CASE STUDY

Power On! Case Study

At A Glance

Power On!: A Graphic Novel of Digital Empowerment, scheduled for release in 2022 by MIT Press, tells the story of four young friends, Antonio, Christine, Jon, and Taylor, as they navigate high school and learn to use computer science to challenge structural and racial barriers in their own lives and communities.

The graphic novel, based on groundbreaking research about disparities in learning opportunities in computer science that fall along race and socio-economic lines, as well as the real-life experiences of teenagers, is written with insights and feedback from young people themselves. *Power On!* is a catalyst for reimagining how CS is taught and learned—and how Black, Latinx, and other historically underrepresented youth can intervene in a world where technology increasingly shapes nearly every aspect of our lives.

This case study describes how the graphic novel was co-created by an innovative partnership among researchers, youth, and educators. The case study offers a model for adapting educational research, typically written by and for adults, for youth audiences—arguably the audience with the most at stake. Key insights from the case study include the following:

1. **Collaborate with young people early on.** When youth are brought in on the ground floor of creating educational content, the more impact their insights and knowledge will have in reaching young audiences.

2. **Speak to young people's identities and lives.** Reflecting the fullness of who young people are—their race, ethnicity, gender orientation, and lived experiences—syncs with what we've learned about youths' sense of their own identity as an asset in life.

3. **Language matters.** To cross over as credible, content that features young people as protagonists must capture the idioms and rhythms of how young people talk to each other.

4. **Expose and resist the culture of low expectations.** Be transparent with youth about the injustices they may confront to engage and enlarge their critical thinking.

equitable futures
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5. **Don't shy away from young people's social realities.** Don't underestimate young people's awareness of the systemic forces affecting their lives and communities. Be straight with them and engage their experiences.

6. **Connect computing to what matters to young people.** The more educational content bridges to young people's passions and aspirations, the more relevant and meaningful it will be.

7. **Caring adults make a huge difference.** When young people feel seen and encouraged by adults they respect and trust, their sense of self and of life's possibilities grow.

8. **Young people assert their rightful presence.** Leverage young people's strong sense of agency by having them make space and take space in their own narratives.

The Context

The rise of technology and computer science as an inescapable part of daily life—and the digital divide that metastasized in its wake—has spurred a decade-long movement among educators and others to deliver "CS for All" in public schools across the country with major investments in new computer equipment, curriculum, and teacher professional development.

Despite these advancements, "there was always the question: How do we know if this is really working for students?" said social scientist Jane Margolis, recognized in 2016 by President Obama as one of nine Computer Science Champions of Change. Meanwhile, access to academically challenging CS courses by Black, Latinx, new immigrants, and youth from lower income households continues to lag. In **California**, for example, the number of high schools offering CS classes has grown by 61 percent in recent years, but only a fraction (3 percent) of the students take computer science. In 2019, just 36 Black girls and 453 Latinx girls took Advanced Placement CS courses.

The consequences of this disparity are serious. Young people need computer science skills to thrive in the digital economy and have agency in our democracy. And, the computer science sector needs greater diversity to assure that its innovations represent the needs, concerns, and perspectives of all communities.

Margolis and her longtime colleague Jean Ryoo, director of research at **UCLA's Computer Science Equity Project**, had come to believe that "students are really the ones who can tell us what works in education and what doesn't." To test their theory, they launched an ambitious research project to foreground the perspectives and experiences of high schoolers too often shut out from conversations that determine who learns—and how—in CS classrooms.

For the past few years, the research team has studied students' experiences learning CS at a large West Coast urban school district where the majority of students are Latinx and from households with lower incomes. They have also been working with Black teachers and students in rural Mississippi. Funded with support from the National Science Foundation and the Bill & Melinda Gates Foundation, the research combines weekly ethnographic observation in the classroom with in-depth interviews and surveys with students. While the global pandemic has slowed data collection, the team is hopeful to resume in-person work with partners in Mississippi in Fall 2021.

Power On!

When Margolis was encouraged by her editor at MIT Press to write a version of *Stuck in the Shallow End*, her seminal book on race, education, and computer science, for young adults, Margolis jumped on the idea and reached out to Ryoo, who proposed adapting the book as a graphic novel to appeal to young readers.

First published in 2008, *Stuck in the Shallow End* drew a striking analogy between the kind of systemic barriers that barred generations of Black Americans from swimming pools and learning to swim to inequities in the nation's schools where the quality of education—and CS education in particular—have produced what Margolis and the book co-authors call "virtual segregation."

