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Policy brief

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A whole new world: Education meets the metaverse

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The metaverse is upon us. Soon it will be as omnipresent as TikTok, Instagram, and Facebook (now Meta). As technology advances to bring us new immersive and imaginary worlds, how we educate children and prepare teachers must also advance to meet these new opportunities. When education lags the digital leaps, the technology rather than educators defines what counts as educational opportunity. This is largely what happened with the introduction of "educational" apps designed to be used on smartphones and tablets meant for adults. Today, as the metaverse infrastructure is still under construction, researchers, educators, policymakers, and digital designers have a chance to lead the way rather than get caught in the undertow. To leverage the potential of the metaverse as a 3D, global, interconnected, immersive, and real-time online space, we need new ways to connect the physical world with augmented and virtual reality (VR) experiences.

In this policy brief, we offer a path for bringing best educational practices into the metaverse. We suggest a series of well-worn principles derived from the science of *how* and *what* children learn to guide the design of new educational technology. We also suggest ways in which design in this new space can go astray. In the end, we challenge those creating educational products for the metaverse to partner with educators and scientists to ensure that children experience real human social interaction as they navigate virtual spaces, children's agency is supported as they explore these spaces, and there is a real eye to diversity in the representation and access to what is created.

A vision

Imagine a circular classroom, surrounded by white boards and populated with movable chairs. Energized students are mesmerized by the tales of the Greek myths, the power of Zeus the god of the sky, and stories of the great Hercules—his son—whose strength was legendary.

Suddenly, a timeline is projected onto the middle of the floor. Children whisk away their chairs to stand in the present, ready to move backward and descend into the year 300 BC—a year in which they will encounter a new reality. They enter the metaverse of Greek culture. Carts buzz by them, traders in marketplaces surround them and high atop the hill, they see—with their own eyes—the temples of the gods and the people who worship them. They explore, they ask questions, they ponder, they learn!

The experience was designed to whet the appetite of the students, but questions remain: "How could we possibly know about the richness of Greek life? If we did not live there, how do we discover what was sold at the marketplace and which gods were all important?"

Then, the teacher positions each child on the timeline so that they return to the present. The walls around them turn to images of brown dust in which they see ruined old temples and pieces of columns dotted along the ground. Each child is now given a chance to become the archeologist, to use her avatar to find the answers to the question of how we construct the past while nested squarely in the present. The avatars are equipped with a shovel, a brush, and are given a plot to till. The teacher continues, "The society that you witnessed, like all societies of times past, became buried in the dirt. Each layer of dirt is like a story book that you can uncover and piece together." The children move their avatars and begin to examine the dirt in a new way—in a careful and inquisitive way. Each finds shards of pottery and even partial faces of statues that once stood tall. After 20 minutes of working the soil, they show their discoveries to the others in the class. Opportunities for collaborative learning and co-creation are embedded into the virtual and real learning spaces they have built together.

Piecing their shards together as if they were solving a historical puzzle, they find an urn and a statue. They learn that the myths are more than stories—they were part of a bygone religion called paganism that real people practiced during time now buried beneath the earth's surface. Archeologists like them helped to rediscover that society.

This deep, transferable learning that will last a lifetime comes to us by virtue of the metaverse delivered in a hybrid, guided play environment that could represent the school of the future. But notice that the interaction is inherently social with live people and live moment to moment, emotionally laden interactions. And notice that the teachers are still crucial to this experience. Make no mistake that the metaverse is coming. It is our job to specify how engagement in this always-on, virtual universe augments education rather than detracts from it and how it can preserve the key socially interactive qualities that are core to how humans learn.

Defining the metaverse

Forbes Magazine offered varied definitions of the metaverse from tech leaders. Each speaks of a space that is a combination of virtual and live—creating a "third space," as sociologist Ray Oldenburg noted, that is not home or work.

The metaverse of the future is likely to fully support augmented and virtual reality, artificial intelligence, and the connectivity to link all worlds. Indeed, in its most democratic instantiation, anyone will have the opportunity to create a space and be part of a user-generated global community on an interoperable multiplatform where they can

share their games or goods with the world. The G5 internet speed should allow this to be a reality.

