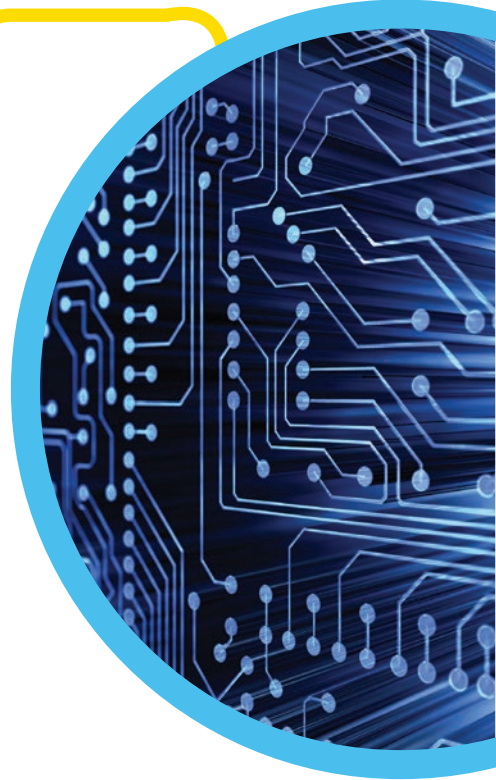




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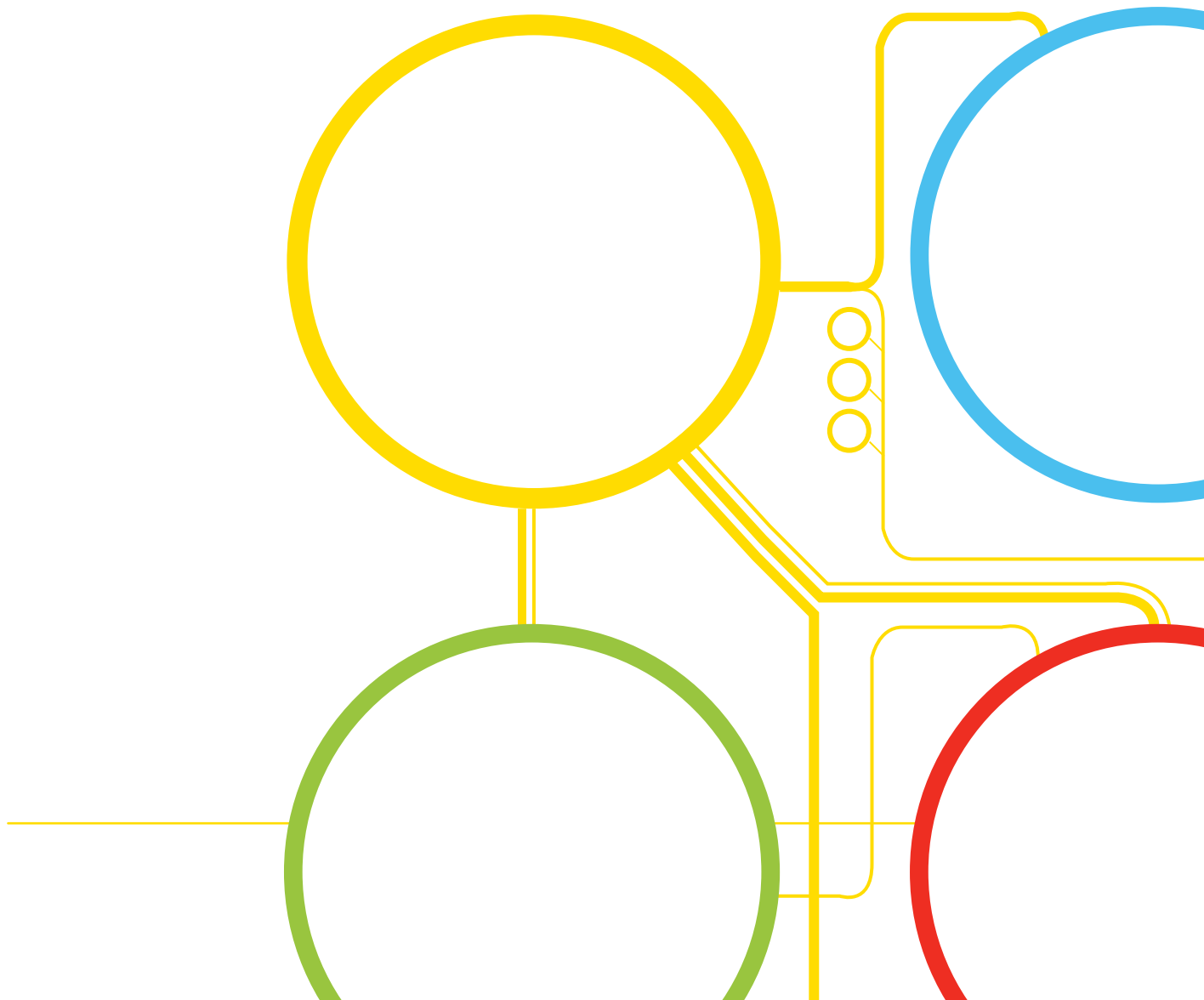
Systematic Creativity
in the Digital Realm

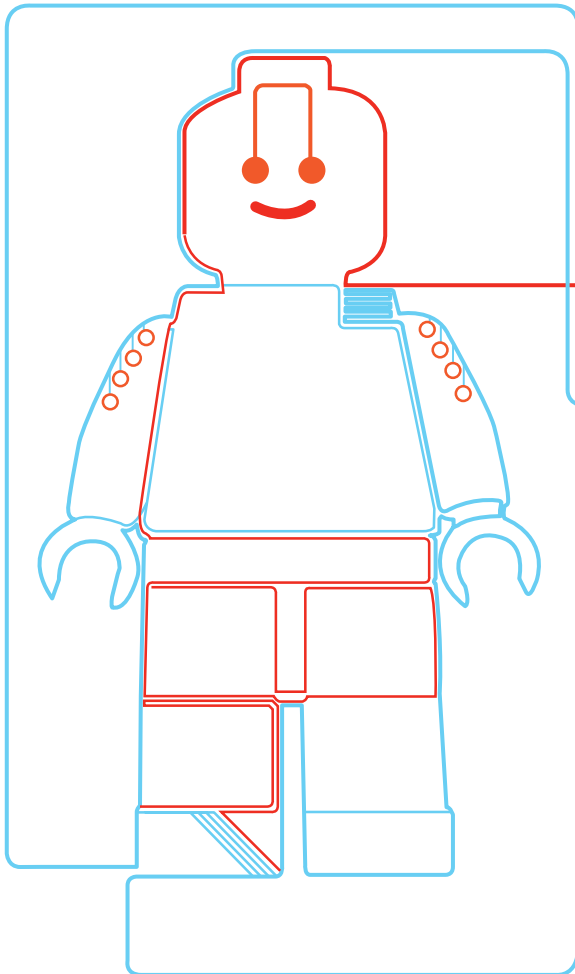


Defining Systematic Creativity in the Digital Realm

Edith Ackermann, David Gauntlett, Thomas Wolbers, Cecilia Weckström

LEGO® Learning Institute 2009





Preface

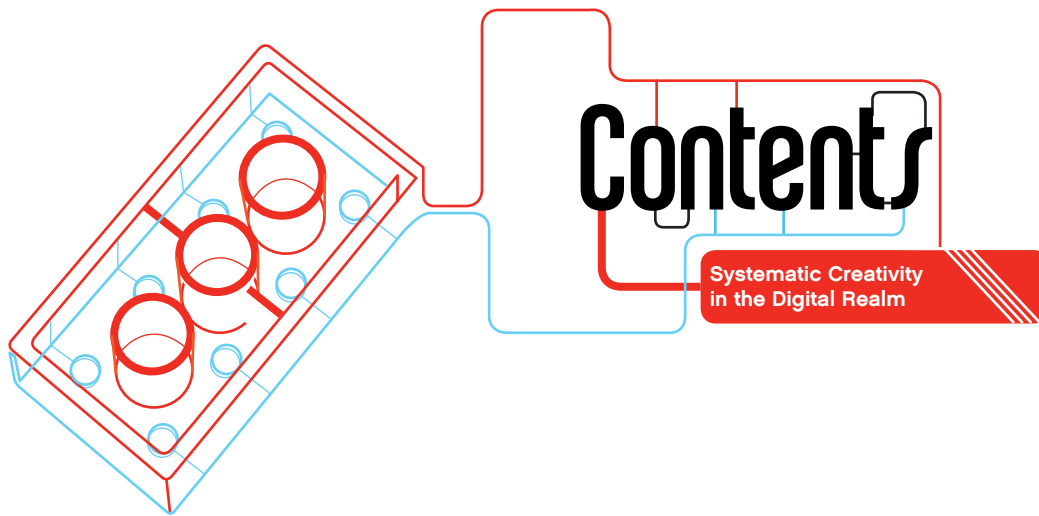
What is creativity in the digital realm? What is it like to grow up digital and how is the digital realm influencing how children play, learn and create? What are the similarities and differences between physical and virtual — as well as 'analogue' and digital play, learning and creativity? Furthermore, what is the role of systems and platforms in supporting play, creativity and learning?

