Something interesting happened during the course of our fieldwork: games emerged as a viable component in the effort to make academic learning more relevant for students. A host of games-based platforms, most notably *Minecraft*, were adopted as technologies for accelerating the design of new learning futures. The rise of games as a catalyst for rethinking schooling and learning was driven primarily by the urgent call to raise the science, technology, engineering, and math (STEM) literacy rates in U.S. schools. Its limited resources notwithstanding, Freeway launched a new game development track just as we were about to begin our ethnographic inquiry with the school. Freeway adopted games as a way to draw students into classes and learning environments that provided a more deliberate path to developing STEM skills. The decision to offer a game development course also reflected the school district’s inconsistent policy and pedagogy toward technology (discussed in chapter three).

One of the classes that we spent the most time in during our fieldwork was Freeway’s advanced game design class, which was held in what was informally called the Game Lab. The room was impressive. It was outfitted with about twenty-five iMac computers with large monitors. All of the Apple computers were loaded, for example, with powerful graphics applications, digital video editing software, and game authoring tools. Students also had access to a couple of Samsung Galaxy Tablets, a Wacom graphics tablet, a digital music keyboard, and two small digital cameras. The computers were Internet enabled, which meant, *in theory*, that students could connect to the proliferation of data, information, and distributed expertise available online. A large projection screen in the classroom enabled live video conferencing.

In contrast to the view held by outsiders and even some Freeway students that this was a “ghetto school,” the Game Lab was a technology-rich
space. It was also the space in which the school district, Mr. Garcia (the school’s principal), and Mr. Warren (the advanced games class instructor) had made a significant bet on the future of learning at Freeway.

The decision by Freeway to leverage games to expose students to STEM education was consistent with broader national trends in education. The widening effort to incorporate design, systems thinking, and coding into the K–12 curriculum is an indicator of a broader push to strengthen STEM literacy among U.S. youth. Schools around the nation are involved in what is tantamount to a rebranding campaign in an effort to align their curriculum with STEM-based skills. Among other things, there are serious political and economic incentives for schools to offer more robust STEM learning opportunities.

School administrators run the risk, politically, of being out of step with a widening ethos that has made STEM learning the main measure of success in public education. Moreover, powerful institutions from the White House (under Barack Obama) to the National Science Foundation have issued compelling economic incentives for schools to invest in STEM readiness and education. The nationwide emphasis on STEM is a response to several factors: a steadily evolving knowledge economy, skill bias technical changes in the labor market, and concerns about America losing ground in the global race for supremacy in education, technology, and innovation.

But Freeway’s embrace of new learning futures faced some serious challenges. The school, it turns out, did a relatively good job of securing tech for students. However, it struggled to offer a curriculum and instructional environment that was commensurate with the technological resources that it provided. For example, the school’s strict vision on workforce development—learning specific tech skills to get a job—demonstrated little awareness of the more nuanced STEM-based competencies. STEM education is important not only as a means to a good-paying job but also as a catalyst for sparking curiosity, creativity, and a questioning disposition among students. An effective STEM education encourages students to ask probing questions, analyze the world and data around them, develop critical thinking skills, and cultivate the disposition to test new ideas. These skills, we believe, are useful across a wide spectrum of life’s activities, including social, educational, economic, and civic life.
This chapter and the one that follows offer a close-up view of the challenges and opportunities resource-constrained schools face when they embrace the call to ramp up STEM learning. More precisely, we focus on Freeway’s adoption of games and the quest to prepare students for a rapidly evolving STEM economy. In this chapter we address how the institutional limitations in resource-constrained schools severely challenge the efforts to integrate STEM-based instruction and learning. Also, we consider the broader social context and inequities that conspire to limit the development of a more diverse pool of STEM talent in the United States. If STEM is the future, then the failure to provide the nation’s fastest-growing segment of students—Latino, immigrant, and lower-income—with the academic skills required to succeed in that future is unethical. The challenges facing Freeway in its efforts to catalyze STEM learning are symptomatic of a broader national crisis.

The next chapter identifies some of the creative strategies that a group of Freeway students, many of them only modest academic achievers at best, employed to turn the game development class into a unique learning experience. Their resilience in the face of compelling institutional barriers such as inadequate curriculum design and instructional expertise suggests that these students were capable of far more than what their teacher or school expected from them in the formal academic setting.

The Opportunity to Learn STEM

To frame our analysis of how the games class structured STEM-based learning, we turn to the work of education scholar Jeannie Oakes. She contends that some of the most common institutional practices in schools structure different kinds of learning opportunities, which can often lead to disparate academic outcomes. In her analysis of educational inequalities, Oakes considers what she calls the “opportunity to learn.” She writes: “What happens if different kinds of classrooms systematically provide students with different kinds of learning experiences?” Further, she asks: “Do these differences mean that some kinds of students have greater opportunities to learn than others?”

Even as digital media, games, and STEM education make their way into a wider mix of classrooms, not all twenty-first-century learning is
equal. That is, the degree to which students gain mastery in STEM skills varies significantly by school and the resources—social, technical, and instructional—available to them.

Our yearlong immersion in the advanced game classes allowed us to assess to what degree the class provided regular and substantive opportunities to cultivate STEM-based skills. This was especially true in terms of the opportunity to engage more cognitively complex activities in relation to game design. We organize our analysis of the opportunity to learn STEM via the game design class around three primary themes. First, we consider what students were expected to learn in the game design class based on state education standards. Second, we address another key aspect of academic-oriented learning—the quality of the learning environment, including, for example, the amount of time-on-task that students were able to devote to game design and, by association, STEM literacy. Third, we explore how the teacher’s perceptions of student ability shaped students’ opportunities to cultivate greater competency in STEM education.

**STEM Learning Standards**

To better understand the kinds of things that students were *supposed* to learn in the game development class, we reviewed the Technology Applications standards prepared by the State Board of Education Texas Essential Knowledge and Skills Committees. The Technology Applications curriculum has six strands:

- creativity and innovation
- communication and collaboration
- research and information fluency
- critical thinking, problem solving, and decision making
- digital citizenship
- technology operations and concepts

The standards that our research team reviewed online were presented in open and iterative form and candidly recognized that courses like game design are under constant revision as a result of the technological
innovations and shifting practices and platforms that are continually reshaping the games industry. The primary purpose of the six strands is to provide some general learning guidelines, goals, and outcomes related to the development of the social, technical, and educational skills necessary to demonstrate mastery in digital-, media-, and technology-oriented classes.

