Schoolyard Geology as a Bridge Between Urban Thinkers and the Natural World

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ABSTRACT

Students who have a strong urban place-identity may perceive the natural world differently from many geoscience instructors. These urban thinkers have less experience in the natural world and are more comfortable in built environments. They may have subtle differences in cognitive and spatial skill development, interest level in the natural environment, comfort with field experiences, and possible fears of outdoor settings. Curriculum is more effective at reaching urban thinkers when it accounts for these differences. Since urban thinkers are more comfortable in the built environment, short excursions on campus or in the schoolyard can be a bridge between settings familiar to urban thinkers and geologic processes important for the study of geosciences. These mini–field experiences provide opportunities for students to ask questions about the world around them, especially if emphasis is placed on the physical processes that shape the urban landscape. Once students are familiar with the observations and interpretations appropriate for analyzing a familiar urban setting, they will be more receptive to learning about the natural world. *© 2012 National Association of Geoscience Teachers*. [DOI: 10.5408/11-246.1]

Key words: urban education, affective domain, student attitudes, field trips, mapping, analogies

INTRODUCTION

A recent advertisement for our department's geology club shows a photograph of a student writing in a dusty field notebook with the backdrop of a breathtaking landscape. While it certainly caught my eye, did it have the same effect on the diverse range of students passing it in the hallways of our urban Los Angeles university? Are the methods changing for attracting students to the geosciences and then teaching them effectively?

There is concern that changing technology has led students to "think and process information fundamentally differently from their predecessors" (Prensky, 2001). While students may be changing, we may not be adapting our curriculum to the new needs of these students (e.g., Oblinger and Oblinger, 2005; Rodgers and Starrett, 2005; Sandars and Morrison, 2007). At the same time, Bennett et al. (2008) argue that claims of sweeping transformations in learning styles are overstated and not supported by evidence. The effects of technology, however, go beyond issues of learning styles. Technology can isolate modern students from the natural world in an unprecedented manner, and this isolation has unique implications for the effectiveness of geoscience curriculum. Geoscientists study the natural world, and today's students have less exposure to it. Our community has begun to recognize this issue, devoting a special issue of this journal (Abolins, 2004) and a series of National Association of Geoscience Teachers workshops to the topic (NAGT, 2008).

I argue that our students have made a transformation to urban thinking. In this commentary, I define and clarify urban thinking, discuss its implications for teaching geosciences, and outline effective teaching strategies that target urban thinkers. I draw on my experience teaching in an urban public high school, a state prison, and a college campus in urban Los Angeles. The issue of how to engage urban students is at the heart of recruitment into geoscience careers and pedagogy for teaching earth science at all levels.

TRENDS IN URBANISM

Every new generation seems to be undergoing a "revolution" of sorts, so why is urbanism particularly important to geosciences now? Two factors account for the growth in urban thinkers in our classrooms: a physical urban migration of the population and an artificial "urbanism" due to the digital media revolution.

Urban Migration

According to the U.S. Census, nearly 80% of the country lives in urban areas, basically twice the proportion from a century ago. While the definition of urban has changed in the intervening years and is a matter of debate among demographers, the global migration to urban centers is undeniable. Today, the U.S. Census Bureau reports that more than one-quarter of our country lives in a "central city," where residents tend to have more limited opportunities for connection to the natural environment (e.g., Wolch et al., 2005). The steady growth in both numbers and proportion of urban students should cause geoscience educators to pay increasing attention to issues related to urban thinking.

Artificial Urbanism From the Media Revolution

New media options that have arisen in the last few decades have had a profound impact on the time people spend outdoors. In Japan, the average amount of outdoor play dropped from more than 3 hours in 1955 to less than 1 hour by 1991. This change is largely attributed to gradual urbanization and a decrease in the amount of natural play areas. Equally notable, however, is a rapid decrease in "experiences with nature" that occurred between surveys in

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1984 and 1991 (Ministry of Environment, 1996). This change might be attributed to the popular Nintendo gaming system, which was released in 1985.