We explore how the qualities of the digital realm can bring together play, learning and creativity in new ways and how the physical and digital LEGO® idea combines to provide systematic creativity through immersive play, learning and creative experiences for children of all ages.

In April 2013, the LEGO Learning Institute integrated into the LEGO Foundation.

All work of the LEGO Learning Institute is now published exclusively under the LEGO Foundation name.

The **LEGO** Foundation



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Background

In 2008 the LEGO® Learning Institute conducted a foundational research study in partnership with academic experts to define how the LEGO System in Play supports systematic creativity and learning. The resulting report, *Defining Systematic Creativity*¹ outlined a number of key concepts that this study builds on. The report's conclusions can be summarised as follows:

On creativity:

- Creativity is the ability to create ideas and artifacts that are new, surprising, and valuable.
- Systematic creativity is a particular form of creativity that combines logic and reasoning with playfulness and imagination.
- Systematic creativity is important in many different types of activities and disciplines: art, science, design, and engineering.

On ways of being creative:

There are three generally recognised ways of being creative:

- Combine** - coming up with new, surprising and valuable ideas and artifacts through combining existing ideas and objects.
- Explore** - expanding our understanding of an area or creative domain by coming up with new, surprising and valuable ideas and artifacts.
- Transform** - transforming the way we see or understand the world through coming up with new, surprising and valuable ideas and artifacts.

On creative behaviour

Children develop the foundation for creativity through free play:

Curiosity is about asking why and imagining explanations and possibilities (if...then), turning the unfamiliar into the familiar.

Playfulness is about asking what if and imagining how the ordinary can become extraordinary, fantasy or fiction.

1. Ackermann, Edith; Gauntlett, David; & Weckstrom, Cecilia (2009), *Defining Systematic Creativity: Explaining the Nature of Creativity and How the LEGO System of Play Relates to it*, Billund: The LEGO Learning Institute.

Both curiosity and playfulness create, inspire and together engage different parts of our minds in an enriched dialogue, setting the stage for combinatorial, exploratory and transformational kinds of creativity.

On myths and misconceptions about creativity:

Myth: You have to be an artist to be creative. In fact, there are creative people in all fields and professions: scientists, business executives, journalists, engineers.

Myth: Only a small set of people are creative. In fact, everyone can be creative. Not everyone will develop ideas or inventions that are totally new to society. However, everyone can come up with ideas they've never had before, or create things that are new and surprising to their friends and community.

Myth: Creativity comes from individuals working alone. In fact, most creative ideas and inventions result from groups of people working together and interacting with one another.

On the Creative Process:

- Creative ideas don't come from a single 'Aha!' moment. Rather they result from an iterative process, sometimes called the Creative Learning Spiral.
- In this process, people imagine new possibilities, create something based on their ideas, play and experiment with their creations, share their ideas and creations with others, reflect on their experiences – all of which leads them to imagine new ideas and new projects.
- People don't necessarily go through this process in a step-by-step progression. Rather, they weave together different parts of the process, as they try out new ideas, test the boundaries, and explore alternatives.

On creativity and constraints:

- Many people assume that creativity starts from a blank page, with total freedom to make whatever you want.
 - In fact, most creative activity involves both freedom and constraints. An architect, for example, is constrained by the properties of the building materials, the desires of the client, and the budget for the project. These constraints limit certain options, but also spark creative ideas and suggest new possibilities.
-

- For children to develop as creative thinkers, they also need constraints – a structure or framework to guide their activity, but also enough freedom to explore and experiment.

On systems and creativity:

Systems have been proven to be essential for creativity:

- Systems of science channel creativity into solving specific problems (as in maths, physics and engineering).
- Systems of art channel creativity into unique expressions, giving form to imagination, feeling and identities (as in painting, music and sculpture).

On how toys can support systematic creativity:

Many toys support creativity by encouraging playfulness and imagination – clay for molding sculptures, crayons for drawing pictures. In order for toys to support systematic creativity, they must also encourage logic and reasoning by:

- Providing a logical set of constraints that children can understand and master.
- Offering a system of parts that children can combine (and recombine) in organized ways. By encouraging imagination and playfulness along with logic and reasoning, toys can provide both the structure and the freedom that children need for systematic creativity.
- The LEGO® System is one of the few systems able to blend the qualities of both kinds of systems into a creative medium that enhances both.

On becoming more creative:

We are all creative and can become more so through practice. It is possible for individuals to engage their creativity systematically by cultivating the relevant mindsets behind the creative process:

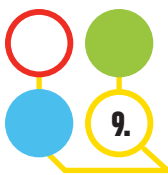
- **Curiosity** – replacing skepticism toward risks with a curiosity to learn from successes and failures.
 - **Mental readiness** – rather than focusing on what you feel you lack, appreciating your desire to move forward.
 - **Confidence** – promoting your sense of self worth by knowing that you are devising a new and better reality for yourself and others.
 - **Positive framing** – generating enthusiasm for the new ideas and opportunities you might find.
 - **Commitment** – choosing to make a difference.
-



Defining Systematic Creativity in the Digital Realm

The focus for this second study is to ascertain to what extent the same findings apply and in what way they are different, based on the qualities of the digital realm. Therefore the purpose of this study is:

- To understand the similarities and differences between physical and virtual – as well as ‘analogue’ and digital play, learning and creativity.
- To understand the ways in which tangibility and physical manipulation is important for creativity and learning.
- To articulate which elements of the LEGO® idea are most relevant to translate to the digital realm in pursuit of systematic creativity.
- To outline a set of principles for consistently applying the elements of the LEGO idea relevant to the digital realm across a number of digital creative, learning and play experiences.



Chapter 1: Children Young People and Growing up Digital

Introduction

In recent years the debate around technology has intensified – and become somewhat polarized – between those who hold it up to be transforming social relationships, the economy, and vast areas of public and private life, and those who feel that these claims are exaggerated or ahistorical. These contrasting views about technologies tend to take on an even greater force when it comes to their potential impact on the lives of children and youth.

On the one hand, there is a far-reaching debate about the ways in which digital media and technology are threatening or even destroying childhood. Young people are seen to be at risk, not only from more obvious dangers, such as pornography and paedophiles, but also from a wide range of negative physical and psychological consequences that derive from their engagement with technology.

On the other hand, we witness a far more optimistic debate fueled by the advocates of the new 'digital generation,' whom Buckingham (2008) calls the 'techno-enthusiasts'.² Techno-enthusiasts regard technology as a force of liberation for young people – a means for young people to reach past the constraining influence of their elders, and to create new, autonomous forms of communication and community. Far from corrupting the young, technology is seen to be creating a generation that is more open, more democratic, more creative, and more innovative than their parents' generation. Unsurprisingly, these enthusiasts are in conflict with critics who assert that this view is excessively evangelical, and that it ignores the history of media innovation, which shows that new products and opportunities have been subject to inflated claims about creativity, communication, and democracy, for well over 100 years.

2. Buckingham, David (2008); *Introducing Identity. Youth, identity, and Digital Media*. Edited by David Buckingham, The MacArthur Foundation Series on Digital Media and Learning, Cambridge, MA, The MIT Press.



To conclude, while the skeptics may be too concerned about the alienating effects of technologies and often downplay the children's potential as agents of change, the techno-enthusiasts tend to idealize both the technologies' qualities and potential and the children's power of appropriation:

This relentlessly optimistic view inevitably ignores many of the downsides of digital technologies – the undemocratic tendencies of many online communities, the limited nature of much so-called digital learning and the grinding tedium of much technologically driven work. It also tends to romanticize young people, offering a wholly positive view of their critical intelligence and social responsibility that is deliberately at odds with that of many social commentators. It is also bound to ignore the continuing 'digital divide' between the technology rich and the technology poor, both within and between societies.³

Too often, the debate revolves around whether digital media is 'good' or 'bad' for young people. The reality is somewhere between these extremes, in that some aspects and uses of digital media can be highly positive, and others can be negative. There are multiple variables, such as the amount of time spent; what the users choose to do, what else they do in their lives; and many other factors.