According to the Technology Applications standards developed for high school, it would be reasonable, for instance, to expect Freeway students to create a prototype game that includes, among other things, multiple game levels with increasing difficulty. This reflects the ability to design not only different levels but also different problem-solving strategies. The standards also imply that students’ games should reflect examples of physics, which may include lighting, shading, perspective, motion blur, and reflections. Game design is also part art, which means that students might demonstrate some degree of aptitude regarding color theory, texture, balance, skinning, and drawing. Moreover, a carefully designed game might layer the game play experience with different points of view and camera angles. Games are dynamic systems that reflect varying degrees of artificial intelligence, mathematical functions, and creative and artistic expressions. It is, after all, the combination of these features that makes game design such a promising domain for academic-oriented learning.

How did the learning goals established in Freeway’s game design class compare with the Technology Applications standards? In the advanced game design class at Freeway, students were expected to create a game using a platform called Gamestar Mechanic. The decision to use Gamestar Mechanic reflected the core dilemma that shaped this “advanced” game design class. Mr. Warren, the course instructor, envisioned the class as a catalyst for igniting student engagement with STEM-based literacies, but in reality the lack of a sharp curriculum vision undermined any opportunity to foster a rich formal learning experience. Gamestar Mechanic was designed primarily as a game-authoring tool to teach elementary and middle school students some of the rudimentary aspects of game design. The adoption of the platform in a high school advanced class was peculiar and illuminates how curriculum-poor conditions established relatively low standards and limited opportunities for students to engage more robust forms of STEM learning.
Coding

Some of the standards, not surprisingly, involved developing greater fluency in programming languages. In a multiplatform world, the art and science of programming is a steadily evolving skill. For example, the differences across platforms, such as coding for a personal computer or mobile device, require nuance. Despite the growing calls to expose all students to basic coding literacies, virtually all of the Freeway students that we met had never been introduced to even the most rudimentary aspects of programming.

During our fieldwork, a number of enrichment programs (in Austin and beyond) devoted to introducing a greater diversity of students—girls, African Americans, Latinos—to the basic aspects of coding began to grow and attract attention from media and philanthropists. Tech companies, led by Google and Facebook, have launched educational programs and national campaigns encouraging students to learn to code. Two students from the game design class had played around informally with coding languages but had no real proficiency. Their efforts to learn coding involved going online to find tutorials. Freeway did not offer any courses in coding.

The absence of computer science courses at Freeway was actually typical as the overwhelming majority of U.S. schools in which black and Latino students are the majority generally lack even basic instruction in computer science. Computer science courses are a principal gateway to STEM-oriented career tracks. Many of the most highly compensated and high-status occupations in STEM are computer related. Learning to code has become so central in the digital economy that some states have even considered education legislation that would allow learning a coding language to be a substitute for learning a foreign language. Critics, however, charge that learning a foreign language is substantially different from learning programming language. Learning to code is as much about learning to problem-solve—dealing with complexity—as it is learning the technical aspects of programming. One indicator of the low number of black and Latino students having access to high-quality computer science education is the extraordinarily low number of Latino and black students who take the college AP exam in computer science every year. The data strongly suggest that significant proportions of
black and Latino students are locked into schools and learning environments that do not prepare them for future opportunities in STEM.

Quality of the Learning Environment

From the very beginning of the class it was clear that there was no curriculum or plan for the kinds of games that students were expected to create. For instance, there were no clear-cut instructions, guidelines, or rubrics for students to consider. Moreover, there were no discernible pathways to level up, that is, produce subsequent games that demonstrated more complex ideas or game play mechanics over the course of the semester. For example, students could have been asked to produce board games, paper prototypes, or simple digital games as a way to make their ideas actionable through rapid ideation and prototyping techniques. In addition to providing a foundation for building their design and game creation skills, these kinds of early assignments could help students foster creative confidence and academic efficacy.

One of the few students who consistently worked hard on his Gamestar Mechanic project complained that the version of the platform available in the class lacked many of the assets that were required to produce richer games. He wanted to enter his class project in a Gamestar Mechanic student competition. His expectations for the class—producing a game high enough in quality to receive outside recognition—were considerably higher than Mr. Warren’s expectations.

Throughout our time in the class (the entire year) there were no lectures or any teacher-led discussions about the features of the game creation software available in the class specifically or game design principles more generally. Further, Mr. Warren did not provide textbooks, handouts, or online learning materials related to game design for students to consult. How was this possible? First, we learned that Freeway, already facing severe budget constraints, could not afford instructional materials for the course. Second, Mr. Warren’s lack of teaching experience limited his capacity to design a classroom environment that supported students’ opportunity to learn some of the basic principles of game design.

Learning materials like books and electronic resources not only support instruction and provide guidance; they also help establish certain expectations for the learning climate. When no materials exist for students
to consult, the possibilities for learning are seriously undermined. Students were expected to learn mainly through individual or collaborative exploration, experimentation, and discovery. While a few of the students tinkered with Gamestar Mechanic, many used it only on the rare occasions when Mr. Warren insisted. Consequently, their time spent on game creation tasks was limited.

Time to Learn STEM

Oakes contends that one way to assess the opportunity to learn is to consider the amount of time students are able to devote to learning. She found that when it comes to the time to learn, students in higher-track classes benefit in an assortment of ways—quality instruction, more time on task, academic rigor, regular attendance—that enhance the amount of time they are able to devote to learning compared with students in lower-track classes. Admittedly, observing learning is a challenge due to the subtle and often invisible aspects of learning. Even when students appear to be listening, working, or following instructions, it does not necessarily mean that they are learning. Thus, we focused on engagement—that is, the extent to which time was allocated for interacting with some of the more cognitively demanding elements of game design referred to in the state standards, such as critical thinking, prototyping, and technical operations.