In some populations, time spent on computers correlates with decreased outdoor activity (Fotheringham et al., 2000), while time spent watching television does not (Burdette and Whitaker, 2005). The growth in new media options has also been used to explain a 20% drop in the number of per capita visits to U.S. national parks from 1988 to 2003 (Zaradic and Pergams, 2007). In that study, time spent on the Internet, watching movies, and playing video games (along with gas price fluctuations) was a statistically important factor in determining how often families visited national parks, but television usage was not. Rather, national park visits grew per capita for the first three decades in which television existed, a trend that ended with the spread of computers and new media. Video game and computer usage tripled during the last decade (Rideout et al., 2010), so we can expect further changes.

Digital media is changing the landscape of urbanism. Up until this transition, the growing population of urban students was isolated from nature by geography—they lived within the built environment. Now, additional isolation can be by choice. An entire generation is beginning to grow up as urban thinkers, whether they are geographically urban or not.

URBAN THINKING

The impact of urbanism on how people think can be better understood in the context of human evolution. Other species have physical, genetic adaptations to their environments (think of Charles Darwin's finches). For humans, a long developmental period of learning and exploring as infants is our evolutionary adaptation; we do much of the adapting to our specific environment after we are born (Gopnik et al., 2001, p. 8; Heerwagen and Orians, 2002, p. 32). Some cognitive scientists suggest that a natural part of this developmental process is for humans to construct a "place-identity." From infancy, humans begin to recognize places and categorize them. One benefit of this skill is that it allows individuals to quickly identify whether they are "safe" when they enter a new environment. But place-identity is more than that. Hauge (2007) summarizes work on the topic by saying "place-identity becomes a cognitive 'database' against which every physical setting is experienced." In other words, people view and interpret all environments through the lens of their place-identity. They use place-identity to recognize environments, to construct meaning out of them, and as a defense mechanism (Proshansky et al., 1983). Place-identity and place preferences are not static but rather change over the course of child development and with new experiences (Korpela, 2002, p. 370).

WHAT IS AN URBAN THINKER?

In my definition, urban thinkers have minimal exposure and familiarity with the natural world and are therefore *more comfortable in the built environment than in natural settings*. Their place-identity is set up around the built environment, which has implications for how they perceive the natural world. Since no person grows up in complete isolation from nature, there is no "pure" urban thinker. The individual effects of urban thinking I discuss here may be present to different degrees in different urban students, and many programs successfully introduce urban students to geosciences. Being mindful of the effects of urban thinking can make such programs even more successful.

I highlight four broad categories in which urban thinking might affect the learning of geosciences: (1) cognitive skill development, (2) disinterest in nature, (3) discomfort in nature, and (4) outright fear of nature.

Cognitive Skill Development

Natural settings offer a different set of sensory stimuli than do built environments. As a result, urban thinkers may develop different sets of skills as they grow and develop in response to the stimuli in urban environments.

Geoscience is an observational science, but students come with different levels of experience making observations of the natural world. Urban thinkers develop observational skills in a domain different from the one applicable to most geoscience studies. When approaching a new system of objects that need to be categorized, we often consult our mental library of schema that we have used to categorize other objects in the past (cars can be sorted by shape, movies by emotions they evoke, coins by size and color, etc.). Urban thinkers have sets of schema useful for the built environment that may not apply to the natural world (Kellert, 2002). This skill goes beyond merely categorizing objects—it's about knowing what to look at when making observations. Essentially, an urban thinker is more likely to be a novice in the expert–novice continuum when it comes to geoscience observations and requires more detailed instructions about what specific features to focus upon when asked to "make careful observations."