Myths and misperceptions about young people and digital media

Myth: *Digital natives are 'loners'.*

False. Today's children are as social as ever. The difference is with whom they interact, what they like to share, and how they share it.

Myth: *Digital natives are socially incompetent, or 'geeks'.*

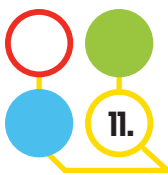
False. Today's children are no less able or willing to negotiate their needs and wants with friends, peers, and family. Even very young children are quick to learn how important it is to build circles of trust (especially online) and when it is best to play by the rules to stay safe within a chosen 'club'.

Myth: *Digital natives are couch potatoes.*

Misleading. True, natives may be born into families that eat too much, or exercise too little. Granted, they can spend hours staring at a screen. This said, the same children are the first to fall for Wii, the dance revolution led by X-Factor or American Idol, and they are the first to embrace mobile technologies (Ipods, cell phones) that let them loose when they have the option: in fact, many digital natives crave to be physical.

Myth: *Digital natives are out of touch with reality.*

Misleading. Today's children are moving between worlds (surfing, zapping) and while they love to expand their interests and friendships beyond borders (sometimes at the expense of those physically present), research shows that most children play online with



people they already know in real life. In addition, they are the first to be thrilled when location-based technologies allow them to bridge in new ways their virtual and physical selves, friends, and interests.

Myth: *Digital natives have the attention span of a gnat.*

Misleading. If interested, today's children will stick to a task for days and weeks in a row, and they will care to the point of 'geeking out'. True, the natives rarely do just one thing at a time, or one thing after the other. Instead, they zap, surf, and pursue multiple threads: They will talk to you, check the weather online, and SMS to a friend, all at once and without losing track. There is a difference between multi-tasking and attention deficit.

Myth: Digital natives are illiterate!

Misleading. Today's children may be bad spellers (perhaps because they do not care) but they do know how to 'text' (because they care). They may not send postcards or perfect their hand-writing but they will use e-mail, comment on their friends' Facebook entries, and (when older) may create a blog, wiki, or participate in online forums. If anything, today's children are helping us rethink what it means to be literate in the digital age.

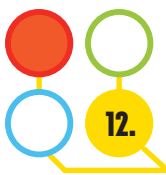
The changing nature of childhood

The similarities and differences between children of today and children of yesterday are a blend of elements resistant to change, and areas where there is significant change from previous generations. Said otherwise, there are things that stay the same and things that change.

Similarities to previous generations:

Need for Nurture - Every child needs to be held, heard, and respected for who s/he is. Children also need room to explore, grounds to settle, friends to share with and, most importantly, they need to be given a second chance if they make a mistake. Lastly, children need transitional places — and associated props — which allow them to safely enact, play out, and work through otherwise 'dangerous' ideas. They need 'compasses' or self-orientating devices (directions) and anchoring techniques (guidance, boundaries) so as not to get lost in their journeys.

Developmental Trends - Most children of a given age will share certain interests and abilities relating to age, or developmental stage, no matter their personal style, gender, or when and where they are born. For example, toddlers will typically argue their point of view differently than a four years old or an eight years old. They may revert to screaming or brute force, while older children have generally come to realise that using words to ask or negotiate may be a more effective strategy. A 3-year-old doesn't reason in the same ways as an 8-year-old or a teen.



Forming Identity - There are differences in how children form their identity even among children born in the same place and at the same time. This may be because of their upbringing, background, family history, personality, predispositions, or gender, usually a combination of factors. As a result there are many different ways in which individuals engage in the world, see their own potential, relate to others, and leave their mark. Much research has been dedicated to the study of individual, stylistic and gender differences, in both children and adults.

Assimilating Culture - Certain generational traits have been clustered under broad headlines like Baby Boomers, and Generation X. While research on the millennium generation is fairly new, and often contradictory, some core generational traits are emerging, which prove fairly robust and surface repeatedly in different studies, under slightly different wordings. The purpose of this report is to offer a workable framework grounded in research findings that will enable parents, educators, and decision-makers to identify some of these core traits and understand how they affect how today's children play, learn, and create.

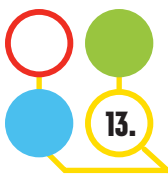
Differences to previous generations:

We have identified six distinctive, yet related areas of difference to previous generations. Each area constitutes a dimension that, together with others, informs how today's children play, learn, and create. The dimensions are:

1. **Sharism** - new ways of relating.
2. **Shifting identities** - new ways of being.
3. **Border-crossing** – new ways of moving between worlds.
4. **Literacies beyond print** – new ways of authoring and expression.
5. **A culture of gaming – or ‘simuling’** – new ways of playing it safe.
6. **A culture of bricoleurs, makers, hackers, and hobbyists** – new relationships with things.

1. Sharism — *New ways of relating – a growing precedence of co-creation over individual construction, of ‘information brokerage’ over personal elaboration. .*

More than in previous generations, today's children seem to be approaching things ‘outside in’ instead of ‘inside out’. In substance, they tend not to don't first think and then act, or first try out things for themselves and then share them with others. Instead, today's children are more likely to mingle before they make, and share before they think. They often love to circulate half-baked ideas, small snippets, usually at a fast pace, instead of keeping things to themselves. They do so with kindred spirits — present or absent. Therefore such open sharism calls for trustworthy allies.



2. Shifting identities — *New ways of being – Shifting boundaries between what is perceived as me (private) and not-me (public), between where I/mine ends and where you/yours begins, between what gets incorporated (taken in) and projected out (objectified, seen as 'other').*

More than in previous generations, today's children are keen on exploring different facets of their personalities. Their sense of self is fluid. To them, the divide is not between virtual and 'real' self. Instead, they exist at all levels. While putting on a mask or swapping gender are not new (e.g. role play, carnival), digital environments enable you to be present simultaneously in different contexts and, in each, you will be taken at face value (or mask value!). Children's tendency to loosen boundaries between me/not-me and their ability to be in different places at the same time is said by some to mark the end of the notion of the individual as we know it.

3. Border crossing – *New ways of moving between worlds — Moving between physical and digital realms and new ways of belonging.*

More than in previous generations, today's children engage in parallel adventures, and belong to multiple tribes. They move between worlds (virtual, physical) often without moving their bodies. They may feel at home in more than one place / not live in a place in particular. Children's increased desire to cross borders, both geographic and cultural or beyond the surface of things, ends the notions of territory and roots as we know them. It engenders a deeply felt sense of belonging to a global family or village, which contributes to the development of today's nascent cultures of sharism and liquid selves.

4. Literacies beyond print — *New ways of authoring and expression – Deep changes in what it means to be literate, and consequently, a literate thinker. From write to notate to annotate, from research to search.*

More than in previous generations, the gap between reading and writing is closing, as well as between speech and writing. Writing becomes more like a quick assembly, or collage, of cut-and-paste fragments. Reading becomes a more active process of highlighting, earmarking, annotating, linking, and tagging. More than ever, today's children mix and match media rather than start from scratch, nor do they stick to their creations for long. Instead, they borrow from those who inspire and they address their creations to those who matter—and if time permits, they 'massage' (reconfigure, repurpose, add to) what comes in to add their own mark.



5. A culture of gaming — or 'simuling' — *New ways of playing it safe – A growing expectation that the tools at hand and the worlds to dwell in are responsive and forgiving, and that they let you experience things in their 'unreality' and take risks safely (having an 'undo' button means you are always given a second chance).*

The use of the word 'simuling' requires some explanation. Unlike 'simulating' which often implies the faithful reproduction of an original in an attempt to mimic an existing reality (e.g. a professional flight simulator), 'simuling' is here meant as the creation of an alternative world, physical or virtual, that is 'true to itself' or valuable in its own right. More than in previous generations, today's children demand that the tools they use provide immediate feedback, and most important, that they can undo a bad move at any time, and keep track of things. This quality of digital technologies encourages both a culture of iteration (try again, build on top, take what you find a step further) and rapid prototyping. Today's tools run operations for you, and help you program, and dynamically visualize complex data, in ways that pre-digital tools hardly did.

