Designing for Children
- With focus on 'Play + Learn'

Matter Matters

The Transformative Power of Materiality in the 21st Century Classroom

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Abstract: Learning has traditionally been considered a process based in the mind, with the brain as the seat of thought and cognition. There is a common disregard for the material objects that children use intimately in order to learn, relegating them to the role of neutral backdrops to the intangible learning process. However, this is a misstep, as the 21st century has seen an explosion of learning materials in classrooms.

This paper examines how materials can mediate learning through a close analysis of the curriculum, classroom environment and teaching practice of one elementary school class. I propose an addition to the canon of literacy—Material Literacy—to help inform designers and educators about the ways in which materiality influences their practice, and encourage the integration of material-based thinking into the design of learning. In that sense, the title "Matter Matters" serves a dual purpose: it highlights that materiality is a source of, and gives birth to, forms of knowledge, and it also emphasises the need to incorporate the study of materiality into contemporary pedagogic discourse.

Key words: Materiality, Learning Materials, Learning, Sociomateriality, Material Literacy.

1. Introduction: Why Things Matter

"Because we are used to talking about technology as something we design or use or in other ways do something with, the words and phrases available create an imaginary of humans and technology as clearly separate elements—humans are active and technologies are passive, humans do and technologies have things done to them. When we start approaching materials as a part of practice, just as humans are, our verbal repertoire starts sounding out of tune with our approach."

Estrid Sørensen, The Materiality of Learning: Technology and Knowledge in Educational Practice (2009)

In classrooms across the world, for centuries, learning has been an exercise in materiality. Education has always relied on the use of physical, material objects—traditionally instruments like chalk, pencils and paper and today more technological devices like computers and tablets—to carry out the task of educating. While this may seem fairly obvious, I believe that it is this very ubiquity of learning materials that has led to their disregard in pedagogical research. Our literature lacks a methodology of study that approaches the transfer of knowledge in between these elements—how learning materials mediate cognition. When it comes to learning, we are not very materially literate.

Figure 1: A classroom in Baltimore, USA. This photo appeared in the New York Times on Nov 3, 2017 with the caption "A teacher helped second graders at Church Lane as they worked on their HP devices, which can convert from laptops into tablets. The district has committed more than $200 million for the laptops." Matt Roth for *The New York Times*.

When we think about how children learn, we think about biology: the hemispheres of the brain, synapses firing, memory and retention. When we think about how to teach children, we think about outcomes: test scores, grades, literacy rates. However, could these established approaches be missing the effects of materiality by separating the child's immediate experience from the learning process? As I spent time observing students in classrooms and speaking to teachers, I realised that in thinking broadly about cognition, it is easy to forget that children are surrounded by a constellation of materials—paper, plastic, wood, metal, cloth, natural specimens—that form objects that they must use, adapt to and learn from. I believe that in conceptualising formal education at the crossroads of biology and academic outcomes, we lose focus of the material reality of the child, who, as the progressive education theorist John Dewey wrote in Democracy and Education (1916), "…has a body, and brings it to school along with his mind."
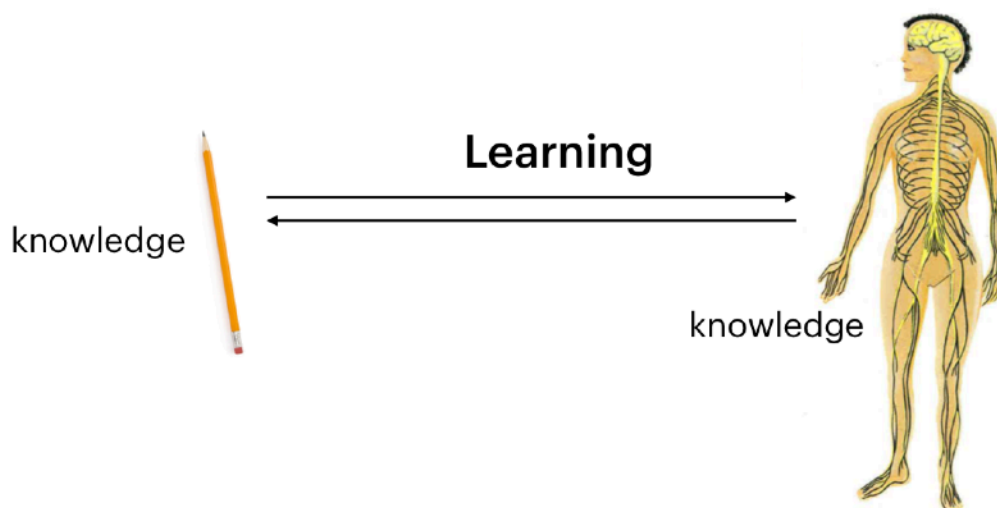