The significant relationship between time and learning, however, is not simply about the amount of time set aside for learning (quantity of time); it is also about how the available time to learn or engage subject matter content is spent (quality of time). What made our analysis of learning more challenging than usual was that there was very little instruction from Mr. Warren. There were also virtually no assignments. Teachers are generally expected to introduce students to specific texts, concepts, ideas, and techniques and then require them to demonstrate their understanding through an essay, test, homework, experiment, or creative product.

In the games class, for example, students might be expected to read documents and textbooks that offer insights into the mechanics of game design. Typical assignments might require students to spend some of their time writing, sketching, and building prototypes. These kinds of
classroom activities—engaging course learning materials and participating in the demonstration of proficiency—support engagement with STEM-based literacies such as hypothesis testing, design, coding, or research and information fluency.

And yet, students spent very little time formally engaged in these kinds of learning tasks. Instead, several students played games in class but generally not for the purpose of informing their own approach to the design of games. In other instances, students used the classroom Internet connection to watch videos, listen to music, or consume content that did not appear to have any relevance to the main goals of the class—learning how to design and build games. Students were rarely required or expected to engage in game design learning tasks during class time.

Many education researchers believe that time-on-task is a critical factor to consider when assessing the opportunities that students have to learn. If students do not have sufficient time to devote to tasks that encourage engagement with core class concepts and ideas, then the likelihood of meaningful learning outcomes is substantially reduced. From the outside looking in, the students in Mr. Warren’s class had substantial time (each class was an hour and a half) to learn the basic components of game design. However, if the attainment of STEM skills in game-based learning settings is at least partially contingent on students devoting time to tasks like systems thinking, computer science, iterative design, multimodal storytelling, media production, or building playable prototypes, then the opportunities for cultivating STEM literacies at Freeway were, in fact, limited.

Perception of Student Abilities

The learning opportunities that schools provide their students are institutionally created and perpetuated, in part, by perceptions of student ability. When teachers think that their students are capable of stretching cognitively, they are much more likely to assign rigorous tasks. Conversely, when teachers think that their students are incapable of handling challenging academic work, they are much less likely to assign rigorous tasks. Oakes writes, “We know that the learning opportunities teachers are able or willing to create in classrooms are affected in some
ways by their perceptions of the characteristics of the groups of students they encounter.”

Although he had a great rapport with many of his students, Mr. Warren’s lack of attention to curricula-related details, coupled with the near absence of any projects from students to assess, strongly suggests that he did not have high expectations for what his students might be able to accomplish. During our fieldwork, students were never required to produce some of the basic artifacts that reflect substantive engagement with the creative or rigorous cognitive activities associated with game design. For example, students were not asked to produce design documents, research, artwork, storyboards, or prototyped games for feedback and assessment.

Moreover, even if Mr. Warren wanted to design a rich curriculum and require his students to produce game-based artifacts for teacher feedback and assessment, his lack of classroom experience combined with no expertise in game design severely handicapped his ability to do so. The decision to appoint Mr. Warren as the instructor for the game development class despite his lack of expertise was not an aberration. Researchers call this “out-of-field teaching,” and it is much more likely to occur in high-minority and lower-income schools than in predominantly white and higher-income schools. The higher percentage of out-of-field teaching in lower-income schools means that even when students have access to STEM courses, the instruction that they receive may not be on par with the instruction that more affluent students receive.

This is less a critique of Mr. Warren than it is of an educational system that routinely places teachers in classes that they are not prepared to teach. His appointment in the class was one of many indicators that when it came to implementing Freeway’s vision for a game design track, the school’s curricula planning and learning resources were incommensurate with its ambitions. Mr. Warren cared about his students, and they often spoke very highly of him. However, like so many others, Mr. Warren succumbed to the view that simply providing lower-income students access to technology—computers, game-authoring software, graphics applications—was an indicator of achievement. By emphasizing the acquisition of tech over the acquisition of high-quality instruction, the class was simply not built to deliver a robust STEM learning experience.
Our research team pondered whether the relatively low standards set in the class would have been permitted in a school with more affluent families. Our conclusion: likely not.

The Costs of Curriculum-Poor Conditions

Curriculum-poor conditions like the ones we learned about at Freeway are consequential. More specifically, students pay a steep price and one that has long-term effects on their future readiness and life chances. Classrooms that lack a clear curricula vision do not just limit the opportunity for students to learn in that class; the cumulative effect is often much greater. Curriculum-poor classrooms severely restrict the ability of students to develop the full range of skills that adequately prepare them for postsecondary education and an economy that values higher-educated and higher-skilled persons. Next we offer two examples that illuminate how curriculum-poor conditions cost students.

In the first example we consider how the curriculum-poor conditions failed to ignite interest in media and technology of two students who enrolled in the game development class with high hopes for learning and their future. The second example considers how the curriculum-poor conditions failed to develop a repertoire of skills that enhance the ability of students to make important industry and real-world connections. The first example illustrates how curriculum-poor conditions limit the capacity of students to grow their human capital, while the second example illustrates how these conditions can also limit the capacity of students to grow their social capital.

Looking for a Spark: The Consequences of Curriculum-Poor Classrooms

A number of students enrolled in the game design class optimistic that they would be able to ignite specific interests and, in some cases, forge open future-oriented pathways in areas such as game design, art, graphics, and engineering. The limitation of the class notwithstanding, Mr. Warren was a caring teacher for the students who displayed an interest in games and digital media production. He sincerely valued the interests that students were developing out of school and encouraged them
to bring those interests, skills, and projects into his class. Further, he invited students to take a greater ownership stake in their own learning. For some students this was an invitation to dive deeper into interests that they were developing, work on outside projects in school, or tinker with emergent interests.

As a result, Mr. Warren created an opportunity for a learning experience that softened the boundaries between formal and informal learning spheres, academics and pop culture, school work and play, and adult-driven and peer-driven modes of learning. However, as we discovered during our fieldwork, allowing students to bring outside interests into the classroom does not guarantee that they will encounter rich learning opportunities or develop depth expertise or a stronger sense of academic efficacy in school.