6. A culture of bricoleurs – makers, hackers, and hobbyists — *New relationship with the external world – New ways of creating content and making things, of making objects and content 'do things', and of repurposing, recycling, and trading them.*

Clearly, today's children are messing around with digital media and content without necessarily constituting a culture of makers. However, many entertain a different relationship with things — man-made or natural, digital or physical, found or fabricated — and think differently about how these can be transformed and repurposed. These children are digital bricoleurs, eager to modify content by hacking, mashing up and modding. When older, they develop new ways of authoring and creating (crafting, fabricating), of making objects and content 'do things' (controlling, programming), and of repurposing, mending, and trading these (recycling).

To conclude, the six dimensions mentioned above form a system. Each is important in its own right yet they are also mutually reinforcing in shaping how digital natives play and learn, and how they come up with ideas they never had before, or create things that are new and surprising to their friends and community. Clearly, not all young people exhibit the 'neomillennial' traits described here, yet the trends are worth paying attention to, especially as larger efforts are being undertaken to narrow the divides among the youth. The world as a whole is increasingly wired, and we are charged with preparing our youth to face the challenges of the future.

Chapter 2: Play in the Digital Realm

The changing nature of play

To understand how the digital realm is influencing play, it is worth delving into how the children themselves see play in the virtual and physical realm. To this end, the LEGO Group conducted an ethnographic study with 42 children and their parents in the US, Germany, Sweden, Finland and Japan in 2008. The respondents were boys and girls, ranging from age 3 to 14, who were comparatively advanced in the ownership or use of devices and technology.

Five key findings highlight the changing nature of play:

The digital context has transformed children's play –

Pursuit of digital play is bringing children into new areas of the house, not traditionally associated with play areas, such as the parent's bedroom, the home office and so on, creating issues around time-sharing of space and devices, and the parental need to monitor play. Mobility, both physical and virtual, adds privacy and our studies (Kirchmann and Weckstrom 2009) show that children increasingly own what they can carry,⁴ and Gameboys, Nintendo DS's, mobile phones are all vehicles for more independent play and connecting to others.

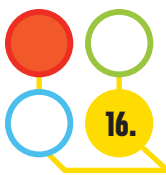
The desire for tangibility is a barrier for digital products –

Parents struggle with the notion of what constitutes 'a good gift' when it comes to products in the digital realm, in addition, children also long to have a tangible outcome of play. It gives them an enhanced sense of ownership and allows them to display creations they are proud of.

Play moves seamlessly across physical and digital –

More than any other generation, children today see play spaces as fluid and connected between bricks and bits, or physical and virtual environments. Children know what is real and what is not, but they perceive the boundaries as more fluid and full of connecting links. They are in a place in-between.

4. Kirchmann, Tim; Weckstrom, Cecilia (2009): *Kids' Inner Circle Study 2009: Digital creativity*. LEGO® Report.



Digital play is driven by the desire to live out stories –

'Living out stories' describes the familiar activity that dominates children's play: children placing characters within fictional settings and events, and enacting their behaviour and dialogues. Through living out stories children explore and learn about the world around them and understand their place within it. Stories provide children with safe territory for experimentation. There are many influences on which stories children decide to live out. However, most children have a couple of areas of interests about which they are really passionate. Around these areas of interest children will often form a web of content and expertise, a universe, which fuels their stories. Two typical sources of universes and stories are media franchises, such as Star Wars and Harry Potter, and events in everyday life which make an impression on children are often translated into stories and lived out.

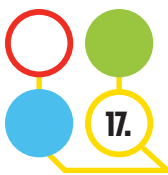
The expanded play offered by networks is pulling children online -

Online networks enhance social play, and the networked digital playground is always switched on. The excitement of sharing a play space is similar to a 'real' collective playground. While the opportunities for children to physically go to their local playground are increasingly limited, a virtual playground is a place they can access from home, at any time of the day, and squeeze into their time restrictions. The technologies also facilitate children playing together in new ways, using networked play – for instance by collaborating against an opponent who is outside their immediate circle. Online, children stretch and test their roles in a parent-free space and this creates a fast track to establishing an independent identity. Spending time with peers is one way children define an identity independent from their parents. Being online allows children to expand the collaborative audience for displaying, testing and affirming. Representing oneself in an online environment is becoming an integral part of the personal identity of children.

Four ways of bridging the virtual and physical through play

The findings above show that the digital realm can augment play in different ways, and that the more compelling play scenarios are those where the virtual and physical each play a part in enriching the experience. Indeed one of the very successful products of late, the Nintendo Wii, convincingly bridges a multitude of realms: solitary and social play, digital and physical environments. Our findings highlight four distinct kinds of play that successfully incorporates the affordances of the digital realm into rich expanded play experiences:

- 1. Play in an evolving virtual world – walking through the looking glass (e.g. online games, social virtual environments, computer games / microwords);**



Virtual worlds are evolving 'invented realities' that respond to players' interactions as if they were real. They are ideal environments for living out stories. James Gee (2008) asserts that "Playing an MMOG is like performing on a stage". The player, like an actor, is creating the role and world he or she inhabits. Yet as the world is constantly in a state of flux, players have to continually adapt to changes. As they progress through the game, the challenges the world presents redefine the nature of the game itself.⁵

"The element of imagination that most significantly distinguishes virtual environments from other online media or interactive sites is our ability to step into them, bringing many of our physical world attitudes, dispositions, and beliefs into the virtual space, while leaving others behind [...]" The fact that it is a space inhabited by others, who are themselves both distributed (in the sense that their physical bodies are spread out all over the world) and co-present (in the sense that their avatars are in the same space), provides the basis for constructing the world they each inhabit.⁶

By shifting the constraints of the physical world, as we know it, and always giving players a second chance, virtual worlds offer a unique transitional zone for players to let go of usual ways of doing and thinking, and to push the boundaries, i.e. take risks, without enduring the consequences of doing so 'for good'. Social virtual environments offer valuable occasions for self-exploration and identity formation (Turkle, 1994; Bers, 2001)^{7 8} Examples of social virtual environments, online games, and computer microworlds include Facebook, Second Life, MOOs and MUDs, SIM, and even Tetris.

2. Play with 'smart' things – fairyland come true! (e.g. talking dolls, intelligent bricks, realtional bots, sensing devices);

Smart things are best defined as play-props with a mind of their own: They look like inanimate objects but they act like people, or pets! They enable one to open up a whole new world of dream-come-true that blurs the usual divide between animate and inanimate, virtual and physical. Like in a fairyland, teapots are brought to life and horses talk. Yet unlike in a fairyland, they actually respond to players' interaction. Add to this that smart toys don't just exist in the virtual realm (section 1) but they come to you: they sit in your living room or bed room, perform their function, and can be cuddled, held, and driven around. They exist in their own physical and tangible bodies.

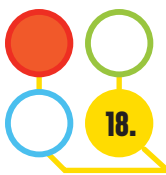
Obviously, toys need not be animated – or personified/anthropomorphised – to capture a child's imagination. Indeed, for younger children, the simplest of toys, such as Duplo blocks, invite them to explore and create meaning for themselves. Yet for somewhat older children, a toy that exists, behaves, and responds, offers a different kind of engagement: it intrigues because it does things on its own, it

5. Gee, James Paul. 'Learning and Games.' *The Ecology of Games: Connecting Youth, Games, and Learning*. Edited by Katie Salen. The John D. and Catherine T. MacArthur Foundation Series on Digital Media and Learning. Cambridge, MA: The MIT Press, 2008. Pp. 21–40.

6. Thomas and Brown 2007, p. 147.

7. Turkle, S. 1994. *Life on the screen: Identity in the age of the internet*. New York: Touchstone

8. Bers, M. 2001 'Identity construction environments'. *Journal of the Learning Sciences*, 10 (4): 365-415.



appeals because it is a surprising hybrid, and it becomes a partner because of its relative autonomy. Playing with smart things allows children to project what makes them human (like having ideas or feelings) into the toys; to explore the fine line between agency and causation; to optimize the dance with the toy and to negotiate control, and ultimately, to build their own smart or responsive toys.

Popular examples of smart toys include, at the high end, Aibo, the deluxe relational bot designed by Sony, Pleo, all the way down to Furbies, Neopets, Tamagotchi, and talking dolls. They also include 'smart' tinkerable building sets (with smart bricks, actuators and sensors), such as Topobo and LEGO® Mindstorms®.

Some 'smart toys' can be problematic, and far from the LEGO® ideal model of play, if they have many preset functions straight out of the box. Sophisticated electronics do not necessarily nurture creativity – indeed, they can have the opposite effect, doing all kinds of dazzling tricks but failing to nurture exploration and imagination. Clearly the better kind of smart toys are those which encourage experimentation, creativity, and communication.

