues by repackaging the Meritocracy Myth that anyone can succeed given access to information, resources, and hard work. In media, as in policy discourses, the dominant discourses remain - Girls and women must assimilate into STEM. STEM education programs and fields do not have to accommodate the needs of girls and women. Girls and women, like all disenfranchised groups, are required to prove their worth to STEM fields, while the STEM itself has no social responsibility for their well-being. Solutions for the STEM crisis focus on the micro-- the individual level-- and fail to consider the larger institutional issues regarding gender and STEM education and/or STEM workforce (Heybach & Pickup, 2017).

In our analysis, the media package girls and women for STEM and are positioned so as to fit neatly into a predetermined role. Never has the crisis narrative considered how girls and women might change STEM, nor does it spend much time talking about how STEM has change, and how such changes might come about. Even when STEM advocates seek to employ activities and programs ostensibly based upon girl's and women's interests, they do so primarily for recruitment purposes only. Visual imagery has the potential to disrupt established long-standing beliefs practices about how the world ought to be. What we found in our preliminary analysis is that the STEM imagery we encountered failed to offer alternative views on women and STEM. In other words, visual media imagery can foreground or mask different aspects of STEM policy discourses in order to complement or complicate the policy discourse messages disseminated to the public. Media can and ought to disrupt and critique societal normative assumptions and dominant oppressive political structures. In that regard, our work here becomes one small but important essential step in questioning the media's role in public understanding of "problem" and the "solution" of women and STEM.

The commonality across all the visual imagery we have reviewed is that girls can be fitted into STEM with little to no disruption to the overall structure of STEM fields, thus maintaining the systematic barriers that exist with little or no distraction from larger issues of inequity in education and American society (Mansfield, Welton, & Grogan, 2014). Within this reading, the problem is superficially attributed to too few girls/women taking courses in, majoring in, or entering STEM fields. In reality, girls are being actively marketed to and mined for the potential economic and political benefit they bring to the STEM workforce and the global competitive marketplace it serves. In other words, they are "packaged" for STEM. How this plays out in terms of actual recruit and retention of women in STEM remains to be seen.

Our investigation into the visual imagery associated with girls and STEM across different media platforms reveals a sanitized space in which (mostly) white, middle class girls engage in an idealized world of STEM devoid of any wider context in which one might view, question, or critique the purposes of STEM education and recruitment. Such work is important because it enables researchers and practitioners to peel the layers of media that contribute to public understandings of STEM. Doing so, enables us to critically understand the ways in which the challenge of STEM education and girls has been framed for public consumption. While we

maintain that the categories we identified are non-exclusive and therefore overlap and intersect, they nonetheless help us to understand both the overt and covert perspectives, assumptions, and biases latent in the media's discourses about STEM and girls. In reflecting upon *Who STEM is For*, we must acknowledge the message of inclusion many media send to girls and women about their potential place in STEM. At the same time, the imagery and messaging that operates across multiple media platforms exemplifies normative feminine cultural stereotypes and assumptions about what girls ought to be interested in and what girls/women should aspire to be.

As a media phenomenon, with its YouTube presence, games, journals, toys, makeup, and dolls, Project Mc^2 relies on gender normative assumptions about "what girls like" (Makeup! Games! Journaling! And, it's PINK!) to recruit girls into STEM. There's clearly nothing wrong with makeup, games, keeping a journal, or liking pink. However, to explicitly associate those with "being a girl" through visual imagery and to then use them as an entry point into STEM exploration, continues to construct STEM education and STEM careers as things not quite for girls. The other images we included that illustrated girls surrounded by objects and visuals explicitly connected to STEM, still employed artistic practices like perspective and foregrounding to physically isolate the girls from the content and activities in which they were engaged. Finally, to call girls StemChicks is demeaning. Rather than genuine conversations or the production of thoughtful imagery for girls, STEM recruitment continues to rely upon packaging girls for STEM, so that STEM is constant and it's the girls who need to fit the mold of both what STEM wants and what society continues to pressure too many girls to be.