The stories of Caroline and Emmanuel illustrate how the curriculum-poor aspects of the game design class undermined the ability of students to meet some of the learning outcomes established in the Technology Application standards or realize their own interest-driven aspirations.

**Caroline and Emmanuel**

Caroline was one of the few female students enrolled in the advanced games class offered at Freeway. Mr. Warren championed her as one of his prize pupils. Like a proud parent, he boasted about her art skills. Caroline, a junior when we met her, enjoyed drawing and was especially fond of anime—the Japanese art/animation style that is popular in comics, children’s cartoons, and games. When we saw her sketchbook, it was full of drawings that appeared in a classic two-dimensional anime style. There was a mixture of black and white as well as colored-pencil drawings that reflected a bold style. The eyes of some of her characters seemed to possess life. Caroline was self-taught and started drawing when she was in sixth grade. Her inspiration was a cartoon that she watched as a kid, Naruto. She liked to practice, and, as she told us, “every drawing just gets better and better the more I do it.”

During the school year we had the chance to learn more about Caroline. For example, we discovered that she did not like attending Freeway. “The students here are too rowdy,” she told one of our interviewers. And like many of her peers, Caroline thought that homework was a waste of
time. Even more disheartening was her claim that “most of the teachers here don’t really care how well you do.” Her ambivalent attitude about school made the sketchbook that she maintained even more intriguing. If school failed to motivate Caroline, her interests in anime had the opposite effect.

Her reasons for enrolling in the games class were partly aspirational and demonstrated the degree to which Caroline was engaged in some sophisticated translation work. Unlike some of her peers, she did not view Mr. Warren’s class as a career path to games but rather as an opportunity to explore a different career track. “I want to make animation and manga art for books and television shows,” she told a member of our research team. Caroline said that she took the class “to see if it would help me in designing an anime show that I want to make when I get older.”

Emmanuel also viewed the games class as an opportunity to connect an interest he pursued outside of school to the game design class. This was Emmanuel’s first year at Freeway, which may explain his occasional shyness and tendency to recede into the background whenever he collaborated with students in the game design class. He intentionally chose engineering, art, and game design classes to engage his true passion—drawing cars. Emmanuel, also a junior, made repeated references to his love of cars.

Similar to Caroline, Emmanuel maintained a sketchbook full of pencil drawings. Most of Emmanuel’s pictures were side-profile views of cars, often tweaks and modifications to real cars on the street. The pencil sketches displayed clean lines, careful shading, and interesting interpretations of well-known car brands. In one series of drawings he had a Lincoln Continental merged with a Cadillac DeVille, several cars based on Bentleys, and two drawings sourced from BMWs. In addition to the technical illustrations, his collection of drawings included a couple of two-dimensional drawings of female friends and a rough sketch of his dog. He even tried a self-portrait.

Emmanuel carried his sketchbook around like a badge of honor, a physical manifestation of something that he had committed time and creative energy to make. He occasionally sold some of his drawings to classmates. Through many conversations with him, we learned that Emmanuel enrolled in the game design class because he was excited by the prospects of seeing his drawings in three-dimensional aspects
on the computer. Emmanuel, in short, was hopeful that the class would spark his creative aspirations.

**Failure to Spark**

Caroline and Emmanuel came to the game design class with specific goals in mind related to art, design, and animation. Their stories are additional examples of how student aspirations and academic dispositions at Freeway belied the “at risk,” “low achievement” narrative that drove the largely negative perceptions of the school. This is a crucial point insofar as it suggests that even students labeled as “average” or “low performing” may have interests that if acknowledged and supported can lead to important educational breakthroughs.

Caroline and Emmanuel were not exceptional students by traditional standards. Their grades and academic ambitions were modest, at best. Neither articulated postsecondary aspirations. Moreover, both Caroline and Emmanuel were uncertain about how to translate their interests in art, design, and animation into postsecondary or career opportunities. And yet, they each had imaginative ideas regarding how the game design class could help them cultivate their artistic and technical skills and connect them to creative and career-oriented trajectories that were personally meaningful.

Each student was looking for an opportunity to spark a distinct interest. Caroline envisioned an interest-to-career trajectory. “I’d like to draw for an animated television show one day,” she confessed. Emmanuel had aspirations that the class would help take his artwork to the next level, 3D animation. They were ready for a novel academic experience, but the class, unfortunately, was not designed to deliver one.

The level of a person’s interest is believed to have a powerful influence on learning. Hidi and Renninger write that “interest as a motivational variable refers to the psychological state of engaging with particular classes of objects, events, or ideas over time.” When students bring an outside interest into a class we might expect that they will be motivated to engage, perform, and achieve. However, the direction and development of that interest is influenced by external conditions.

In the two examples that we sketch above, Caroline and Emmanuel came to the class with an *emerging individual interest*. That is, both
exhibited “the beginning phases of a relatively enduring predisposition to seek repeated reengagement with particular classes of content over time.”\[^14\] And while this emerging individual interest is generally self-generated it requires external support to be sustained. The educational environment is a context presumably equipped to help students develop and sustain their interests by supporting their ability to go deeper, acquire knowledge, and attain greater proficiency.

Caroline and Emmanuel embodied aspects of emergent individual interest. The effort that they exerted in the maintenance of their sketchbooks suggests that they valued this interest and reengaged it over time. They enrolled in the game design class because they believed it was an opportunity to continue engaging their interests in art and also cultivate new interests in digital media production, animation, and design. In theory they were right. School, and the game design class in particular, should have been an opportunity to explore and further cultivate their interests in digital media content creation.