To date there are a few better established instantiations of what is to come, including the games Minecraft, Fortnite, and Roblox. Roblox, for example, offers a wealth of gaming opportunities and these games have attracted over 42 million active users, an increase of over 19 percent from 2019. And Roblox creators look to attract followers who will use and then heighten the visibility of any particular game.

A number of other examples highlight the power of the metaverse that is changing daily. Virbela offers virtual meeting and even wedding spaces. And Nike made news when it created Nikeland on Roblox. As VR platforms become easier to use and more interconnected, they will become better populated. Further, as VR accessories like VR goggles become less cumbersome, one can expect their use to be expanded and even adopted into educational settings. Thus, it is critical to think about the ways in which researchers can inform designers now so that forthcoming educational products and offerings in the metaverse are of high quality and optimized.

Learning from Web 2.0 and the development of "educational apps"

In 1997, the Nokia 6110 phone offered the first mobile app of a game called Snake. In 2007, the app market took off in earnest after the introduction of the iPhone and even more so when iPads came into the marketplace in 2011. By 2015, when our research team first wrote a series of guiding principles for developing truly "educational apps," the market was already flooded with more than 80,000 so called educational apps; the vast majority of these apps had no research behind their design or implementation that was linked to the science of how children learn. They were designed for platforms for adult use, not educational opportunities for children. Even now, designers use the term "educational" quite freely for products that many scientists think have only passing connection to anything educational.

In our article, we suggested four principles for creating a good educational app. The principles were drawn from consensus on the science of *how* children learn. We wrote that:

1. Learning should be *active*, not passive, and that children learn best in environments that are "minds-on." This means that a simple swipe did not count as an "active" move in an educational setting.

2. The app should be *engaging* rather than distracting and only include bells and whistles that are integrated into the narrative of the game, lesson, or storyline. Many of the apps on the market interrupted the storyline with a chance to probe children's vocabulary (e.g., "What else is red or starts with a B?") and/or include persuasive ads that pop up to distract children to buy a different app.

3. The app should tap into something *meaningful* for the child. There should be some point of connection that will allow children to relate the content of the app to what they know, rather than to start *de novo* in a foreign space.

4. Finally, the app should encourage *social interaction* inside or outside of the app space, not just playing solo.

In 2018, the list of principles was expanded to include that learning should be *iterative,* such that an app would encourage children to achieve a learning goal through a number of different pathways or allow for a similar but slightly different experience on each encounter. Lastly, the experience should also be *joyful,* as children learn better when motivated through joy. Together, the principles of active, engaged, meaningful, socially interactive, iterative, and joyful coalesce in what we called "playful learning*,"* an umbrella term based in science that broadly incorporates how children learn through both free play and guided play.

However, the key to making these apps truly educational requires one additional step. Learning occurs best when the playful activity has a well-articulated learning goal, be it in STEM (science, technology, engineering, and math), literacy, or "learning to learn" skills like memory, attention, and flexible thinking.

By 2021, our team lead by Marisa Meyer and Jenny Radesky reviewed the top downloaded educational apps from places like Google Play and Apple to see if the principles outlined above were becoming more prevalent in current educational apps available for children. Sadly, they were not. Of the highest downloaded paid apps for young children, 50 percent scored in the low-quality range, with only 7 apps earning a score that put them in the highest quality category. Free apps scored even worse.

The bottom line is that developers of so-called educational apps and scientists who study how children learn are not communicating with one another, although the authors have tried to make this possible. Even accessible papers that are widely read do not change the trajectory. The lesson learned is that the 4-year gap between the time when apps became a dominant activity for young children and when the scientific community became engaged was too long. It allowed for a proliferation of low-quality materials that

were rushed to market. The sheer number of available products also made it difficult—if not impossible—for parents and teachers to sift through the offerings to find truly educational products.

It is imperative at this moment, while the metaverse is being developed, that scientists, educators and developers co-construct engaging, immersive, and collaborative opportunities that are good for children and families. Understanding how to support learning goals through harnessing the power of active, engaging, meaningful, socially interactive, iterative, and joyful contexts will transform flashy and fun digital experiences into truly educational ones with true social interaction at their core. The experience with remote learning only underscored how important the social-emotional interaction is for children and how it needs to be built into the metaverse from the start.