It's at this inflection point where *Power On!* aims to intervene with a focus on student agency. As the novel's chief writer, Ryoo drew from Margolis's book as well as from their more recent research that explores how young people's interest in CS deepens when it's connected to their concerns and their social and political realities. In a not-yet-published position paper, Ryoo and Margolis argue that the role that technology has played and will continue to play in reinforcing or combatting inequity makes it even more urgent that Black, Latinx, and other underrepresented youth have a seat at the coding table. The turbulent events of the past year—including the mass protests in support of Black lives, a polarizing election, and a pandemic that has claimed and ruptured so many lives—have only underscored the pernicious effects of systemic inequality.

A scene from the graphic novel where the main characters attend a Black Lives Matter demonstration.
Image drawn by Charis JB

The graphic novel writers and illustrator in a team meeting about the book.
Photo by Jean Ryoo

Principles In Action

Illustrated by Charis JB, *Power On!* shows talking up the promise of good-paying jobs is an important way, but not the only way, to engage the passion, curiosity, and intellect of historically marginalized young people in CS. According to Ryoo, research with youth shows that educators must speak to young people's stated desire to impact the world for the better—and model how CS can be a powerful tool for ethical and humanitarian action.

"We should be making the argument that everyone needs to learn about computer science because it's a new form of power, and it's controlling everything in our lives," she said. "Because if we don't understand how that works, how can we participate in our larger democracy in ways that are well-informed and that protect our rights and our communities?"

Many of the principles that the graphic novel brings to life echo insights that have emerged from new, related research that explores how young people develop occupational identities and how they define, refine, and pursue the futures they imagine for themselves.

Collaborate with young people early on.

The graphic novel was written in close consultation with an advisory board of high schoolers who gave input on the manuscript as it evolved. One teen reviewer, Rocio Hernandez, was so enthused about the novel that she roped two of her friends into reading and giving feedback on the manuscript as well. This ethic of drawing on the expertise of young people is intentional and integral to the design of Ryoo and Margolis's research project, which breaks down the traditional hierarchical structure of academic research with a collaborative approach that they believe yields keener analysis and insights.

"I'm just happy that Jean asked students how they felt because a lot of people who create content for teens do it later in the process when things are hard to change," said youth reviewer Stellaluna Lopez-Ramirez, 17. "By involving us early, it ensured that it would be something that would appeal to teens."

LA students learning together in their computer science classroom.
Photo by Jean Ryoo

Speak to young people's identities and lives.

The members of the youth review board encouraged Ryoo to develop the young characters' back stories so they were more like real people, not symbols. For reviewer Axel Tirado, 19, fleshing out the personalities and motivations of the characters was critical to the authenticity and integrity of the narrative. They also pushed for the social issues raised in the book to receive a similar, in-depth treatment and were pleased with the final version. "I feel like often there's a lot of times when we write about certain things, heavy things—like queer folks or racism or police brutality—there's not always the most nuanced conversation, especially in the mainstream," said Tirado, now a freshman at UCLA.

Another reviewer, Natalia Gopar, 18, approved of how "well realized" the characters were ultimately drawn, including the subtle but pointed ways the young people talked about issues like race and class. She said this mirrored the ways she and her friends talk with each other about school or their parents, many of whom are racial minorities and immigrants struggling economically. Like Antonio's parents in the novel, some split apart under the pressure. "Race is not something we're going on about all the time, but it's something we talk about."

Seeing young people who reminded her of herself and her friends in a graphic novel was eye-opening for Hernandez, 17.

"It made me tear up. It made my whole year. I don't see that representation anywhere," said Hernandez, who told Ryoo, "'Ms. J, I'll make your book into a movie just you wait!'"