3. Play in mixed realities – feet on the ground, head in the sky (e.g. Nintendo Wii, augmented reality, location based devices, tangible table tops, the web of things)

Mixed realities are particular in that they reclaim players' bodies and their place in the physical world while, at the same time, not losing some of the benefits of digital augmentation. Location-based, ubiquitous, and mobile technologies enable players to move about freely. Tangible interfaces allow them to grab hold of things directly. Code bars, RFID tags and GPS allow them to prompt physical objects and places to unveil their special powers: that's when apparently inert objects will start telling you things that you could never imagine, and let you peek beyond the surface of things.

Besides the Nintendo Wii or Dance revolution, an intriguing mixed reality plaything for children of all ages is 'SkyScout', a personal carry-along planetarium that lets you frame a star and, as you do, tells you all about the targeted celestial body: is it a star, planet, or airplane, what its name, how far away is it? Another great example of mixed reality is the I/O brush designed by Kimiko Ryokai and Stefan Marti in the tangible media group at the MIT Media Lab: a magical paint brush, with a tiny smart camera built in, that lets you 'pick up' and draw with textures [it sees] in the world⁹. GPS powered treasure hunts, Alternate Reality Gaming and various apps are all leading the way to enriching our reality through the virtual.

9. <http://web.media.mit.edu/~kimiko/iobrush/>

4. Play routines for moving back and forth between digital and physical, between solo play and playing with others.

As they play, children rarely just do one thing at the time. Instead, they move between worlds, and sometimes even seem to exist in different worlds at once. User-choreographed play routines allow children to choose where and when to do what, and with whom. The role of such routines cannot be underestimated. Invented by the players themselves, they are clever, fun and often tacit ways to pace, ritualize, and orchestrate multiple streams of activity and conflicting urges. Like travelers who sit together in a cyber-cafe while each roams about in cyberspace, children are very particular about where they want to be when, with whom, and to do what! Play routines allows the players to feel whole and in charge, in spite of constantly being on the go, elsewhere, or with someone else, They are a grounding technique for zappers, surfers, and multi-taskers.

In a remarkable work of ethnography entitled 'In-Game, In-Room, In-World: Reconnecting Video Game Play to the Rest of Children's Lives', Reed et al. (2008)¹⁰ analysed how 'in-game' activities are tangled up with 'in-room' activities and the wider worlds that young people inhabit. Findings show that online play is usually but one stream of what's going on in the rooms where the players are. Phones ring, parents pop in, and players interact in many ways with friends, siblings, and material resources — other than the game. "It's a kind of [entanglement] that the players are quite active in constructing themselves. We saw that young people actively juxtaposed consequences for actions in-game and in-world".¹¹

Comparing the findings from the LEGO® ethnographic study with the four distinct play experiences in the digital realm, it becomes clear that although devices and software change and develop at an ever increasing pace, what endures are the motivations behind the play experiences, as exemplified by the findings around social play and the importance of lived stories in children's play. Therefore it makes sense to further explore the underlying motivations for engagement and what is driving the migration online, rather than purely accounting for the kinds of play current products, sites and software enable.

Drivers of play in the digital realm

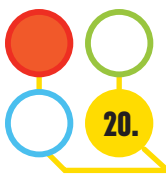
Don Tapscott (2009) suggests in his book *Grown up Digital*¹² that the 'Net generation' (in his study, children born between January 1977 and December 1997) are a group with significantly different modes of being in the world, transformed by technology. On the contrary, the authors of *Living and Learning with New Media*¹³ highlight that what is changing are the different genres or modes of engagement with new media. They mention two drivers

10. Stevens, Reed, Tom Satwicz, and Laurie McCarthy. 'In-Game, In-Room, In-World: Reconnecting Video Game Play to the Rest of Children's Lives.' *The Ecology of Games: Connecting Youth, Games, and Learning*. Edited by Katie Salen. The John D. and Catherine T. MacArthur Foundation Series on Digital Media and Learning. Cambridge, MA: The MIT Press, 2008. 41–66.

11. Ibid. P.63.

12. Tapscott, Don (2009), *Grown up Digital - how the net generation is changing your world*, New York, McGraw Hill.

13. Ito, Mizuko; Horst, Heather; Bittanti, Matteo; Boyd, Danah; Herr-Stephenson, Becky; Lange, Patricia G.; Pascoe, C.J.; and Robinson, Laura (2009), *Living and Learning with New Media: Summary of Findings from the Digital Youth Project*, Chicago, The MacArthur Foundation.



of online engagement which, in our view, apply to digital media in general: friendship-driven (general socialising with friends and peers), and interest-driven (specialised activities, interests, or niche identities).

Friendship-driven practices refer to the dominant and mainstream practices of young people as they go about their day-to-day negotiations with friends and peers. In the tradition of yesterday's pen-pals, today's net-pals use digital media to sustain social bonds beyond territorial borders, from SMS to Facebook.

Interest-driven practices are what young people describe as the domain of the geeks, freaks, musicians, and artists who are identified as smart, different, or creative. They find a different network of peers and develop deep friendships through these engagements, but in these cases the interest comes first, and they structure the ways peers mingle and share. In sum, it is not that interest-driven practices are not social, it is more that the socializing is mediated, i.e. an individual's social circle is forming and expanding based on interests.

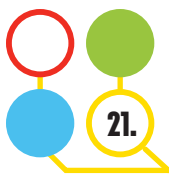
Although some interest-based activities such as sports and music have been supported through schools and overlap with young people's friendship-driven networks, other kinds of interests require more far-flung networks of affiliation and expertise. Before the kind of connectivity enabled by the Internet, the pursuit of such niche interests was difficult, yet the increased connectivity now puts entire communities of practice a mouse click away, enabling young people to pursue a greater diversity of interests along with drawing on expertise from much further afield than ever before.

Ways of playing in the digital realm

Friendship-driven and interest-driven genres provide a broad framework for identifying what the authors saw as the most salient social and cultural distinction that differentiated new media practice among young people. In addition, they identified three modes of participation that describe different degrees of commitment to media engagement: 'hanging out', 'messaging around', and 'geeking out'.

Friendship-driven engagement: 'Hanging Out'

'Hanging out' is often regarded as a laid-back and somewhat passive form of engagement (one that lacks purpose and direction), and gets associated with a 'general shift from given childhood relationships, such as families and local communities, to peer and friendship-centered social groups'. Unlike with other modes of participation (e.g. 'messaging around' and 'geeking out'), parents and educators tend not to see the practices involved in 'hanging out' as supporting learning.¹⁴ 'Hanging out' involves socialising, developing their taste and discussing music, movies, TV shows and games.



While fashion, content and technologies are changing rapidly, the formal hanging-out practices still remain the same ever since a distinct youth culture evolved after WWII. Ito (2009) uses the term 'hypersocial' to define the process through which young people use specific media as tokens of identity, taste, and style to negotiate their sense of self in relation to their peers.

Interest-driven engagement: 'Messing Around'

Unlike 'hanging out', where the desire is to maintain social connections to friends, 'messing around' represents the beginning of a more intense, media-centric form of engagement.¹⁵ 'Messing around' is about exploring and extending the understanding of the technology and making content themselves. It involves exploration with relatively low investment, where there are few consequences of trial, error, and even failure. Some activities that the authors identify as 'messing around' include looking around, searching for information online, and experimentation and play with gaming and digital media production.

'Messing around' with new media requires an interest-driven orientation and is supported by access to online resources, media production resources, and a social context for sharing media knowledge and interests. Online and digital media provide unique supports for 'messing around' safely. Tools like web forums and chat channels allow new users to observe and, in some cases, dabble and mess around anonymously, effectively lowering the barriers to entry. In contrast to learning that is oriented toward a set, predefined goal, 'messing around' is largely self-directed, and the outcomes of the activity emerge through exploration.

This casual way of engaging with media and materials is also characteristic of much of video game play¹⁶. In contrast to the early days of gaming, where customisation was limited, today players take for granted the ability to modify and customise the parameters of a game. The authors report that "not only were the youth [...] constantly experimenting with the given parameters and settings of a game, they also relied on game modifications and cheats to alter their [real-time] game play." Another example of casual messing around with game parameters is provided by "players who enjoyed experimenting with the authoring tools embedded in games." Games such as Pokémon or Neopets allow user authoring and customisation of the experience through personal collections of customised pets, which, in turn, provides an easy entry into messing around with game content and parameters.

'Messing around' with digital media is driven by personal interest, but fuelled by a broader social dimension of friendship-driven practices. The proliferation of sites for storing and circulating personal media is making sharing easier and more

15. Ito et al. *Living and Learning with New Media*, 2009. P.20.

16. *Ibid.* P.24.

wide-spread, in turn making messing around more popular. Gamers too, find support for their 'messing around' activities in their local social relationships. Among boys, gaming has become a pervasive social activity and a context where they casually share technical and media-related knowledge¹⁷.