The category *What STEM is Worth* captured the overriding messages of images and text that explicitly connect girls and women to the economic imperative of neoliberal agendas, reinforcing the discourses found in policy documents like *Changing the Equation* (Sabochik, 2010) and advocacy by school reform groups like Democrats for Education Reform. Such visual media and texts, however, are specifically designed for consumption by girls and their families, using images to simultaneously convey complex concepts while oversimplifying the larger discussion about STEM barriers. To be sure, girls and women should be valued as vital and full participants in all fields, including STEM. Here, though, they are treated as a pragmatic solution to a needed source of labor in STEM fields. Girls and women are needed to serve corporate and national security interests, but their acceptance in such fields is contingent upon their willingness to work hard for another's "higher goal" (i.e. corporate profits, military and technological dominance, and the good of the nation's economy), even though they have little say or agency in what needs to change, why, and how. Moreover, it is not that women are recruited into STEM fields for social justice reasons. Rather, like other minorities being recruiting into STEM, women are the focus because of their sheer numbers, which follows the assumption that a larger pool of applicants will enable the few truly talented and hard-working to rise to the top. Thus, girls and women are packaged for STEM so they can be slotted into whatever field and job needs a worker prepared to order.

Ultimately, the category *Why STEM and Girls?* encompasses the previous two because the media we examined serve to present a rationale for why girls might be good at STEM, even as they seek to encourage girls and women to explore and pursue STEM. Given that the skills that appear to be most crucial for the 21st century workforce-- communication, collaboration, creativity, and critical thinking--are also associated with girls and women producing media that reflect and reinforce these connections help to cement girls in the public's mind as a natural fit. Such gendered essentialization of traits, skills, and dispositions reinforce gender binaries and

biases, and implicitly marginalize those who don't fit the categories and stereotypes. In this instance, girls are packaged for STEM for the general public, that is, the public needs to be convinced that STEM is also a girl's place, not because she has the STEM content skills and knowledge, but because she has soft skills that supposedly the men (and few other women) in STEM don't naturally have.

We end our essay with a necessary reflection. Indeed, there has been a great deal of important research on girls and women, particularly in regard to STEM barriers (see, for instance National Research Council, 2010; Stout, Dasgupta., Hunsinger, & McManus, 2001). The American Association of University Women has been researching and advocating for girls and women for over 150 years. A number of their reports, including the report *Solving the Equation* (Corbett & Hill, 2015) have specifically considered women and STEM, the barriers that persist, and how different stakeholders might work together to move girls successfully into STEM fields. Finally, the Obama Administration's advocacy for women in STEM led to research and programmatic funding directed at recruiting girls to STEM, making STEM more appealing to girls, and challenging both public and private sector stakeholders to work together to help girls and women achieve STEM goals. While the above-mentioned efforts are substantial and ought to be recognized as part of the growing work within a social justice perspective, they are neither sufficient in addressing the larger institutional barriers women and other minorities face in the western capitalist society such as the United States, nor should they be admired without necessary critique and reflection.

Since the outcome of the 2016 election, STEM policies, programming, and funding have not yet been fully determined. Preliminary budget decisions are expected to have profound implications for programs that focus specifically on girls and STEM education, even though the Trump Administration has indicated support for STEM education programming (Strauss, 2017). One such area that has piqued the Administration's interest is that of Computer Programming, for which President Trump wants to increase funding by $20 million by 2020 (Klein, 2017). Even so, Trump's proposed education budget is significantly lower than the previous administration, and while Congress has authorized additional spending beyond President Trump's request, those who advocate for girls and women must remain cautious and vigilant. Much of the recent policy updates and discussions coming out of the Department of Education seem to backtrack on many of the issues particularly concerning girls, women, and those who advocate for them. Changes in Title IX regarding campus sexual assault, removing information and rescinding rights for members of the LGBTQI community, rescinding birth control policies under ACA, ignoring climate change data, facts, and research all indicate that the STEM the nation needs is not the STEM that will be valued by this Administration. Nor is the role of women in this STEM revision secure.

Ultimately this essay is about the need for continued vigilance and action as it relates to critical media literacy and visual imagery. As we acknowledged earlier, this essay serves as an introduction to some of the critical work that still needs to be done. More rigorous analysis needs to be conducted in order to understand the ways in which media have framed, across all discursive platforms, the problem and the solution of girls and STEM. The connection between media, corporations, public, and political agents needs to be further interrogated if we are to understand how public schooling is shaped by the policies that govern it, the stakeholders whom it serves, and the millions of dedicated educators, researchers, and administrators who play a role in perpetuating or disrupting dominant discourses.

For us, the potential for radical change continues to exist. Through a continuing critical analysis of media and policy, we aim to continue our work towards the goal of inclusion of girls, women, and all people in the nation's fabric with full citizenship standing and personhood rights.

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