Restating the principles of learning

The principles of *how* children learn are stable whether applied to classrooms, digital games, or community settings, which includes designing playful learning into public spaces like bus stops, parks, or even the metaverse.

A range of education stakeholders, including learning and development researchers, educators, and employers reached consensus that success in the workplace of tomorrow will require mastery of a suite of skills or what the Brookings Institution has termed, "skills for a changing world." Such skills, like collaboration, critical thinking and creative innovation, broaden our view of achievement beyond core academic subjects like reading and math.

In a paper published by the Brookings Institution, Hirsh-Pasek et al. presented the value of playful learning for enriching a suite of skills that she and Roberta Golinkoff called the 6Cs. Our claim is that educational products and classrooms have been riveted by attention to content that can be most easily measured and tested. While society surely needs children to understand the basics of reading and mathematics, it demands so much more for a child to be prepared for the workplace of the future. The 6Cs or outcomes are based on the science of learning and backed by a large body of evidence; collaboration or social relationships are the foundation for an interconnected suite of skills. The following is a brief description of the 6 Cs as presented by Golinkoff and Hirsh-Pasek in their book "*Becoming Brilliant*:"

- **Collaboration:** Collaboration reflects how social engagement is central to human nature as a core for learning, community building, and cultural understanding. Interestingly, recent neuroscience research shows how collaborative play yields unique patterns of synchronized brain activity between infants and adults. These initial collaborations further support the development of young children's self-regulation skills. Children advance their understanding of collaboration through the elementary school years, which supports academic achievement.

- **Communication:** Communication—speaking, writing, reading, and listening—is essential in our daily lives. In early childhood, language skills develop through back-and-forth conversations between children and their parents. When children begin kindergarten, their language skills at that time are the strongest predictor of their later academic performance in language, reading, and math, as well as their social skills. Communication builds on—and is contingent upon—infants' first collaborative interactions with others in their environment. The ability to collaborate and communicate—together—lay the groundwork for all subsequent skills.

- **Content:** Traditional content includes reading, writing, math, science, social studies, and the arts, but it is also important to recognize "learning to learn" or executive function skills, including attention and working memory, that support children's academic achievement. Content builds on the scaffold of collaboration—and particularly communication—across the disciplines, including math, literacy, science, and social studies. While we often think of learning in "bins" (e.g., children learn math content only in math class), a growing body of research shows that executive functioning provides a broad foundation for reading and math skills. Only once children have established collaboration and communication skills can they be ready to master content and move toward higher levels of learning.

- **Critical thinking:** Strong critical thinkers can evaluate the quality of information they receive and ideally use those skills both inside and outside of the classroom. Yet students particularly struggle with this task when evaluating online sources, an essential skill in the 21st-century. The good news is that critical thinking and the related skill of reasoning can be taught. Critical thinking is preceded by children's abilities to collaborate, communicate, and engage meaningfully with curricular content. Only once they have that content mastery can they begin to think critically about the knowledge they gain.

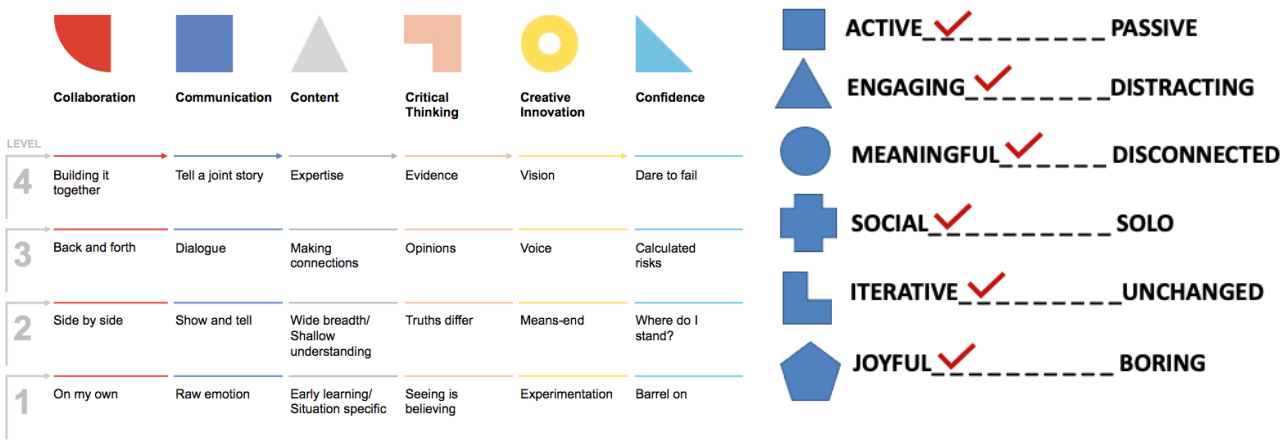
- **Creative innovation:** Creative innovation—the synthesis of content and critical thinking—enables students to use what they know to make something new and develop innovative solutions to the challenges they face now and in the future. Play directly supports that innovation in both language and art. Moreover, because play encourages curiosity and exploration, it also fosters creativity,