Figure 2: An illustration of how objects can mediate learning and facilitate the transfer of knowledge.

We also dismiss the relevancy of learning materials, and they are "relegated to brute tools subordinated to human intention and design," as Tara Fenwick argues in her paper on sociomateriality and learning.[1] However, as this paper will describe, these learning materials co-exist and together with students, teachers and the classroom environment they form a network of learning wherein each actant in the network co-shapes the others based on its materiality.[2] Whether the child reads, watches or hears information, or writes on paper, scrolls through webpages or taps a tablet screen, we might inquire how these learning materials produce unique and meaningful effects on the learning process, and how this mediation can be evaluated through a design framework.

2. Case Study: The B School, New York, USA

To illustrate how students, teachers and objects form a network that co-shapes the learning process, I use the example of a second-grade classroom at The B School, an independent all-boys K-12 school in Manhattan. I spent two days with Mrs. Balliett's second-grade class and observed them go through various activities, including math and French classes, recess and play rehearsals. According to established psychological theories of childhood development, middle childhood—beginning around age seven and until approximate age eleven—is characterised by the development of logical thought and is therefore a critical period in which to study the impact of materials on learning. And typically in America, schooling at this level tends to be more material-heavy.

3. Mediation by Materials

One of the major themes for this year's second-graders at The B School is a social-studies based investigation into the question "What does it mean to be a New Yorker?"

The scope of the "What does it mean to be a New Yorker?" theme is broad. The boys study Massimo Vignelli's famous design for the New York subway system. There is a large paper map pinned up on one of the classroom walls, and they discuss Vignelli's failed iterations. They collaboratively work on a project called "Manhattanrama," a large model of the city, complete with all the skyscrapers, bridges and parks. To build these elements, the technology teacher, Mr. D, helps students use Google Earth to map out different neighbourhoods and use CoSpaces to create immersive VR experiences. In teams of two, they use TinkerCad, a 3D modelling software, to construct their skyscrapers, which they then 3D print with the in-house printer. They learn about New York's iconic bridges via a slideshow Mr. D prepares and they construct models of them out of cardboard and make charts. They also use Adobe Spark Video to create audio tours of New York's parks, guiding viewers through narration. Finally, the class play was also inspired by the city.