Spatial thinking skills can also develop differently in natural versus urban settings. In studying how children in different settings conceptualize their space and navigate routes, many authors recognize a progression from route memorization to full spatial representation of their environment (references in Rissotto and Giuliani, 2006, p. 83). Many urban settings are complicated enough that they promote route memorization and inhibit the development of spatial representations. This problem may be compounded by more children being driven to school by their parents than ever before (20% in 1971 versus 90% in 2002 from one study in Great Britain), especially in urban areas where parents cite fears that urban environments are unsafe (Rissotto and Giuliani, 2006, p. 76). Students who walk to school draw detailed and accurate maps of their neighborhood, a sign of effective spatial understanding, while those driven by parents have the worst spatial understanding (references in Rissotto and Giuliani, 2006, p. 78). This shift dramatically decreases children's mobility and can have a profound effect on their spatial thinking skills. Since full three-dimensional spatial representations are prerequisites for many earth science tasks, some urban students may require additional practice to improve these spatial skills.

Disinterest

In geoscience education, we strive to have our students ask questions about the world in which they live. Students whose place-identity is entirely urban may not see themselves as living "within" the natural world. They may be burning with curiosity about *their* world—but not about the natural world that we primarily study in geosciences.

We know that students tend to learn better when they have a strong motivation for the subject, but urban thinkers have not developed a strong interest in nature because they lack exposure to it (Vaske and Kobrin, 2001; Fisman, 2005). Zaradic and Pergams (2007) ask, "[without a] nurturing connection to the subject matter ... will [citizens] still pay their tax dollars to maintain Yellowstone?" A related question is, will they want to learn about it in a class?

Many geology departments advertise their programs with photos of scenic beauty and promises of frequent trips to the outdoors. An urban thinker places less value on these pastoral settings (Zaradic and Pergams, 2007, p. 140), so we can expect to attract fewer urban thinkers to the geosciences using these tactics. Since geographic urbanism and ethnic minority populations are highly correlated, it may not be surprising that minorities are underrepresented in the geosciences. We tend to promote our science using methods that are less likely to have value to urban students.

Discomfort

Since field experiences are an integral part of geoscience courses, we should consider how urban students feel in outdoor settings. Researchers document a range of feelings of discomfort, from a deep feeling of being a "fish out of water" to more mundane logistical concerns.

As humans, we spend our early years learning about the specific hazards of our environment through social interactions, and our young brains get wired in the manner most efficient at processing stimuli from that specific environment. When we are taken out of that setting, we may react with strong feelings of discomfort. People with greater exposure to urban environments find natural settings "uncomfortable" and "overwhelming" (Bixler and Carlisle, 1994), and they therefore prefer built environments (Hoyt and Acredolo, 1992). Korpela (2002, p. 370) argues that one role of place-identity is to regulate anxiety and threats from unfamiliar environments.

In addition to emotional discomfort, physical discomfort and logistical concerns can impact urban students who have little experience in the outdoors. Students fail to learn if they feel physically uncomfortable or unprepared for the environment. When I first taught the Schoolyard Geology lessons, many of my students identified the mini–field excursions as their "least favorite" part of the course. Students had not expected the modest temperature extremes, wind, and walking around. Also, many found that learning strategies they used in the classroom (e.g., listening carefully to the professor and writing copious notes verbatim) were less effective outdoors, where they had trouble hearing the instructor and found it awkward to write without a desk.

Proper preparation before field experiences can reduce a range of discomfort. Orion and Hofstein (1994) investigated the role of preparation in field experiences and developed the concept of a "novelty index"—a measure of how new the field experience is for students. When the novelty index is low, students are more focused in the field and achieve higher levels of learning. Basically, the less familiar students are with what will happen during the field experience, the less they learn. The novelty index can be reduced by a range of in-class preparation activities. Instructors can specifically discuss logistical aspects such as weather, terrain, and sun exposure. They can present maps, videos, and photos of the field site and provide details about the specific activities students will complete while in the field. In my own course, I had done few of these preparations. When I made efforts to reduce the novelty of the outdoor experience, student discomfort and anxiety went down. In future classes, none of my students reported the same activity as their "least favorite."