which can—and should—be seen as an asset to any job. In fact, creativity is ranked as the third most important skill for employment according to the World Economic Forum. Creative thinking depends on collaboration, communication, sufficient content knowledge, and the ability to engage critically with that content by seeing connections between content and real-world experiences. Creativity enables children to make something new out of those connections—to generate original solutions to problems.

- **Confidence:** Children who are confident in their abilities demonstrate persistence and flexibility, even when they experience failure. Confidence is closely related to "grit," which is defined as "perseverance and passion for long-term goals" and a "growth mindset"—the belief that one can improve her abilities because they are not fixed in time at a particular level. Parents' attitudes toward their children's performance—and occasional failure—also strongly predict children's views of their own abilities, which sometimes leads to the development of a fixed, as opposed to growth, mindset. In this way, children's interactions with others help to shape their perceptions of their own capabilities. The final skill in the set, confidence, both physical and intellectual, enables children to use their skills in collaboration, communication, content mastery, and critical and creative thinking to push the boundaries of their learning.

Taken together, playful learning provides a checklist for *how* children learn and the 6Cs offer a systemic checklist of *what* children learn—or what they can and should learn. Once the formula is clear, it is easy to fashion the digital and live landscapes to conform to best principles for learning. A metaverse can be designed to offer a context and experiences that enable and encourage collaboration, communication, mastery of content, creative thinking, creative innovation, and confidence. Figure 1 offers the twin checklists for playful learning characteristics and the 6Cs—the how and what of learning. With a well-defined learning goal, if designers and educators use this checklist, they can determine whether the virtual space in the metaverse they are designing is likely to be truly educational or merely just fun.

FIGURE 1. WHAT AND HOW CHILDREN LEARN



Source: Becoming Brilliant, 2016.

Revisiting the previous Greek mythology lesson, it was fun, active and minds on, engaging without being distracting, meaningful in its interconnections, and socially interactive. It also encouraged students to build the project together, to communicate with one another around the content of history, archeology, and STEM. It fostered critical thinking as the students bring the evidence from the dig to bear on their view of the artifacts they find. And in this exercise, they showed persistence in piecing together the pieces of the puzzle—the jug. The learning goal was well defined as one to demonstrate the history of the myths, careful critical reading, and STEM skills through spatial learning and puzzle construction. Finally, the example clearly "jumped" the screen of the fantastical world, when the class re-entered the real world and the teacher, now guide on the side, led the class through the lesson plan, connected today's insights with what they discovered in their previous lessons, and supported children's development of skills outside of the metaverse.

Consider the alternative. A virtual space is created that looks well-designed and is gamified. The graphics are spectacular and there is related content available to explore, but these puzzle pieces do not fit together to result in a full understanding of the times (picture the ability to click on what are essentially Wikipedia articles as children navigate the space). Ads for other virtual spaces abound. Children are given a list of tasks to complete to earn "points" that are linked to a project grade. Teachers log in to ensure that all children meet the minimum requirements, but their role has been minimized as they "supervise" the digital activities of 200 children a year. These children are solo agents in an attractive space, but designers must note the difference in what Troseth and Strouse call the distinction between *attention-directing* versus. *attention distracting* features of interactive digital media. Early studies on TV viewing and electronic books in young children show that strategically placed auditory or animated pictures can direct children's attention to important content and aid comprehension, but that too many interactive features can distract. Educational spaces within the metaverse align with the

science of how children learn. *Now is the time to design educational spaces with children at the center.*