This snapshot of the eleven kinds of objects, devices and processes that make up a single learning module is illustrative of the phenomenon of materials forming a complex network in the classroom. Tara Fenwick defines this by claiming that materials are "dynamic actors, enmeshed with human activity in a network of elements which are constantly mutating and evolving." Using this framework on the "What does it mean to be a New Yorker?" theme we can begin to ask how these objects mediate learning.
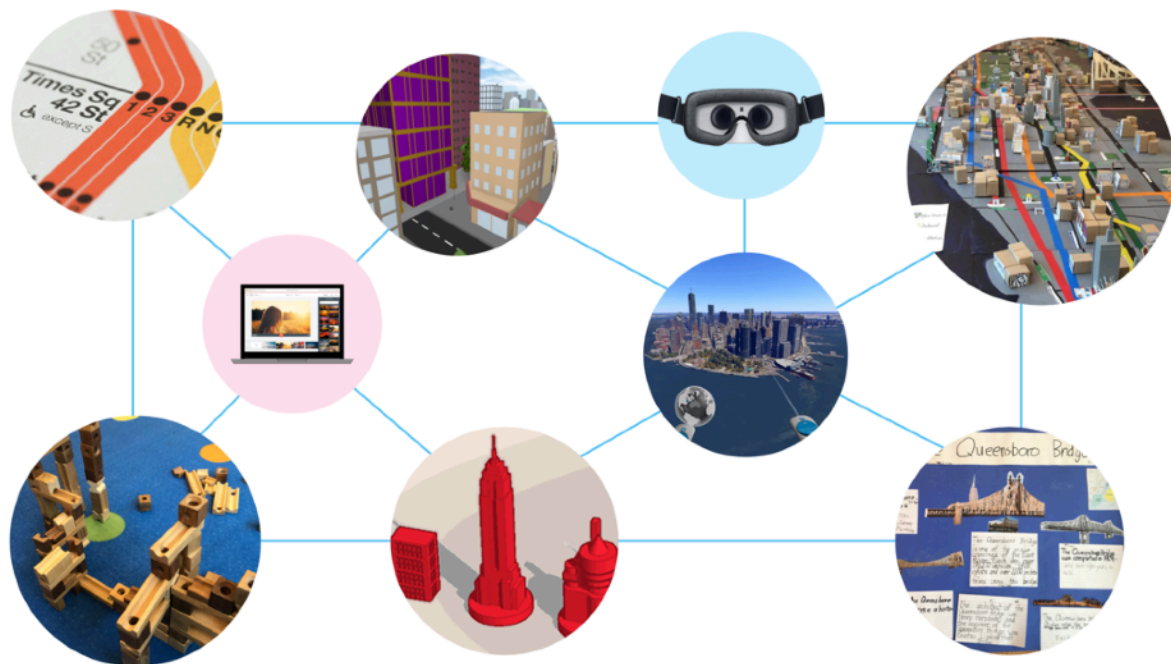
Figure 3: An illustration of the range of materialities in a single learning module at The B School.

In the context of learning, it is useful to think of the mediating capabilities of objects by observing the way they present knowledge to the child. Through a description of how the route taken by a train shapes the way in which knowledge of the landscape is available to passengers, Dutch philosopher of technology Peter-Paul Verbeek explains that objects mediate how humans are present in the world and how the world is present to them.[3] Consider the iPad, a now commonly used device in classrooms. The way in which a student uses an iPad, a sleek handheld touchscreen device whose screen is made up of light-emitting pixels, is radically different from reading and writing on paper. The device allows students to sit in any position, it is easy to carry and it supports multisensory content with audio, visual and tactile components. These material qualities of the device mediate the student's physical experience as a learner—for example, the lightness and fragility of an iPad dictates that a student cannot use it as a makeshift cricket bat or doodle in the margins, as one could do with a textbook—and therefore it mediates the way knowledge can be accessed by the student as well as the kind of knowledge that can be produced on it. The device actively constitutes the relationship between learner and the learnings.

The combination of multimodal, multisensory and multimedial experiences produced by objects with varying degrees of technological sophistication leads to mediation happening in a number of "constantly mutating and evolving" ways. The learning taking place within this network, in which human and non-human "actors" are bound together, as sociologist

and philosopher Bruno Latour's Actor-Network theory suggests, is defined by the materiality of each "actor." It is clearly illustrative of the powerful presence of materiality in the classroom, and its ability to co-shape the entire learning process. It is this equality between humans and non-humans in the network that led Estrid Sørensen to assert that "Humans are not above materials, but live amongst and constantly adapt to materials."

4. Material Literacy: Suggestions for the future

Through my analysis of the short account from The B School, I can confidently say that the study of the consequences of human-material entanglement is a rewarding one. More importantly, it is an urgent one: it makes us question our established notions about how learning happens and recognise the limitations of the brain-based, cognitive approach. The diversity of experiences and forms of knowledge generated by children's involvement with objects is evidence of how heavily learning relies on material culture and the subsequent embodied knowledge produced. The brain is not a computer, nor does learning happen in a vacuum distant from the material reality of the human. Beginning to pay attention to how things mediate the transfer of knowledge, the assimilation by the child and the conversion into learning reveals the limitations of keeping critical thinking about materiality out of the classroom.

However, there is no definitive framework for such study to take place under. This is a loss to the multiple stakeholders in education—designers, educators and policy-makers—but especially to a broader audience of non-Western, resource-poor, technologically-limited educational settings. I propose the introduction of a new form of literacy to the existing canon: material literacy. Conceptualising material literacy is my attempt to open up the applications of my study into a mode of thinking which can be implemented in any kind of material environment.