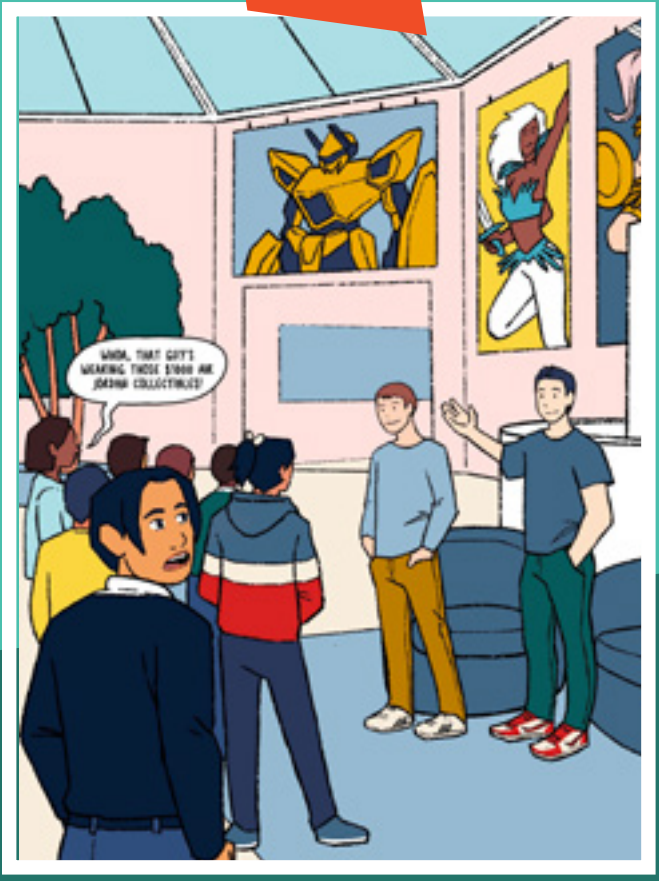
Language matters—especially if you're creating content for and about young people.

Get that wrong and you won't get across to young audiences. All the youth interviewed for this case study emphasized how critical it was that the teens in the novel spoke in a realistic, credible idiom. Lopez-Ramirez laughed when she recalled her initial reaction to some of the dialogue in an early draft: "We don't talk like that!" In places where the speech struck her as "too formal," she offered alternatives in her notes. ("Maybe change it to this to make it more realistic.") Hernandez was inspired to draw up an entire list of vernacular terms for Ryoo to draw from and was instrumental in fine-tuning the slang used by characters who are Salvadoran American. (Christine's Salvadoran aunt, for example, affectionately calls her friends "bichos" and says "Que chiva!" to signal her approval.)

Expose and resist the culture of low expectations.

The novel shows how tracking students of color and students experiencing poverty in computing classes that focus on rudimentary typing and word processing skills, instead of the critical thinking and algorithmic problem solving of computer science, is a major barrier to the goals of CS for All. In the novel, Christine's guidance counselor discourages her from taking a CS class, steering her toward a class in hospitality instead. Meanwhile, Taylor is tracked into a remedial CS class where the teacher repeatedly confuses her with another Black student, and they spend their time typing, not coding. These storylines were based on real-life classroom observations, said Ryoo, who added that it was just as important to show how the young characters' growing critical consciousness helped them resist the boxes they were put into and engage in larger struggles against structural biases and inequality in their schools.

For Lopez-Ramirez, 17, Christine's experience echoed her own negative experience at the first high school she attended before convincing her mother to let her switch schools during her freshman year. In Christine, Lopez-Ramirez saw someone, like herself, who was "showing ambition and advocating for herself but getting shut down."



Field trip scene in the graphic novel, inspired by the research.
Image drawn by Charis JB

Computer science students go on a field trip to a game design company. This inspires a scene in the graphic novel.
Photo by Jean Ryoo

"I would say, 'Hey, I want to take this class,' or 'Give me something else, this is too easy,'" she said, but the head counselor kept ignoring her needs. "They said there was nothing they could do. I got a sense they didn't want to find a solution for me."

"I didn't even know [the school] had CS classes until I left," she said ruefully. "They didn't talk about it or say, 'You should take this class.' I kind of knew there was a CS class because there was a room with a lot of computers in it, but how to get in—*that* was a complete mystery."

Don't shy away from young people's social realities.

The more educators acknowledge and engage students' lived experiences, the more coding and programming will matter to them. When students in the novel take a field trip to visit the sleek offices of a gaming company, they are confronted with a workforce that largely does not look like them. Later, the young characters attend a Black Lives Matter protest, an experience that will influence their decision to organize and pressure the school board to make CS courses available to all. For the novel's young reviewers, these storylines of political reckoning spoke to their own experience with structural bias and their sense of self in relation to the world.

"I thought that was so real and important to me because I believe in fighting for social justice. I was like, 'I relate to these characters already!'" said Hernandez. "As you grow up, you see everything you used to sleep on, like police shootings. And now you're aware of it and learning about it, and thinking, 'That's not right.' Kids who are like me, we see it firsthand. You live it, you hear the police sirens. You think, 'Who was it this time?'"