Fear

Beyond simple discomfort, some urban thinkers may harbor downright fear of the natural world. Part of an urban thinker's socialization includes a highly sensationalized view of nature from electronic media. In particular, the hazards of outdoor experiences such as attacks by mountain lions, blizzards and avalanches, and even serial killers that prey on hikers receive a disproportionate amount of news coverage. Lacking direct experience with nature, urban thinkers may internalize these fears and conclude that nature is simply too dangerous a place to spend time (Zaradic and Pergams, 2007, p. 139). As a high school teacher in an urban school district, I was surprised by how often my students voiced these fears. They should not be underestimated when we take urban students into unfamiliar natural environments.

SCHOOLYARD GEOLOGY: MAKING NATURAL SCIENCES ACCESSIBLE TO URBAN THINKERS

To better reach urban thinkers, we can draw an unexpected connection. Sempken (2005) describes how Native Americans' strong "sense of place" affects their perception of geosciences. He argues that place-based teaching is an effective way to reach students with strong place-identity. For urban students, the place to which they feel most connected is their local built environment. To reach urban students, I propose that geoscientists must find ways to connect our ideas more directly with constructed landscapes like campuses and schoolyards. From this idea, I created Schoolyard Geology. The activities are available online at http://education.usgs.gov/lessons/schoolyard.

One of my primary goals as a geoscience instructor is to encourage students to look at a landscape and ask, how did it get to look the way it does? We can explore this fundamental question for a built landscape just as well as we can for a natural one; the physical processes may be different, but the approach to answering the question always involves making careful observations about what we see and using the present as the key to the past. Once we illustrate this process in a familiar built landscape shaped by processes that are familiar to urban students, it becomes easier to ask questions about natural landscapes and introduce the natural physical processes that shape them.

While many college geology departments have laboratory exercises that investigate different building stones on campus or in nearby municipal buildings (e.g., Kemp, 1992; Hoskin, 2000; Kean et al., 2004; Guertin, 2005), these lessons typically have students engage with the rocks in the same way that they would observe a large sample in a classroom-based lab exercise. Few activities focus on *physical processes* that shape urban environments.

TABLE I: Issues facing urban thinkers and possible solutions.

Section in This Article	Issue Facing Urban Thinkers	How Schoolyard Geology Helps Urban Thinkers
Cognitive skill development	Urban thinkers have sets of schema for the built environment that may or may not apply to the natural world.	Urban schemas apply to urban environments.
	Urban landscapes may promote route memorization, leaving urban thinkers with less experience constructing full spatial representations of their environment.	Practicing mapping and spatial skills in a familiar setting allows students to build on the representation they already have for the environment they know best.
Disinterest	Urban students feel connected to the built environment but don't necessarily feel that they are a part of the natural world.	Students are curious about their own environment and will be more interested in asking questions about the built environment.
Discomfort	Natural settings are uncomfortable because they are unfamiliar.	On-campus field experiences to familiar settings have lower novelty indices.
		Frequent mini–field trips build familiarity gradually.
	Physical discomfort and logistical issues come from lack of preparation.	Shorter trips are less likely to cause prolonged discomfort.
		Students see firsthand what preparations help most (e.g., jackets, hats, and sunglasses).
		Students practice learning outdoors, allowing them to develop strategies for working outside a classroom.
Fear	Natural environments are often sensationalized as places to fear.	Campuses are familiar and feel safer.

Urban schoolyards have both a diversity of materials and a history of processes that shape the way they look today. In the sections that follow, I describe some specific activities to explore the "geologic" history of urban campuses. I call these activities Schoolyard Geology, but they apply equally well to K–12 settings as they do to college campuses. My main goal is encourage creative mini–field experiences that emphasize the processes that shape urban landscapes. Table I highlights how these activities specifically help address the issues I raised in previous sections of this article.