Studies show that educators can help students nourish and develop their interests through modeling and innovative task organization, and by offering feedback that encourages students to maintain attention and grow more curious and competent about an interest.\[^15\] Educators can also establish the learning environment and conditions that not only create the opportunity for students to reengage an emergent individual interest but also deepen that interest.\[^16\]

As high school students, Caroline and Emmanuel were at a crucial point in their emergent individual interests: their interests as digital media artists were poised for further development. This is a period when an interest’s relationship to postsecondary education and career-oriented trajectories becomes more salient for some students. Educators—both in and out of the classroom—are in the unique position to build the conditions that help students link their interests to future opportunities. The failure to design an educational environment that offers learning opportunities that deepen engagement with an interest, for example, can lead to reversal or an interest becoming dormant or disappearing altogether.\[^17\]

Throughout their time in the game design class, Caroline and Emmanuel struggled to find learning opportunities that enriched their interests in the digital media arts, design, and animation. Caroline hoped
to connect her interests in anime to the games class and articulate a career-oriented trajectory. She needed a curriculum, instruction, and learning climate that fostered the ability to explore the areas of art, story, and character development in greater depth. Emmanuel had no substantive experience with graphics software prior to the class, so what he really needed was hands-on instruction, guidance, and feedback to enhance his design, art, and technology skills. Unfortunately, in an environment that offered no instructional expertise, instructional materials, or innovative tasks, Caroline and Emmanuel had to develop their design and technical competencies on their own. As a result, the class was of very little value to them, and midway through the semester their interest began to wane.

We highlight the stories of Caroline and Emmanuel to note that interest-driven learning does not happen simply because a student can pursue an outside passion in school. Rather, interest development has to be organized through rich curriculum design, supported by instructional expertise, and deepened by cognitively demanding tasks. Our observations and subsequent analysis compel us to conclude that linking interests to the formal learning environment is an important aspect of more relevant learning but is insufficient alone to produce learning that is deep, robust, and connected to future opportunities.

Designing the Networked Classroom

If Mr. Warren struggled with developing a curriculum-driven vision for the game design class, his persistent efforts to connect his students to the various stakeholders in Austin’s burgeoning innovation economy were considerably more robust. Austin is a mini-hub for game development companies including Electronic Arts, Disney, Sony, and Blizzard Entertainment. Equally noteworthy are the small independent game, interactive, and mobile media start-ups dotting the city’s creative economy landscape. Throughout the school year Mr. Warren maintained an open-door policy, inviting journalists, educators, school board members, state elected officials, and members from local game studios to his class.

Mr. Warren strongly believed that for his game design class to reach its potential it was imperative to expose Freeway students to the industry and cultivate meaningful social ties. As we discuss in the book’s conclusion,
one of the more urgent challenges that Freeway students confront is their isolation from the social networks and information channels that are the real links to opportunity and economic mobility in a knowledge-driven economy. In this section we explain how curriculum-poor conditions undermined Mr. Warren’s ability to fully catalyze the social ties he labored to turn into an asset for his students.

A visit by Catherine and Jillian, two twenty-somethings from a local game studio, was a clear example of a great idea—exposing students to industry professionals—falling short because of curriculum-poor conditions and naiveté about employment in the creative sector. These arranged encounters with industry and other local VIPs were often a missed opportunity for Freeway students to learn valuable lessons about the world of creative work and the significance of cultivating meaningful professional connections.

At the start of their visit Catherine and Jillian stood in front of the class to answer questions. Many of the questions that the students asked were understandably inexperienced. “What’s the best way to get a job in the video game industry?” “What kinds of positions are available at your studio?” Many of the students were half-interested at best in the two visitors. Some of the members from the UT Crew (a group of students you will meet in the next chapter) showed slightly more interest. Working to try to keep students attentive, Mr. Warren announced, “Ok guys listen up. . . . If you want a job in the industry here’s your chance.”

The two visitors talked about their own paths to careers in game design. Catherine noted that she studied art and design at the University of Texas and made her own way to games via that track. “There was no one in my department who worked with games,” she said. Jillian traveled a more unconventional path. “I got my degree in a field that is far from the industry, Asian studies,” she said. But she picked up a skill in college—writing—that she believes serves her well in the games industry. Her strong writing skills led to her first job in quality assurance, where she was able to point out flaws in games and write powerful descriptions.

“You have to be able to write in the industry; it’s actually quite important,” Jillian explained.

Both Catherine and Jillian emphasized the importance of going to college and developing your skills as a writer and a thinker. To make her
point about college even more pronounced, Jillian pointed to Watkins, a university professor, and stated, “That’s the guy that you need to know.”

The suggestion that the ability to write and think was a key element of finding opportunity in the game industry illustrates an important point about literacy in the era of smart technologies and knowledge-driven economies. Digital literacy is routinely championed as a key feature in the new world of learning and preparation for the economy of tomorrow. But as Jenkins et al. argue, a key aspect of education in the twenty-first century is the twin mastery of the long-standing literacies associated with print culture and the newer forms of literacy associated with digital media culture.\(^{18}\) Jenkins et al. also note that before students can thrive in the digital realm, “they must be able to read and write.”\(^{19}\) Importantly, they note that “youth must expand their required competencies, not push aside old skills to make room for the new.”\(^{20}\)

In his book *The Art of Game Design: A Book of Lenses*, Jesse Schell lists writing among the various skills a good game designer needs.\(^{21}\) He identifies two distinct forms of writing, creative and technical. Whereas the former includes creating the fictional world, characters, and events that will shape the game world and gameplay experience, the latter includes, for instance, the creation of design documents that clearly map all of the game details. The perspectives from Jenkins et al. and Schell reiterate the idea that the ability to write and communicate effectively remains critical in an economy driven by knowledge, technology, ideas, and innovation. When we reviewed our field notes we were stunned to find virtually no reference to students submitting any type of written work. The curriculum-poor conditions neither required nor expected students to demonstrate proficiency in any form of writing, creative or technical.

Further, Catherine explained that oftentimes employers want to see your work and suggested that students maintain a portfolio of the creative content they generate. This could include anything from drawings to artwork to blogs and even games. She offered her website as a sample of a digital portfolio that included, among other things, information about her work experience, samples of her work, and a repertoire of art, design, and social skills. In addition to her technical proficiency with software such as Unreal 3, Maya, Photoshop, and Illustrator, Catherine performed management and supervisory roles. She also touted her
writing, editorial, and communication skills as assets that could support the achievement of team-wide objectives.