Where the principles of learning meet the metaverse: The promise and the worry

The promise

The metaverse is but a context—an immersive one—that can in principle bring the best of digital technologies to bear on education if and only if it is done right, with the science of learning and real children in mind. Dissecting the possibilities, it is clear that games or activities in the metaverse hold the promise of being active rather than passive. Children can explore in this space "physically" and mentally. Whether the activity is engaging or not will be in the hands of the developer. As with apps, there are many products that capture the attention of children, but that interrupt the experience in ways that thwart engagement. Children do not learn when we interrupt a narrative or give too many choices. Thus, designers must be purposeful in creating a story board and having a flow through that board that does not divert a child's attention to a new and irrelevant task or place.

The question of meaningfulness should be readily solvable in the metaverse. Indeed, the realities that one can inhabit, if connected well to the child's real or imagined world, can create a mental web that would support deep transferable learning. In one review, Hopkins and Weisberg ask whether children can transfer knowledge from fantasy in books to real world contexts. Data suggest that they can, though to a lesser degree than if they had learned in real-world contexts; this result also mirrors findings about younger children's ability to transfer newly learned information from television. Another study, however, hints that children might even learn more from fantasy because fantasy might heighten learning in unusual contexts. In more recent research, Hopkins and Weisberg confirm this hypothesis when testing five-year-olds' learning of scientific principles.

The question that is more difficult to ponder is exactly what is meant by creating a social environment for children in the metaverse. The example presented above gives but one glimpse of what this could be if the games created are not for solo consumption but led

by teachers for engaging students. Research in the science of how and what children learn squarely puts the foundation for all learning in social relationship building. An infant who is interacting with a parent has well-timed, contingent, semantically appropriate and emotionally aligned responses. The research suggests that stronger synchrony between caregiver and child supports brain growth and connectivity, as well as early learning.

Even at two years of age, a virtual agent does not substitute for a real person even if the virtual agent responds in a contingent manner that mirrors the human. Work from our laboratory suggests that at four years of age, children learn more from reading with a parent than they do alone, and measures of physiological arousal and self-reported emotion from the parent suggest a special bonding that occurs between child and parent—human to human. A series of articles in a recent compendium of research on digital versus human learning confirm this assertion. Finally, even for older children, synchrony plays a role. A recent paper by Lamb and colleagues finds that when elementary school teachers and students are verbally and socially engaged, they not only understand more of the material, but brain activity is synchronized. This is likely just the first of many pieces of evidence coming from this emerging approach of using neuroscience research in real-world classrooms.

What is so special about social relationships? Why would emotional expression, bonding, touch, smell, and body language matter? Perhaps because they are critical forms of communication that would be absent in a virtual world—or at least in the metaverse as it is now conceived. Note that social interaction could be preserved if the virtual environment served as a *prompt* for interactions between real people in either the real or virtual setting rather than as a *substitute* for interaction. By way of example, an intact class that together "visits" Greece with the guidance of a teacher preserves live social interaction even in a digital backdrop, whereas creating a set of avatars to go on a trip together—even if controlled by live students—would not achieve the same effect. More research in this area is critical.

The augmented reality, VR, and 3D world also holds the promise of porting children to new environments that they could never have explored or visited. For critical thinking, students can solve real problems, enter a makers' fair and show their wares not only in their school, but to a broader community. They can visit different time periods to bring evidence to bear on age-old questions about Greek culture or even enter scientific laboratories and connect these experiences to real-life learning.

Students can become creators, even as young children, who paint and compose with the top teachers and artists to assist them. They can even piece together history from fragments and craft their own story behind the Greek myths. From their own classroom, guided by teachers, the metaverse offers a hybrid world of enormous potential *if it is done right*. And to do that right, teachers and caregivers will play a key role as the guides to faraway places and immersive learning. Only skilled teachers can select lesson plans based on what they have observed spark interest in their students. Teachers can help

children navigate in spaces that might bring up difficult feelings (e.g., navigating in a supermarket metaverse that helps build number and money knowledge for a child whose family is food insecure). Teachers can select virtual spaces that they know will help each and every child in their class feel represented. Teachers can help children push beyond their comfort zones and tackle academic and social challenges based on individual's strengths and difficulties. And teachers and caregivers can link what children are learning with what they already know. The metaverse is not a replacement for teachers, instead, it is a tool through which teachers can spark learning and social interaction in new ways.