The need for material literacy is more pressing today than ever before. We can predict with reasonable certainty that in the near future, innovations in education will be more material than philosophical, considering the speed at which technological innovations have taken place in the last few decades. From MIT professor Seymour Papert's computational learning tool LOGO in 1980 to the sophistication of platforms available on personal computing devices like smartphones in 2019, we have come a long way. More and more schools and educators are pushing the limits of what materiality can mean in a classroom.

In a bid to create these classrooms of the future, there are kindergartens that incorporate digital tools at that early age, as well as new educational settings like online preschools.[4]

While there are great opportunities in these materials, there is also widespread ignorance and therefore, widespread misuse.[5] How can we prepare ourselves and children for the material renaissance that is certain to come? To answer that we need to define what capital-e Education means to us as we enter the second decade of the millennium and how materials can play a prominent role in that conception. John Dewey wrote in Democracy and Education (1916) that "it is well to remind ourselves that education as such has no aims. Only persons, parents, and teachers, etc., have aims, not an abstract idea like education...Even the most valid aims which can be put in words will, as words, do more harm than good unless one recognizes that they are not aims, but rather suggestions to educators as to how to observe, how to look ahead, and how to choose in liberating and directing the energies of the concrete situations in which they find themselves."

Inspired by Dewey's ideas of the agency educators can exercise through awareness of their human-imposed conditions, material literacy will help educators observe their practice more critically, and encourage children to use materials consciously. Alongside established models like language literacy, and newer ones like digital and visual literacy, this addition will strengthen how we think about thinking, or learn about learning. Dewey's notion of the evils of solidifying aims of education would play a role in this fluid conception of literacy, reinforcing the idea of tools being powerful, not neutral. It is helpful to think of Howard Gardner's theory of multiple intelligences, and his claim that learning is split up into modalities, or nine intelligences, such as bodily-kinesthetic and spatial-visual, alongside logical and linguistic, which relate to an individual's unique competency.[6]

Although this theory has received criticism, with some of Gardner's contemporaries arguing that it is too broad and static to be useful in understanding human competence, it is an important idea to raise awareness about other modalities of learning than simply based in the mind or other cognitive science-based notions. The concept of material literacy can rely on Gardner's theory as an ally.

How would material literacy be implemented? I believe this is where design research and ultimately the design of learning materials (whether industrial, graphic, animation or user experience design) can play a prominent role. In his seminal book The Design of Everyday Things (1988) Don Norman lays out guidelines for the design of objects derived from the psychology of the user, which could be interpreted for this purpose. He was the first to use the term affordances in the context of design, and he describes them as the "relationship between the properties of an object and the capabilities of the agent that determine just

how the object could possibly be used."[7] He means that the possible interactions depend on both user and object—a button on a website affords clicking to the human operating the computer mouse. This is useful to consider in light of the sociomaterial idea of education wherein the network is seen as the location of knowledge. According to Norman, while affordances are relationships, signifiers are indicators from the object about where certain actions are possible. A flat-panel on a door is a signifier that the door should be pushed, not pulled. To design learning materials so that their affordances are clear through visible, articulated signifiers is a useful method to think of designing for material literacy.

Peter Paul Verbeek echoes Norman's notion that a deeper study of materiality would benefit designers. But taking the concept of signifiers further, he concludes his postphenomenological analysis of the mediating role of materials in human lives by stating that this new vocabulary is relevant to the work of designers "who are continually creating artefacts embodying the kinds of mediating capacities mentioned in this book." In his analogy of how the route of the train mediates the landscape for passengers, Verbeek notes that current industrial design focuses on the semiotic function of things—how the route refers to the passenger's knowledge of the journey—as opposed to the postphenomenological perspective which would indicate how the route actively shapes how the passenger knows and imagines the journey and the landscape. I believe that the concept of mediation is a pillar of material literacy as it will allow designers to design for materiality: designing around how things do what they do, instead of simply what they do. Verbeek also coins a new phrase—material aesthetics—which he derives from the original meaning of the word "aesthetics" as the study of senses. He reminds us that to create products that are durable, ethical and inspire enduring attachment (all crucial characteristics from a sustainability point of view), and which focus on materiality, designers need to take all the sensorial dimensions of the object into consideration, not simply the visual forms of signs and signifiers.