Background on Schoolyard Geology

Schoolyard Geology was born out of necessity during college-level geology classes taught in a place where off-campus field trips simply were not possible: San Quentin State Prison (Sevar, 2005). Our inmate students mostly grew up in urban settings and had little familiarity with natural landscapes. They were having trouble recognizing geologic processes at work in the photos we brought because they didn't have a sense for the physical properties of natural materials or the scale of natural landscapes. Many did understand construction practices and knew the prison environment all too well, so we undertook a series of short "field trips" to the prison yard. The prison, established in 1850 before any of the state's educational institutions, has a stratigraphy in its concrete that rivals the Grand Canyon. There were opportunities to describe rock units, make measurements, and recognize geologiclike structures. By drawing analogies with what they already knew, our field trips allowed them to start asking questions about the world around them and then transfer those questions to the geologic settings we discussed in class.

Bridging Between Urban Schemas and Natural Processes: GeoSleuth Murder Mystery

Because urban students may begin without interest in understanding the geologic history of mountainsides depicted in unfamiliar photographs (i.e., disinterest from Table I), Schoolyard Geology introduces the concepts of relative time and scientific inquiry through a drawing of a murder scene (Fig. 1). Through television, most urban students have built both interest in murder mysteries and schemas for solving them (i.e., cognitive skill development from Table I). Looking at Fig. 1, students can easily interpret that the dead body fell on top of an existing rug that was originally laid down horizontally and then distorted when something pushed against it (as opposed to pulled). Through photos

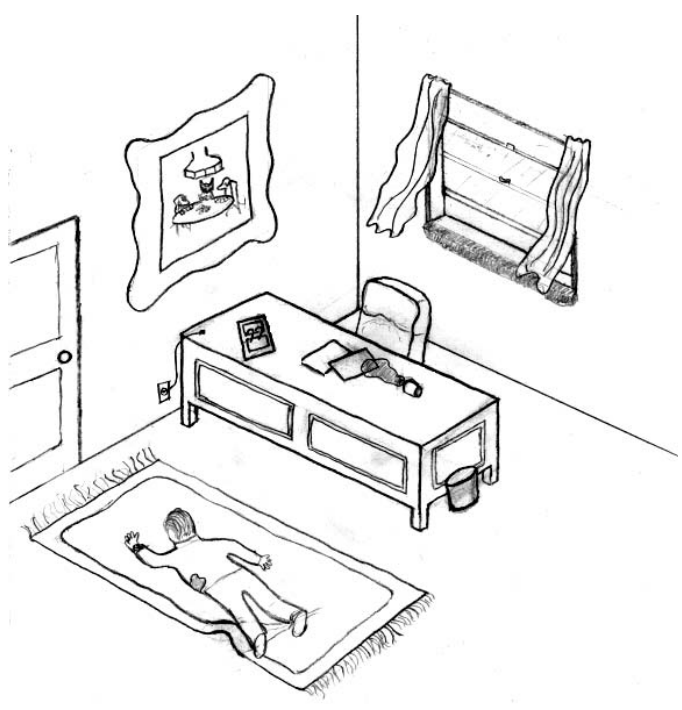

FIGURE 1: GeoSleuth murder mystery.