Interest-driven engagement: 'Geeking Out'

'Geeking out' is about an intense commitment to or engagement with media or technology, often one particular media property, genre, or type of technology¹⁸. It involves learning to navigate esoteric domains of knowledge and practice and participating in communities that traffic in these forms of expertise. It is a mode of learning that is peer-driven, but focused on gaining deep knowledge and expertise in specific areas of interest.

Ongoing access to digital media is a requirement of 'geeking out'. Often, however, such access is just part of what makes participation possible.

Family, friends, and other peers in on- and offline spaces are particularly important in facilitating access to the technology, knowledge, and social connections required to geek out [...] geeking out requires the time, space and resources to experiment and follow interests in a self-directed way. Furthermore, it requires access to specialised communities of expertise. Contrary to popular images of the socially isolated geek, almost all geeking out practices [...] are highly social and engaged, although not necessarily expressed as friendship-driven social practices. Instead the social worlds center on specialised knowledge networks and communities that are driven by specific interest and a range of social practices for sharing work and opinions.¹⁹

Motivations for play in online games

PARC researcher and MMO expert Nick Yee (2007) in his *Motivations of Play in Online Games*,²⁰ outlines a comparable model of the motivations of players of Massively Multiplayer Online (MMO) games. Although on average older, these players exhibit similar behaviours but within the same game as opposed to the modes of participation described above, which may utilise a multitude of channels in pursuit of the subject of one's interest. The wide variation of motives suggest that Massively Multiplayer Online Role Playing Games (MMORPGs) in particular cater to many different kinds of play styles and that indeed, one key to the success of these games is their rich capacity to engage.

Nick Yee conducted a large scale ethnographic study of over 3000 MMORPG players of games such as Everquest, Dark Age of Camelot, Ultima Online and Star Wars Galaxies

17. Ibid. P.26.

18. Ibid. P.28.

19. Ibid. P.28.

20. Yee, Nick (2007). *Motivations of Play in Online Games*. *Journal of Cyberpsychology and Behaviour*. P. 9, 772-775.

and derived a set of sub-components and main groupings based on player feedback on their motivations for play:

ACHIEVEMENT	SOCIAL	IMMERSION
Advancement: Progress, power, accumulation, status	Socialising: Casual chat, helping others, making friends	Discovery: Exploration, lore, finding hidden things
Mechanics: Numbers, optimisation, templating, analysis	Relationship: Personal, self-disclosure, finding and giving support	Role-playing: Story line, character history, roles, fantasy
Competition: Challenging others, provocation, domination	Teamwork: Collaboration, groups, group achievements	Customisation: Appearances, accessories, style, color schemes
		Escapism: Relaxation, escape from real life, avoid real life problems

Yee further stresses that the factor analysis revealed that the play motivations do not suppress each other as has been suggested by others. Just because a player scores high on the Achievement component doesn't mean they can't also score high on the Social component.

To understand the varying levels of participation in other kinds of online communities, Jane McGonigal (2008), author of *The Engagement Economy*²¹ proposes that Yee's work be mapped onto the pyramid of participation. She argues that based on the intensity of gameplay Yee observed in each group,

The top of the pyramid is made up primarily (but not exclusively) of achievement oriented participants; the middle is made up of socially oriented participants; and the bottom is made up of immersion participants. Crucially, all levels of participants are needed, not just the peak users. Emotionally, the base of the pyramid actively supports the top, even if they are making far fewer concrete contributions. But effectively, the peak of the pyramid supports the entire community and the larger goals of the project, by accepting the weight of the majority of contributions. Understanding this distribution may help community organisers design tasks that will fill in missing pieces of the pyramid. In a more general sense, participatory systems that create activities in all three of these categories may find that they are able to attract and sustain a more diverse community.²²

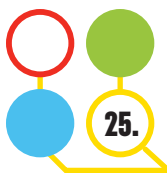
Combining motivations for play and ways of playing

Despite the different contexts in which Yee and Ito have conducted their research,

21. McGonigal, Jane (2008). *Engagement Economy - the future of massively scaled collaboration and participation*. Palo Alto, California, Institute for the Future.
 22. Ibid. P.14.

the findings appear to support one another surprisingly well. One might argue that the 'Achievement' motivation, as outlined by Yee, is similar to Ito's 'Geeking Out' – mode of participation and that indeed the kinds of motivators that drive achievement would not be lost in a 'Geeking Out' context either. Similarly - the 'Messing Around' genre of participation is akin to the 'Immersion' mode described by Yee, again the motivations are similar. The 'Hanging Out' genre is all but matched by the description of the 'Social' motivations.

Messing Around	Immersion
<p>Activity:</p> <ul style="list-style-type: none"> • Exploring and extending understanding of technology and making content. • Looking around, searching for information online, experimenting, play with gaming and digital media production. • Supported by access to online resources, media production resources, and a social context for sharing of media knowledge and interests. 	<p>Motivation:</p> <ul style="list-style-type: none"> • Discovery: Exploration, lore, finding hidden things • Role-playing: Story line, character history, roles, fantasy • Customisation: Appearances, accessories, style, color schemes • Escapism: Relaxation, escape from real life, avoid real life problems
Hanging out	Social
<p>Activity:</p> <ul style="list-style-type: none"> • Socialising, developing tastes and discussing music, movies, TV shows and games. • Using specific media as tokens of identity, taste, and style to negotiate sense of self in relation to peers. 	<p>Motivation:</p> <ul style="list-style-type: none"> • Socialising: Casual chat, helping others, making friends • Relationship: Personal, self-disclosure, finding and giving support • Teamwork: Collaboration, groups, group achievements
Geeking out	Achievement
<p>Activity:</p> <ul style="list-style-type: none"> • Intense commitment to or engagement with media or technology, often one particular media property, genre, or interest • Requires the time, space and resources to experiment and follow interests in a self-directed way. • Social worlds center on specialised knowledge networks and communities that are driven by specific interest and a range of social practices for sharing work and opinions. 	<p>Motivation:</p> <ul style="list-style-type: none"> • Advancement: Progress, power, accumulation, status • Mechanics: Numbers, optimisation, templating, analysis • Competition: Challenging others, provocation, domination



Research at the LEGO Group²³ further suggests that in some cases a progression of the genres of participation and motivations can be discerned from the engagement that children have with their LEGO® interest. For example, when new to a story universe, game or toy, children often start out in the 'Immersion mode', 'messing around' with the product to understand its scope, limitations, the world, and the story; and as the connection deepens, it paves the way to connecting to others who share the same interest, ('Social' or 'Hanging Out' mode) and in some cases continues all the way to the 'Achievement' or 'Geeking Out' level of engagement.

Equally, if children are already familiar with the generic type of product or functionality, they may enter the LEGO world through a recommendation from a friend, ('Social' or 'Hanging Out' mode), and if captivated by the product, may move into 'Immersion mode' and subsequently follow the path of engagement as described before. Alternatively, more experienced gamers may enter the experience already at the 'Achievement' level and remain in this mode for the majority of their engagement. In short, despite in some cases clear patterns of progression being visible in some cases for how children and young people may engage in a product or story universe of interest, this does not mean that all engagement follows a linear route. Just as different moods call upon different modes of engagement, so too do different products and interests at different points in time.

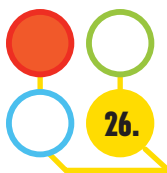
What makes play in the digital realm 'fun'?

What makes an experience fun? What motivates someone to join a new group or keep an online community working together over time, instead of disbanding? What are the emotional payoffs of active participation? In short, it appears that experiences that appeal to user's motivations for engagement, that trigger a set of emotional rewards, and that support Flow²⁴ are the ones that will keep us returning over and over again. McGonigal highlights²⁵ the research of economist Edward Castranova, showing that the economy of engagement is an economy of feelings, in which positive emotions – pride, curiosity, love and feeling smart – are the ultimate rewards for participation. Castranova argues that positive feelings are the single most important motivation for playing games and that most players turn to games specifically to produce the emotional high associated with accomplishing something concrete, feeling capable, and being recognised for their successes.