After Catherine and Jillian left, our research team reflected on what the visit suggested, more generally, about the class. Ideally, the students would have conducted some research on the studio and prepared a set of questions related to, for example, the studio’s mission, previous and current titles, and adaptations to an industry that is undergoing wide transformation as a result of social gaming and mobile platforms. This kind of preparation—conducting research on a company and industry-specific related data and trends—is quite common among those seeking jobs in today’s hypercompetitive economy. Additionally, the encounters with local talent—game designers, tech companies, and media professionals—presented opportunities to help students not only connect to industry talent but also gain experience cultivating the social skills that are a prerequisite for entry into the knowledge economy.

For example, during the visit by Catherine and Jillian, Freeway students could have handed out business cards and shared their games, sketchbooks, music compositions, and other content for creative and professional feedback. The outside visit presented a great opportunity to learn about internships and other potential opportunities to make connections with the studio. These kinds of interactions and the rich lessons they might provide require a curricula vision that is responsive to the needs of students and cognizant of industry trends. Additionally, a well-designed curriculum could help students use the informal knowledge gained through these exchanges to inform their academic pursuits and creative aspirations.

* * *

The curriculum-poor conditions failed to spark the emergent interest development that some students articulated when they initially enrolled in the game design class. In many instances the inadequate curriculum design severely limited the opportunities for students to grow their human capital in STEM-related areas. As we noted above, the formal aspects of the class fell far short of the state standards in digital media and technology.

In addition to the educational costs, the curriculum-poor conditions led to important social costs. Entry into creative work is as much about
social capital (who you know) as it is about human capital (what you know). The many encounters, for example, with game industry studios and personnel provided unique opportunities for Freeway students to learn more about the creative industries in Austin. Equally important, they provided an opportunity to practice some of the networking skills that are essential in creative economies.\textsuperscript{22} The curriculum-poor conditions resulted in a missed opportunity to help students gain some experience building the social capital skills—networking and cultivating social ties—that are part and parcel of the knowledge economy. Students like Caroline and Emmanuel paid real costs for a game design class that articulated lofty goals but failed to produce the curricula conditions and learning climate to realize those goals.

The $TEM Economy

Among the many reasons why schools like Freeway have intensified their focus on STEM education, none may be more significant than the widely held view that the best-paying occupations in the United States require STEM skills. Most STEM occupations offer wages that are significantly above the U.S. average.\textsuperscript{23} The hegemony of the STEM economy—the rising premium on technology skills, high educational attainment, complex problem-solving skills—will continue to influence education policy discourse, curriculum planning, and future visions of learning.

According to the U.S. Bureau of Labor Statistics, STEM employment will far outpace non-STEM employment in the expected rate of job growth.\textsuperscript{24} Whereas the projected growth rate for all occupations between 2014 and 2024 is 6.5 percent, the growth projections for STEM occupations are notably higher.\textsuperscript{25} For example, mathematical science occupations are projected to grow 28 percent and computer occupations by 12 percent during the same period.\textsuperscript{26} STEM workers, on average, earn 26 percent more than their non-STEM counterparts.\textsuperscript{27} Furthermore, STEM professionals are less vulnerable than their non-STEM counterparts to periods of joblessness or unemployability.\textsuperscript{28} In an economy increasingly defined by technological transformation and a bias toward more nuanced cognitive skills, the value of STEM-oriented competencies—complex problem solving, data analysis, computational
thinking, experimentation, and mathematical and statistical analysis—will only increase.29

These shifts more broadly are connected to what Frank Levy and Charles Murnane call “the new division of labor.”30 The pervasiveness of computers in the workplace has profoundly transformed the occupational structure of postindustrial economies. As we discuss in greater detail in the chapter’s conclusion, some economists argue that the computerization of work drives a sharp demand for more cognitively complex skills such as expert thinking, solving uncharted problems, and complex communication.31 These trends assert greater pressure on educational institutions to cultivate the skills that align with the new division of labor. This is precisely what the emphasis on STEM education intends to do, that is, accelerate the capacity for schools to build a more highly skilled workforce.

Even as the STEM economy is projected to be a significant feature of the larger U.S. economy, only a small number of Latino and African American students are adequately prepared to enter the STEM education and career pipelines. The underdevelopment of STEM talent in lower-income schools is one of the essential challenges driving the education crisis in the United States.

The School-to-STEM Transition: Alternate Paths

The lack of information about and exposure to STEM careers is a significant barrier facing many lower-income youth like the ones we met at Freeway. Most of the students in our study were simply unfamiliar with the many different career options in STEM. The misinformation regarding what types of education and training establish different pathways to STEM employment is also an impediment to opportunity. For instance, there is widespread belief that the attainment of a bachelor’s degree is the route to a career in STEM, but alternative educational pathways exist. The STEM labor market is heterogeneous and comprises many sectors, including government, academia, and private.32

The U.S. Department of Commerce, for example, found that nearly one-quarter (23 percent) of STEM professionals completed an associate degree or at least some college.33 In a report titled The Hidden STEM Economy, the Brookings Institution presents what it calls a “new portrait of the STEM economy.”34 The report maintains that half of all STEM jobs are
available to workers without a four-year college degree. Jobs that require some degree of STEM knowledge but only sub-bachelor’s level training, the Brookings report notes, can be found across various sectors such as the health care, construction, and installation and repair industries.

Whereas STEM jobs that require at least a bachelor’s degree tend to be clustered in certain regions and major metropolitan areas, STEM jobs requiring only a sub-bachelor’s degree are more widely distributed across the U.S. metropolitan map. And while these STEM occupations may not offer wages comparable to those with more education and in higher-skilled STEM sectors, such as software and computer systems design, the wages certainly exceed low-skill service-sector employment.

Findings like these suggest that the STEM economy is much more diverse in the education and training required than is generally recognized. Consequently, the emphasis on the attainment of a four-year college degree obscures the other paths to meaningful employment opportunities in STEM. Information about these other educational and training tracks to STEM would be especially encouraging for many of the students at Freeway who had not been adequately prepared for post-secondary education in STEM or any other discipline. This points to another challenge that severely undermined Freeway’s efforts to prepare its students for life beyond high school—the many choke points along the K–12 pipeline to develop students capable of entering the pathways to STEM education.