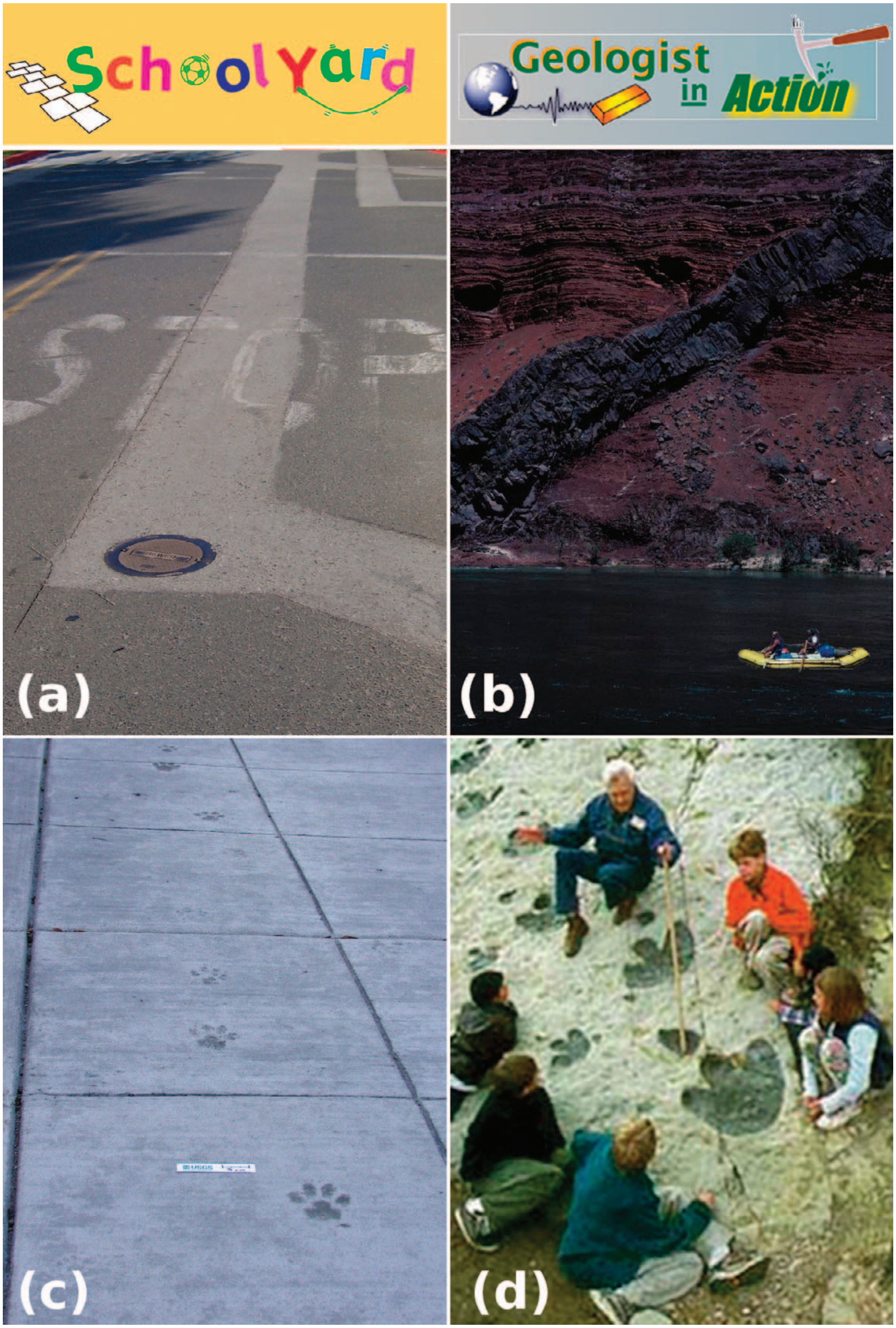

FIGURE 2: Example schoolyard features that illustrate geologic concepts (left), along with correlative images from natural settings (right). (a) A light-colored sewer line cuts across an older road. (b) A mafic dike cutting through Grand Canyon sedimentary rocks illustrates the same relative timing relationship from a natural setting (photo courtesy Ramon Arrowsmith, Arizona State University). (c) Footprints of an animal recorded in a dry concrete sidewalk help students understand conditions required for fossil preservation in the natural world. (d) Dinosaur footprints in the field.