Connect computing to what matters to young people.

More than a quarter (27%) of all students who participated in Ryoo and Margolis' research project described wanting to use CS to effect social or political change, whether that meant designing better prosthetics for disabled military veterans or building an algorithm to help enforce fair labor laws. When Taylor's computing class proves to be a bust, her friends teach her how to build a website for her family's daycare business. In her after-school program, Christine codes a Black Lives Matter e-textile banner that lights up. CS education itself becomes a battleground in the novel's climax as the students, fired up over inequities in their own school, decide to take matters into their own hands.

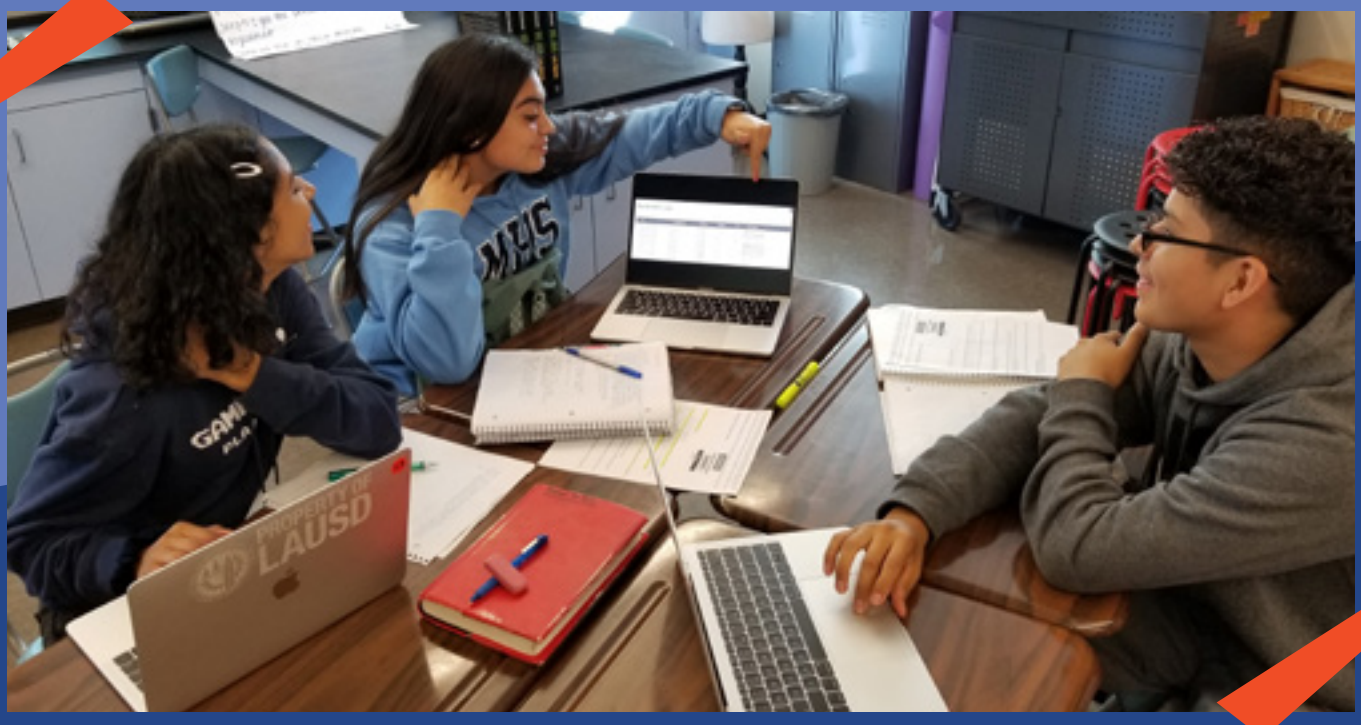
For Tirado, showing the characters turning to activism to change their world was important to spotlight and reminded them of the student-led campaign at their own school to establish gender-neutral restrooms. "I was completely passionate about it," said Tirado, who described a multi-pronged campaign that involved conducting a student survey and a series of formal presentations to faculty, administrators, and even parents. "I wanted to use [the restroom] and other people to use it, too, but it was also something I wanted to leave behind. Like, this was one way I contribute to the school climate and that's really important."

Caring adults make a huge difference.