Clay Shirky (2008)²⁶ too, confirms that the pleasures of accomplishment and the feeling of competence are basic drivers of participation in online communities. He proposes three basic emotional motivations to contribute to a participatory system:

- a chance to exercise some unused mental capacities – the emotion of feeling smart

23. Kirchmann, Timothy; Weckstrom, Cecilia (2009): *Kids' Inner Circle 2009: Digital Creativity Survey*. LEGO® report.
24. Csikszentmihalyi, Mihalyi (1991). *Flow: the psychology of optimal experience*. New York, HarperPerennial.
25. McGonigal, Jane (2009). *Engagement Economy*. P. 12.
26. Shirky, Clay (2008). *Here Comes Everybody- The power of organising without organisations*. London, Penguin.



- 'vanity' – the pleasure of changing something in the world, just to see one's imprint on it.
- 'desire to do a good thing' – the most surprising, and the most obvious

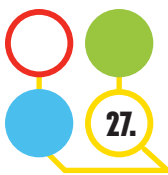
McGonigal argues that another lesson for developers of participatory systems, is to trade on this desire by being transparent regarding its goals and the benefits of achieving them. To love a project, participants must be able to understand it.

Joe Pine (1999) argues that the most captivating experiences are those that absorb our minds, and as immerse our bodies, and have active and passive participation components to them. He mentions four distinct realms of experiences, entertainment (a passive, absorbing experience, e.g. watching television), education (an active, absorbing experience, e.g. learning to do something new), escapism (an active, immersive experience, e.g. playing a computer game) and esthetic (a passive, immersive experience, e.g. visiting the Grand Canyon). He argues that when designing experiences, we should aim to include elements from all four realms in our experiences.²⁷

Flow appears to be a recurring theme in much of the research pertaining to participation and gaming. A positive emotional state, it is defined as the happiness we experience when we are fully engaged in something, when our abilities are in balance with the challenge at hand and we are receiving feedback that we are making progress towards a goal. If Flow is the ultimate fun mechanic, as McGonigal puts it, then any participatory platform that fails to provide the ingredients of flow: immediate feedback, clear objectives, visible failure states, a staged set of challenges and the lack of time pressure - is likely to fail to achieve maximum possible engagement,

On Flow, 'hard fun', and gaming

Seymour Papert's entire career in education was dedicated to designing the conditions that may harness the passions of learners to the hard work needed to master difficult material and acquire habits of self-discipline. To achieve this he did not adopt the usual 'make it fun, make it easy' trick. Instead, much like Csikszentmihalyi, Papert likes to see learners 'in the flow' (on the road to self-directed learning). The words he uses to capture his views on engaging and learning-rich play are 'hard fun', an expression that was given to him by a first grader back in the eighties. The term encapsulates the notion that most people, and especially children, like to take on hard challenges. It also adds an important cautionary note: not all hard things are good things!




Papert writes on his website: 'The Gardner Academy (in San Jose, CA) was one of the first elementary schools to own enough computers for students to spend significant time with them every day [...] A teacher heard one child using these words to describe the computer work: 'It's fun. It's hard. It's Logo.' I have no doubt that this kid called the work fun because it was hard rather than in spite of being hard. However, not all hard things will do. Papert continues: 'They have to be the right things matched to the individual and to the culture of the times [...] they must connect with the children and with the areas of knowledge, skills, and ethic adults will need for the future world.'²⁸

Engaging in 'hard fun' involves free exploration, or messing around, and concentration and discipline. It requires learning to deal with things going wrong by finding out how to fix the problem rather than by giving up in frustration. In Papert's view, provided children get the support and have access to suitable tools, their enthusiasm for playing games can easily give rise to an enthusiasm for making them. 'Of course, the games the children can make will lack the polish and the complexity of those made by professional designers. But the idea that children should draw, write stories and play music is not contradicted by the fact that their work is not of professional quality. I would predict that within a decade, making a computer game will be as much a part of children's culture as any of these art forms'²⁹. Seymour Papert was a visionary in that what was unthinkable a decade ago is now business as usual.

28. ref: <http://www.papert.org/articles/HardFun.html>

29. Papert, S. (1998) 'Does Easy Do It? Children, Games, and Learning' June 1998 issue of Game Developer magazine: http://www.mamamedia.com/areas/grownups/new/21_learning/home.html?src=ibio P. 88.



Chapter 3: Creativity in the Digital Realm

Introduction

To understand creativity in the digital realm, we need to go back to a general definition of creativity. In Ackermann, Gauntlett, & Weckstrom (2009) we used this definition, drawing on various sources:

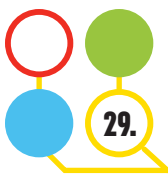
'Creativity is the ability to generate ideas and artifacts that are new, surprising and valuable.'

There are essentially three kinds of creativity

- **Combining** ideas or artifacts in new, surprising and valuable ways.
- **Exploring** an area through ideas or by making something, resulting in new, surprising and valuable understanding.
- **Transforming** the way we see the world through ideas and artifacts that are new surprising and valuable.

Developments in consumer electronics, software, the culture of hacking, modding, Maker Faires and open APIs (Application Programming Interfaces) increasingly enable the creation of tools and content within the digital realm that are exploratory, combinatorial or in some cases even transformational, in that they change the way we see or understand the world. Indeed, online environments are rich grounds to explore an interest in a topic, as suggested by the interest-driven genres of participation and Immersion as motivation for gaming as outlined in the previous chapter. Mixed realities, as we will see, offer equally promising grounds for expanding the play while being anchored in the real world incorporating engaging hands-on activity.

Both friendship- and interest-driven genres of participation are rich in examples of combinational creativity, and increasingly sophisticated and easy to use tools and technologies are making it possible to contribute meaningfully to this realm. However, transformational creativity appears to mostly occur in the 'Geeking Out' genre of participation, pointing to the fact that mastering the technologies and/or code that paves the way for transformational creativity requires a significant investment of time and energy, and often entails joining a community of practice.



In recent years we have seen an explosion of new tools, technology and software available to consumers, bringing previously specialist pursuits such as robotics programming, photo manipulation, video editing, music mixing and recording, desktop publishing and website creation within the reach of anyone with an entry-level computer.

On the other hand, much of the development of late in this this realm is focused around features, functionality and ever increasing complexity at ever lower prices, often without resolving lingering usability and compatibility issues, thus making the threshold for creative expression in the digital realm unreasonably high for children under the age of 9. As Mitchel Resnick³⁰ puts it 'children can 'read' online (consume the content), but still often lack the tools and child-friendly applications to 'write' much of the content themselves', stunting their deeper exploration of the subject. If creative exploration in the digital realm is difficult for children to accomplish, they are by the same token deprived of the deeper learning opportunities that creativity provides. Furthermore the difficulties in combining digital content in new, surprising and valuable ways, let alone doing it in a way that transforms how children see the world highlight further areas of untapped potential in how the digital realm can support children's creative development.

Common myths and misconceptions about digital creativity

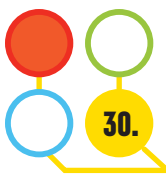
Here are some possible misconceptions about the nature of digital creativity:

Myth: *Digital creativity is about people roaming around in 3D virtual worlds, using strange fantasy 'avatars'.*

False: Digital creativity may occur in 3D virtual worlds, but it takes many other forms (such as in social networking sites, blogs, original website creation, video making and sharing, digital photography and imaging, gaming, in mashups and unintended uses of software, and many other areas). Users of virtual worlds such as Second Life sometimes use the virtual habitat for fantasy play, with avatars which are quite unlike their everyday selves; but it is also common for people to want to appear 'as themselves,' so that their online presence is an extension of their everyday self, and not an alternative to it. Furthermore, some players may be altogether more interested in building in Second Life. They are architects, who set the stage, more than actors, who play on stage.

Myth: *Digital creativity is less of a social activity than 'regular' creativity.*

False: Digital creativity is typically no more or less social than other creative activities. In either case – online or offline – creative activity can be relatively solitary, or highly social and collaborative. Whilst some adults may see working at a screen, large or small, as an isolated or non-social activity, in fact the Internet enables people to engage in highly social and collaborative activities. Indeed, the Internet enables users to socialise and collaborate with people of diverse interests, ages, and locations – usually a broader spread of people than those with whom we would work in offline activities. In addition, hybrid activities enable people to make connections across the two realms.



Myth: *Digital creativity is only for the 'computer children'.*

Misleading: Today's children have in many cases grown up with computers and other digital tools and interfaces around them and many are very familiar and comfortable with expressing themselves in new media. To engage in digital creativity does not necessarily require one to be a 'computer expert' – many software and online tools are becoming increasingly simple and intuitive, but more could be done to make these more accessible to younger children in particular.