To date, there is little data to help the field forge a direction. Some early research suggested that digital games, including Pokemon GO, could increase physical activity for users by encouraging outdoor experiences. The game also seemed to encourage co-use, and many parents reported that it provided opportunities for family bonding. For example, one study by Jakki Bailey and Jeremy Bailenson of Stanford University and colleagues found that children who see Sesame Street's Grover in VR are more compliant with his instructions and give him more stickers afterward compared with children who saw the same content on a television screen. However, these same children performed worse on a measure of inhibitory control based on Simon Says—perhaps because the environment seemed so real that it was harder for them to inhibit acting like Grover. Earlier research on VR with young children suggests that the powerfully rich nature of these experiences can shape memory recall, which serves as an important reminder that children's memories are vulnerable to suggestion. Other work suggests that children reading books with augmented reality were more motivated to read than those reading traditional books, though outcomes from the two sources were no different. And one study with 6- to 8-year-olds suggests that children learned more about physics in an augmented reality environment than in a real one studying concepts like force and friction. Hassinger-Das and colleagues, as well as Hadani and colleagues, provide recent reviews of research on digital technology and child development.

Caveat emptor

The rush to market and the enticement of new tools, however, can also be a downfall. It is imperative to get the social interaction component right from the start. For children and possibly for adults, the interaction of avatars—even if they look real and are wearing the latest fashions—will never be a substitute for real human interaction. It will be important to find ways to meld the virtual and real worlds in ways that preserve real teacher-child, caregiver-child, and child-child social relationships.

It will also be key to avoid distractions. Games in VR environments are chock full of interruptions and distractions. Game builders love to insert bells and whistles—more design is often misinterpreted as providing a better educational experience, but that is not necessarily so. Anna Fisher, of Carnegie Mellon University, found that decorations on

school walls can be more distracting than informative. When activities and behavioral interruptions break the flow of book reading, it leads to lower levels of story comprehension. Studies from our labs and others on technoference (i.e., moments when adults using technology like texting or taking a cell phone call interrupt the contingent interactions between parent and child) tell the same story. In those cases, children have been found to learn fewer words, parents to use less rich vocabulary with their young children, and children exhibit more behavior problems.

It will also be critical to ensure that the child has real agency in these worlds as they explore and discover what they need to do to fulfill the implied learning goal.

Finally, it will be critical to be culturally diverse and culturally inclusive in any games that are made. Indeed, the metaverse could potentially introduce families to perspectives and cultures that are different than their own in ways that promote understanding.

We need to also consider issues of access, accuracy, and power dynamics. Many diverse and marginalized communities, particularly in urban and rural areas, may not have access to consistent reliable broadband that allows them to effectively participate in this new metaverse. Because we've seen how misinformation and inaccurate content can be spread via digital technologies, we must assure that the systems and games are supported by educational and/or historical content that is accurate, relevant, and authentic.

The demonstrated and documented shortcomings of today's technologies when it comes to people of color and marginalized communities show that the metaverse may not be a technological utopia for everyone—from facial recognition software not recognizing and/or misidentifying darker skinned people, to the racial and gender biases in some algorithms, to the proliferation of online hate speech targeting people of color and women.

As the metaverse is designed and implemented, there must be an intentional effort to involve people from marginalized communities in significant leadership and decisionmaking roles to ensure that all users feel safe and valued as they participate in these environments.

Back to the future

And so, we return to the classroom surrounded by white walls that can transport children as if they live in the Magic School Bus. In this world, though, Ms. Frizzle will not be 2D, nor will she be an avatar. She will be a real human teacher, a guide on the side, helping children see beyond their own world into the future and past and even more deeply into the present. In this world, children will have "first"-hand experiences in foreign lands, master a broader suite of skills like the 6Cs, and be better equipped to transfer what they learn into the real world of people and places. The metaverse is coming to education. The question is whether as designers, policymakers, educators, and parents, we can mold intentional and appropriate opportunities that are truly educational within this new and exciting context.

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