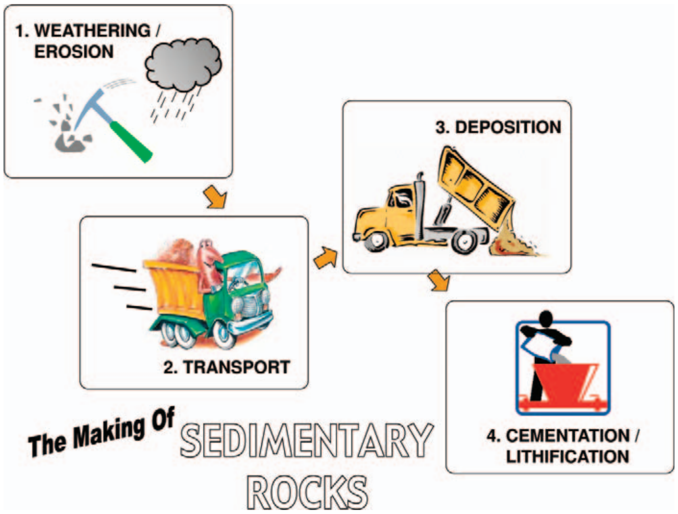

FIGURE 3: The process of clastic sedimentary rock formation presented as tangible ideas that connect to the background experience of urban students.

and discussion, an instructor can relate these interpretations to folded geologic strata, helping build a bridge between the students' existing schemas for the built environment and the desired schema to interpret geologic ones. The Schoolyard Geology Web site highlights details in Fig. 1 that illustrate crosscutting relations, unconformities, and other geologic processes.

Students can practice this same skill on their schoolyard. The images on the left side of Fig. 2 show example features that students might observe in a short field trip outside their classroom. Students connect observations about the schoolyard landscape with processes that shaped it because they have likely seen the processes at work (e.g., construction crews repaving streets or digging trenches). Students can use the tangible schoolyard example to understand analogous processes in the natural world (right side of Fig. 2). For example, students easily grasp why there is a single set of dog footprints preserved on a sidewalk ("the cement dried"), which helps them better understand the unique conditions that must be present for fossil preservation in natural environments. Urban knowledge can be an asset to understanding the natural world if we can illustrate how the two relate, which is the goal of Schoolyard Geology.

Rock Stories

Discussing the tangible process that goes into making building materials is an excellent way to introduce sedimentary rock formation. A sedimentary rock is made up of pieces of other rocks held together into a coherent unit—a definition that includes schoolyard building materials (Fig. 3). I developed an inquiry-based activity in which students investigate schoolyard rocks (for this lesson plan, see the Schoolyard Geology Web site). By observing differences in types of asphalt and concrete (Fig. 4), students can typically determine key rock diagnostics (grain size, shape, composition, matrix, etc.) without additional prompting. Students sit on the ground observing these differences in actual schoolyard building materials, so the activity is a short and contained field experience in which the students must deal with outdoor logistical issues (i.e., discomfort from Table I). It therefore makes an excellent precursor to a more involved field trip on which students are expected to take notes and learn outdoors.

Mapping the Schoolyard

Map reading, which can be challenging for any student (e.g., Ishikawa and Kastens, 2005), can be particularly hard for urban thinkers who may have resorted to route memorization and therefore have less experience building spatial representations of their environment (i.e., cognitive development from Table I). In a third activity from Schoolyard Geology, students construct a map of their own schoolyard—a familiar environment for which they may have good spatial representation. The activity utilizes aerial photos easily available on the Internet to introduce maps as "views from above." Students construct their own map by tracing important features in the aerial photo (Fig. 5). The maps can then be used to practice map-reading skills in a familiar setting.

While not specifically an urban issue, map scale is a challenging concept to teach that can be more tangible with schoolyard maps. Individual features such as buildings or even the markings on a basketball court are often visible in aerial photos and can therefore be measured both on map view and in real life. Comparing the two measurements allows students to discover the concept of map scale. Measuring these features outdoors is a field experience that is typically accessible even to students who strongly dislike the idea of learning outdoors. As a result, the activity provides good practice to help urban students build familiarity with outdoor field work.

FIGURE 4: Different schoolyard rocks.