Diversifying the STEM Talent Pipeline

The persisting difficulties in building a more diverse talent pipeline in STEM—one that includes women, Latinos, and African Americans—shed a critical light on the unique pressures that resource-constrained schools face in preparing their students for an economy that is certain to maintain a bias for STEM-related skills into the foreseeable future.

Freeway’s desire to develop more STEM-ready students was weakened by a combination of factors including, for example, the enduring effects of low-quality education in the early schooling years. There are persistent choke points along the kindergarten through high school pipeline that steadily diminish the pool of black and Latino candidates eligible for college degrees or careers in STEM. Curious about the education
pipeline directing the students in our study, we examined the STEM readiness of students from Central Texas Middle School, the primary feeder school for Freeway.36

Among the nearly one thousand students attending Central Texas Middle School, 72 percent were designated as low income. The school was racially diverse, but Latino (49 percent) and black (22 percent) students made up nearly three-quarters of the school’s population. In addition, 16 percent were categorized as English language learners. The combination of low social-economic status, race and ethnicity, and English language learners makes Central Texas Middle School an especially challenging environment for academic development. Specifically, we looked at the college- and career-readiness data compiled by ACT Inc. in two STEM-related areas of coursework, math and science.37

ACT defines college and career readiness as “the acquisition of the knowledge and skills a student needs to enroll and succeed in credit-bearing first-year courses at a postsecondary institution (such as a 2- or 4-year college, trade school, or technical school) without the need for remediation.” How did Central Texas Middle School fare?

Whereas 90 percent of eighth-grade students were designated as passing mathematics, less than half, or 42 percent, were designated by ACT as career and college ready in mathematics. The outcomes in science were worse. Whereas 81 percent of students received passing scores in science, only 28 percent were identified by ACT as college and career ready in science. This suggests that even when students receive passing grades in their math and science courses, their grade-appropriate readiness for postsecondary schooling in these two areas was notably weak. By the time a majority of these students enter Freeway for ninth grade, the chances of them successfully pursuing academic tracks that prepare them for STEM studies in a postsecondary institution are extremely low. Even if Freeway had developed a robust STEM curriculum, the likelihood that the majority of students could operate at a high level was undermined by inadequate academic preparation during their earlier years of schooling.

The STEM career- and college-readiness status of Central Texas Middle School students is even more striking when you compare it with the status of students from West Hills Middle School, an affluent middle school located across town.38 West Hills is located in what the Washing-
The New York Times classifies as a “Super Zip Code.” These are zip codes containing families that are in the ninetieth percentile for median incomes and college degrees. Austin had eight Super Zip Codes, and one of them was home to West Hills. In the zip code that was home to Central Texas Middle School, 33 percent of the adults had college degrees compared with 79 percent in the zip code that West Hills calls home.

Among the 915 students attending West Hills, only 3 percent were designated as low income. The median household income in the zip code, $129,188, was more than double the U.S. average. The school was predominantly white, 77 percent. Latinos made up 2 percent of the student population. English language learners and African Americans made up 2 and 1 percent, respectively. A combination of factors such as an overwhelmingly upper-income, white, and English-speaking population made West Hills an especially advantageous environment for academic development. While 99 percent of West Hills eighth graders passed math, a respectable 78 percent were identified by ACT as college and career ready in the subject. The outcomes in science were comparable. Ninety-five percent of students received passing scores in science, and 67 percent were designated as career and college ready in science. The educational disparities in STEM readiness between Central Texas Middle School and West Hills are substantial and consequential.

Sadly, the choke points that diminish the pool of Latino and black students able to pursue postsecondary STEM degrees begin long before students reach the middle and high school grades. Kids from lower-income households are more likely than their counterparts from higher-income households to enter kindergarten behind in terms of cognitive and non-cognitive development. In a study of three age cohorts of children, researchers found that gaps in early cognitive skills are highly predictive of gaps at later ages, establishing what they call “a trajectory of cumulative disadvantage for black children over time.” In other words, skills acquired in early education beget more skills in primary, secondary, and postsecondary education.

Much of the educational evidence suggests that from early childhood through high school, children from lower-income families face enormous hurdles in sustaining access to high-quality educational opportunities. As a result of these early childhood disadvantages, many of the students that we met at Freeway faced significant hurdles in what
Claudia Golding and Lawrence Katz call “the race between education and technology.” It is a painful reality to accept, but by the time many Freeway students enter ninth grade their educational and economic futures have largely been determined.

The college-readiness disparities at Freeway parallel national disparities. Consider the data on high school STEM coursetaking in the United States. In 2009, Latino and black students were less likely than their Asian and white counterparts to have completed higher-level math and science courses. Whereas 42 percent of Asian/Pacific Islander and 18 percent of white graduates had taken calculus only 9 and 6 percent, respectively, of Latino and black high school graduates had. Similar coursetaking patterns emerge in science courses. Fifty-four percent of Asian/Pacific Islander and 31 percent of white graduates completed the combination of biology, chemistry, and physics courses in 2009. By contrast, 23 percent of Latino and 22 percent of black graduates completed this combination of science courses in 2009.

The disparities throughout the K–12 pipeline are certainly linked to the low number of STEM college degrees that black and Latino students receive. A 2016 study by the National Student Clearinghouse confirms the escalating concerns about the STEM degree attainment gap in the United States between black, Latino, and white students, for example. Whereas 15 percent of students from higher-income schools earned a STEM degree within six years of high school graduation, only 7 percent of students from lower-income schools did. Even though the growth in the number of black and Latino high school graduates and college enrollees has been outpacing that of whites, the former are still less likely to earn STEM degrees.

The low number of STEM degrees is even more remarkable when you consider the growing number of underrepresented youth who report that they want to earn a STEM degree. Since the 1980s blacks and Latinos have been just as likely as their white counterparts, for example, to express aspirations for attaining a STEM degree. However, compared with their Asian and white counterparts, they are significantly less likely to leave college with a STEM degree in hand. There is no STEM aspiration gap between Latino and black students and their white counterparts. Rather, Latino and black students tend to lack access to
the educational preparation necessary to realize their desire to earn degrees in STEM.