Such sensorial dimensions are a contemporary issue, since the explosion of tools that we see in classrooms have significantly expanded the kinds of gestural interactions possible. Take the instance of drawing, something children do as early as they can grasp crayons: they may now draw with their fingers on a trackpad, with a stylus on a tablet, with a mouse on an image-processing software or traditionally with crayons or markers. Studying the nuances of these different gestures could contribute to developing how material literacy should be defined.

Figure 4: Students using the One Laptop Per Child device, designed by Swiss designer Yves Behar.

Eventually, widespread material literacy would help us think critically about what learning materials can do, as well as be conscious about their implementation. Teaching and learning could be designed to accommodate the unique capabilities for knowledge generation and material engagement that different tools possess. This is especially relevant to resource-poor schools that invest large sums of money in purchasing new digital technologies despite studies finding not enough improvement in fundamental skills like reading and math to justify their cost. A contemporary example of this is the failure of the One Laptop Per Child (OLPC) initiative. Due to its promising start and backing by prominent scientists, many developing countries like Uruguay and Rwanda rushed to purchase thousands of laptops. However, the conception of the future of education as being purely technologically driven is a reductive one, which doesn't take into account the differing needs of various users. Despite the OLPC laptop being brilliantly designed, it was not necessarily what millions of children struggling with poverty across the world needed to raise the quality of their education. It was later denounced by critics as "a flashy, clever, and idealistic project that shattered at its first brush with reality."[8] The network-based nature of sociomaterial learning would deemphasise the blind rush to digitise education and direct attention back to the healthy microcosm of different materialities that are necessary for children to learn effectively.

Hopefully, the concept of material literacy will provide us a set of measures with which to think of the future of education. The implications of this stretch beyond the walls of the

classroom: the social theorist and design reformer, Ellen Key, believed that "The development of the child...answers in miniature to the development of mankind as a whole." As we near 2020, we need to define an ideology for what childhood and education mean to us, and how materials can play a prominent role in that conception. We must ask ourselves: in this century, how will children learn? What is the future of classrooms? What will be the materiality of childhood in the 21st century?

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Notes

[1] Tara Fenwick, "Sociomateriality and Learning: a critical approach," *The Sage Handbook of Learning* (August 2015): 84.

[2] Estrid Sørensen, *The Materiality of Learning: Technology and Knowledge in Educational Practice*, (Cambridge: Cambridge University Press, 2009), 52.

[3] Peter Paul Verbeek, *What Things Do: Philosophical Reflections on Technology, Agency, and Design* (University Park: Pennsylvania State University Press, 2005), 114.

[4] Jackie Mader, "Online preschool: Does it work?" *PBS*, November 3, 2017, https://www.pbs.org/newshour/education/online-programs-are-filling-a-preschool-gap-experts-warn-its-no-substitute-for-face-to-face-learning

[5] A 2019 survey of the classroom technology use by teachers across the U.S. found that while "Teachers place a high value on digital creation tools in developing 21st-century skills, but these tools are among the least used in the classroom." The study found that productivity tools like Google's G-Suite were used in 50 per cent of surveyed classrooms, and digital creation tools like Scratch and iMovie were used in only 25 per cent.

V. Vega, & M. B. Robb, "The Common Sense census: Inside the 21st-century classroom," (San Francisco: Common Sense Media, 2019)

[6] Howard Gardner, *Multiple Intelligences: New Horizons in Theory and Practice* (New York: Basic Books, 2008).

[7] The term 'affordance' was conceived by James J. Gibson in "The Ecological Approach to Visual Perception." It was originally used to describe "...the actionable properties between the world and an actor (user)."

[8] Adi Robertson, "OLPC's $100 Laptop Was Going To Change the World—Then It all Went Wrong," The Verge, April 16, 2018, https://www.theverge.com/2018/4/16/17233946/olpcs-100-laptop-education-where-is-it-now

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