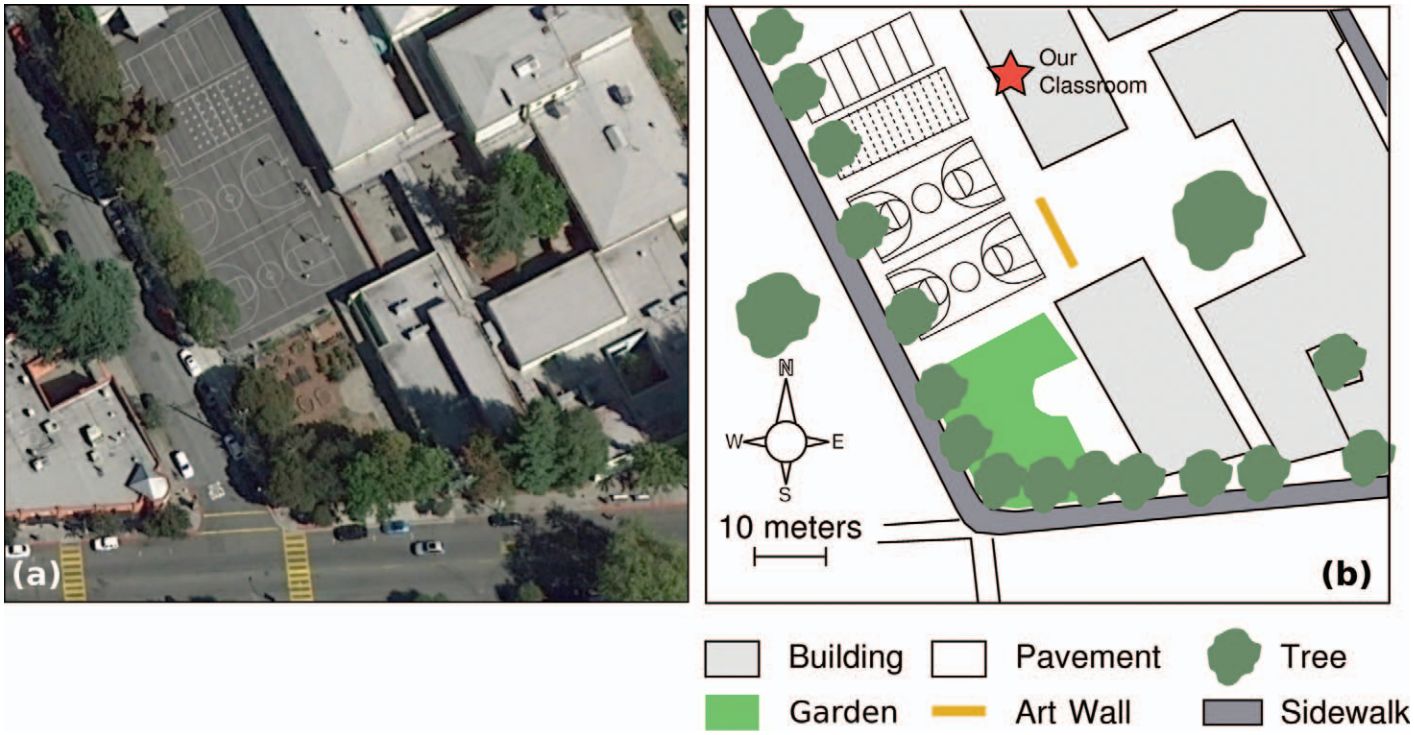

FIGURE 5: Two views from above Claremont Middle School in Oakland. (a) Aerial photograph from the National Map product (http://nationalmap.gov). (b) Map traced from the aerial photograph. Details such as individual lines on the basketball courts are visible, along with shadows from the basketball backboards.

CONCLUSIONS

Growing up in an urban environment affects the way students think about the world around them. They are more familiar and comfortable with the built environment than with natural settings. Efforts to introduce students to the natural world will be far more successful if we begin with analogies from more familiar settings. The goal is to get them thinking about the forces that shape the world around them and looking for evidence of those forces. This process can be done whether the landscape in question is natural or built, but starting with built environments may form an effective bridge for students with urban backgrounds.

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