It’s Hard to Be What You Cannot See

In addition to the education choke points noted above, several other factors help explain the low numbers of black and Latino students in the STEM education pipeline. Among them, for example, is the fact that many lower-income students are simply unaware of the opportunities in STEM and what is required to credibly pursue related career tracks. This is further compounded by the fact that lack of exposure to science- and technology-oriented professions makes these career choices less visible, tangible, or even imaginable. We commonly met students at Freeway who could articulate aspirations for high-status careers. Students, for example, expressed interests in filmmaking, software engineering, and the digital media arts. But in many of these instances it was clear that students had insufficient access to role models or information about how best to realize their aspirations.

Critics often bemoan the fact that so few Latino, black, and female youth pursue STEM careers, and yet how we message who is most likely to occupy these careers is seldom interrogated. To what extent do narratives about STEM literacy, competency, and opportunity routinely imply white, college-educated men?\textsuperscript{49} Latino and black students are less likely to see other Latinos or blacks in STEM careers compared with their white and Asian American counterparts. This suggests a need to actively rebrand computer science, information technology, and STEM-related professions.\textsuperscript{50} A different set of images, messages, and narratives about STEM might appeal to a more diverse group of young people, prompting even greater interest in the field. This all suggests that it will take a comprehensive approach to substantively diversify the STEM pipeline, even rethinking the kinds of cultural representations that inform who we think of as designers, engineers, computer scientists, and tech gurus.

Marvel Inc.’s blockbuster Black Panther (2018) was widely recognized for its box office success that debunked the many industry claims that black-themed films could not succeed in a global marketplace. But
many championed another feature of the movie—the portrayal of Shuri, a young black woman, as the design and tech savant in the fictional world Wankada. Her STEM skills were a critical part of the narrative. Historically blacks in general and black women specifically have seldom been portrayed as designing, thinking, and problem-solving with technology. These cultural representations and the racial, gender, and behavioral scripts they construct not only entertain us; they also reproduce common sense notions about who has the agency to adopt and leverage tech to build better futures.51

These issues are especially significant in light of the workforce trends at technology companies like Google, Facebook, and Apple. In 2014 many of the big tech companies began releasing their workforce data after initially refusing to do so. The data have consistently revealed two decisive trends in tech: the employees in technical and leadership positions are overwhelmingly white and male. At companies like Google and Facebook, black and Latino workers make up about 2 percent of the workforce. The lingering question, of course, is why are these huge disparities in tech employment the norm?52 Thus far we have highlighted the disparities in education—that is, inadequate preparation in the knowledge and skills (human capital) necessary to gain access to STEM occupations. But the gross underrepresentation of blacks and Latinos in STEM occupations is attributable to insufficient social capital, too.

The Significance of Social Capital in STEM

The STEM employment hurdle that black and Latino students face is not simply a matter of inadequate education; it is also attributable to shortcomings in the diversity and reach of their social networks. For example, as we explained in the introduction, Freeway students live literally on the outer edges of Austin’s vibrant tech and knowledge economy, leading to spatial isolation. Importantly, spatial isolation contributes to social isolation.53 Whereas spatial isolation can limit access to certain physical resources (resource-rich neighborhoods and schools), social isolation generally limits access to important social resources (diverse informal social networks and rich channels of information).
Informal social networks are the primary channels through which ideas, knowledge spillover, tips, and rumors about employment and other opportunities circulate. This is social capital. Access to social capital among students comes largely in the form of the social capital acquired by the adults in their lives, including, for example, parents, other adult relatives, teachers, coaches, mentors, and faith leaders. Thus, any solution to the STEM employment crisis must not only bolster the education and training that black and Latino students receive; the solution must also bolster the social networks, information channels, and STEM role models that black and Latino students have access to.

Redesigning the quality of education available to lower-income students in the K–12 pipeline is a significant challenge. Redesigning ways to fortify their social networks and the informal exchange of knowledge and information is even more formidable. Whereas the former requires enhancing the quality of schools and instruction that students have access to, the latter requires expanding the informal social networks, people, and information channels that students have access to.

Conclusion

The adoption of games at Freeway was a sincere effort to embrace the future of learning. In our view there was one fatal flaw above all other shortcomings in the game design class at Freeway. Although students had access to technology, they did not have access to a clear curriculum vision and learning climate that cultivated human capital (STEM-oriented academic skills) and social capital (STEM-oriented social ties). The primary goal of the course was to encourage high school students to tinker and make games with a piece of game-authoring software that was designed for middle school students developing a novice interest in game creation. Making digital “stuff,” it turns out, is actually quite common throughout the K–12 embrace of games specifically and the adoption of technology more generally. The singular focus on making digital content, in our view, is a mistake.

We urge educators to broaden their vision for what STEM classes can accomplish. It sounds strange, but learning how to use a specific piece of software or even building a game should not be viewed as the most
important aspect of a game design class. The primary focus should be on outcomes that are neither technology nor product dependent. While the accomplishment that comes with making a game is certainly noteworthy, the real test of progress is whether technology classes can spark greater academic efficacy among students—that is, the confidence that they can thrive and chart their own destiny to opportunity in formal educational settings.

At Freeway the mere access to technology—high-powered computers, an impressive mix of software, and the Internet—was considered a sign of achievement. Access to technology is certainly important, but having access to curriculum-rich classrooms and cognitively challenging tasks that promote level-appropriate expert thinking, problem solving, and complex communication skills is even more important.55

Games are viewed by a surging number of educators and tech entrepreneurs as an opportunity to ignite more robust learning experiences and academic outcomes. Media and technology in the classroom—film, television, video, computers—have long been viewed as a remedy for the ills plaguing education.56 Games have been positioned as a viable pathway to the STEM literacies and careers that are generally associated with the future of work, opportunity, and social mobility. While this may be true, our fieldwork also suggests that the mere provision of tech-rich and game-based learning classrooms does not, by itself, establish the opportunity to cultivate STEM skills.

New learning futures should not be measured in terms of how much technology schools acquire but rather how technology is used as a platform for growing the academic competency and efficacy of students. Freeway is a powerful reminder that even as the spread of technology and technology courses accelerates in U.S. schools, not all tech-rich classrooms and the opportunities for STEM learning are created equal.