The novel also shows how caring and attentive adults play a vital role in building a young person's sense of self and empowerment. Antonio's CS teacher, for example, leads a discussion about race and class after their field trip to the gaming firm. Mr. Russell, the teacher at Christine's after-school club, talks to the girls about the need for greater representation of people of color and females in the tech industry, and Taylor's parents invite her friends to a Black Lives Matter rally. For marginalized young people in particular, being "seen" and guided in these ways can be life changing.

Hernandez said she has encountered her share of adults at school who "believe you can't take up space in a classroom." But this wasn't the case with her CS teachers. She fell in love with CS after taking a robotics course as a freshman but acknowledges she probably wouldn't have thought to enroll in an AP CS class if her teacher, Ms. Morris, hadn't nudged her. She credits her AP CS teacher for challenging and encouraging her. "It was a change for me as a student," said Hernandez, who will be the first in her family to graduate high school and attend college. "Somewhere somehow, [my CS teacher] has the faith to believe in every student. That's what made me want to do it."

Gopar, who studies art at Cal State East Bay and whose parents immigrated from Oaxaca and run a bakery in Los Angeles, is the first person in her family to attend college. When Ryoo hired her as a colorist for the graphic novel, Gopar was thrilled. "I just thought it was really cool that she reached out to me to help with this project because it provided me with a job opportunity to color those pages and get some experience—and I'm also getting paid for it."



Research photo from the computer science classroom.

Photos by Jean Ryoo

Young people assert their rightful presence.

In *Power On!*, each character is shown using their ingenuity and will to claim space to learn and grow—and hold space for others to do the same against power structures and social forces that try to marginalize them. These powerful enactments of agency are at the heart of a truly liberatory education where everyone— especially historically underrepresented young people—"feels they have a right to be there and to have their ideas heard," said Ryoo, who added that the characters' stories were inspired by real-life acts of resistance by high schoolers that were observed in her team's research.

Lopez-Ramirez was pleased to see Jon, who is gay, as one of four primary protagonists in the book. "I feel like that having [queerness] acknowledged in the CS community was important because a lot of it is white, cis male-dominated. It's scary to think about. It's intimidating to go into male-dominated and straight people-dominated spaces because there's a whole hierarchy," said Lopez-Ramirez, one of only two girls in her AP CS class. "When I imagine my future in CS, that becomes a factor. Do I have to hide myself? Do I have to keep part of myself locked up or can I express myself? Seeing another character traverse that road just felt comforting."
In Lopez-Ramirez's view, the takeaway from Christine's story is that she defied her counselor's efforts to quash her interest in computing by taking advantage of an after-school CS program for girls. "She persisted through that and still found a way to do what she wanted to do."

Hernandez sees her own background and identity as a critical asset in shaping the future of tech. "CS is always going to be here, so we need diversity because not everyone has the same experience," she said. "People are at risk, even if [programmers] aren't doing it on purpose. That's another reason I want to be in it. I have experience, I have input, and you better hear me!"

Taking Ideas To Scale

In advance of the graphic novel's publication date, Margolis and Ryoo will be working with a group of teachers and other education experts to develop a companion curriculum for *Power On*! The curriculum will be designed to facilitate discussions around the issues raised in the graphic novel and to open up spaces for young people to share and develop their own views and agency. The materials, including teaching guides, will be housed on a dedicated website to be launched prior to publication of the novel. The researchers will also be discussing with district leaders about adopting the novel and curriculum in their schools, and with foundations and the philanthropic arms of tech companies to support distribution to under-resourced school districts.

Further down the line, Margolis and Ryoo can foresee an online hub where students can share their own creative responses and experiences as learners, consumers, designers, and coders. Most importantly, they hope the hub will be a space where youth engage each other around the book and other important social/political issues in tech and CS that they're passionate about. "It's about student agency and how important community and the sharing of ideas around a common thing that you're all reading and talking about can be," Margolis said.

The Takeaway

Power On! offers a dynamic example of how educational research—typically written by and for adults—can be adapted to engage the audience for whom the stakes couldn't be higher: young people themselves. Closing the equity gap in education requires deepening our understanding of who young people are and what they care about. This is especially true in the case of youth who have been historically marginalized. As the graphic novel illustrates, centering young people in their own narratives and foregrounding their agency can help us reimagine an educational system that is equitable and connected to their lives, values, and hopes for the future.

A page from the graphic novel where the main characters learn about the lack of diversity in tech and computing industries.
Image drawn by Charis JB

Research photos from the computer science classroom.
Photos by Jean Ryoo