Myth: *Digital creativity is rather technological / to do with graphic design, like architecture / not very expressive / probably for boys.*

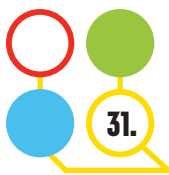
False: Digital creativity takes many forms and can be highly expressive. Both girls and boys have used social networking sites to create beautiful communicative spaces which share information about their identity in a meaningful way. They are drawn to the social sharing and interaction, and as digital natives – as noted above – are unlikely to think of it as a 'technological' place. And more recently, many technologies are available (arduino boards, lilipads, etc.) which allow children to build their own programmable jewellery and accessories, and more generally bring objects to life.

Myth: *Digital creativity involves online dangers of which children are unaware.*

Generally false: Research shows that most children today have received and understood the many messages aimed at them regarding the possible dangers of online interaction. When children are online, they do of course need to be supervised and educated about the risks – in particular about divulging personal or location information to strangers or possible-strangers. However, following campaigns in many countries over the past few years, children are increasingly aware of real dangers, and are able to build trust circles for safe play.

Creativity across the physical and virtual realms

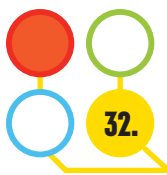
The processes of digital creativity we have seen, are part of how creativity works in general – not separate, new or unique. However, the digital realm has particular qualities, worth considering if one is to understand its potential creative uses by children and youth. In the table below, we show the contrast between 'non-digital' and 'digital' creativity and in the third column consider a comparison with 'hybrid' or 'mashup' creativity, which brings the two worlds together:



Non-digital creativity	Digital creativity	Hybrid or mashup creativity
People use non-digital creativity for pleasure, to create meaning in their lives, and to enact, build, and share stories	Same: People use digital creativity for pleasure, to create meaning in their lives, and to enact, build, and share stories	Same: People link together traditional and digital forms of creativity for pleasure, to create meaning in their lives, and to enact, build, and share stories
The materials at hand may be limited in supply (you may run out of bricks or paint)	The elements you build with are limitless (you don't run out of virtual bricks or paint)	There is a (possibly fruitful) tension between the limited resources in real life and the limitless digital supply
Some forms can be done anywhere, others may require you to be in a place with particular equipment	Some forms can be done anywhere, others may require you to be in a place with particular equipment	Moving between spaces - both real and virtual - becomes a central part of the play or learning
Widespread distribution of process or outputs is often difficult	Widespread distribution of process or outputs is easy	Widespread distribution of process or outputs is (normally) easy
Often benefits from collaboration, but collaboration may be difficult to organise	Often benefits from collaboration, and collaboration can be easier to organise	Often benefits from collaboration, and collaboration can be easier to organise
Sense of community with fellow makers is high if operating within a small area but lacking otherwise	Community of fellow makers widens up, is easy to organise and adds interest and motivation to the activity	Community of fellow makers is easy to organise and adds interest and motivation to the activity
Environmental impact: use of physical materials – impact may have small or large impact as new physical 'stuff' added to the world	Environmental impact: avoids creating new physical 'stuff' in the world, whilst impact of electricity consumption can be relatively small.	Environmental impact: varies according to activity, but hybrid activity offers opportunities to 'offload' the potential environmental impact in the digital rather than physical arena.
May involve more face-to-face social interaction	May involve less face-to-face social interaction (but more virtual interaction)	May involve interactions that are both physical and virtual - adding different dimensions to the experience

This table shows that the primary motivations for creativity remain similar regardless of context, but we can see that the key distinctive features about digital creativity are that

- **It is easy to collaborate and share;**
- **There can be a limitless supply of materials;**
- **It can be small and mobile;**



- **It may have lower environmental impact;**
- **It may involve less face-to-face social interaction.**

The notion of hybrid or mashup creativity adds a fruitful tension between real-life hands-on creativity and the less physical, often screen-based virtual worlds. We see that different situations – such as digital environments, or hybrid activities that bring together the physical and digital contexts – offer possibilities and qualities which can add to the creative experience. Ideally, the fascination of linking together the online and the offline should be a powerful engine for prompting the ideal ‘Flow’ experience of creative engagement.

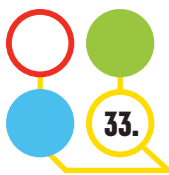
It is also worth highlighting the environmental affordances of a hybrid experience. Small things can be made physically, but when they need to be multiplied or scaled up, the digital dimension can take over, relieving the environmental impact. Similarly, large real objects or environments can be created digitally, but new interfaces mean that our environments remain physically engaging although we do not need to materially construct the things we manipulate or walk around in.

The comparison of non-digital with digital does not necessarily show that online activity is ‘better’ or is always more convenient. Some forms of collaboration are easier in virtual worlds, but others are easier in physical worlds. If our task is to, say, collaboratively build a LEGO® castle, it is easier to do this with physical building bricks. In many cases, collaborating on a design project in real-time is often easier in the physical world, but sharing the results of design activities is easier in virtual worlds. Again, this observation suggests that hybrid activities, which combine the best of both worlds, would be an avenue rich in unexplored possibilities.

The most powerful argument for digital or hybrid forms of creativity lies in the power of the online network for sharing and collaboration. Of course, object and content, activities and forms of creativity can be digital without having anything to do with the Internet. However, an especially potent aspect of creativity in the digital realm is its potential on the network (Anderson, 2006).³¹ Web 2.0 has shown us that as contributions become more powerful, the more they embrace the network. Tim O’Reilly’s (2006) four levels of ‘Web 2.0-ness’ neatly illustrates this³². The contributions that could only exist on a network, such as Wikipedia inevitably seem far more powerful than contributions that happen to be published on the Internet but don’t really make use of the network, such as ‘brochure’ websites, which could be distributed on a CD and not lose anything. (In O’Reilly’s hierarchy, a ‘level three’ application could ‘only exist on the net, and draws its essential power from the network and the connections it makes possible between people or applications’, whereas a ‘level zero’ application ‘has primarily taken hold online, but it would work just as well offline if you had all the data in a local cache’. Levels one and two are mid-points in between).

31. Anderson, Chris (2006), *The Long Tail: How Endless Choice is Creating Unlimited Demand*, London: Random House Business Books.

32. O’Reilly, Tim (2006), ‘Levels of the Game: The Hierarchy of Web 2.0 Applications’, 17 July 2006, <http://radar.oreilly.com/2006/07/levels-of-the-game-the-hierarc.htm>



Importantly, we should aspire to a fifth level, where a powerful collaborative interface between the physical and the digital - which may not have been invented yet - adds a level of interactivity which goes beyond the Wikipedia model, to enable people to come together using a combination of physical tools and environments and digital tools and environments to create new ideas, art, play, and knowledge.

Core study example: YouTube as archetype of the digital creative platform

Web 2.0 applications which foster digital creativity are often broad platforms, rather than specific tools. They do not assert a preference for particular forms, topics, or styles of content, encouraging users to express their creativity in whatever way they choose – within a particular framework, and general type of content. The video-sharing site YouTube is one of the most well-established of these platforms, so it is worth considering some of its characteristics, and some of the associated research.

YouTube is perhaps unusual in that the core content, the videos themselves, cannot usually or satisfactorily be produced by direct input into an online device. Unlike a blog, for instance, which can be immediately contributed to by typing on a keyboard and hitting 'publish', YouTube contributions usually require more work – most often recording using a digital video camera, followed by some editing – before the work can be uploaded. (This is not always the case – some laptops and phones can record video material and publish it to YouTube immediately, although such contributions are lo-fi even by YouTube standards). Apart from this caveat, however, YouTube is an archetypal digital creative platform.

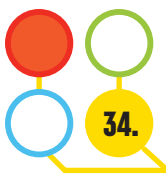
There are three principles which underpin the YouTube platform and drive its success:

1: A framework for participation

YouTube offers a framework for participation. The key element here is the invitation to users to upload their own videos under 10 minutes in duration. Thus, some aspects are set or closed: it's primarily a place for videos, and in particular, short videos. Everything else is open. YouTube has grown into a home for poets, engineers, medics, teachers, and a multitude of others, and the content has blossomed into an incredible array of material and topics in diverse styles, including performance, education, video journals, sport, technology, family life, and how-to guides and discussions on everything from car maintenance to breast-feeding. Summarising the variety is almost impossible. Although it only launched in 2005, in October 2009 YouTube was able to announce that more than 1 billion videos are viewed day, and hundreds of thousands of videos are uploaded by users daily (Helft, 2009)³³.

This highlights the sense in which YouTube is in a sense, just, a platform for creativity. In an unglamorous formulation, it is a database website, which invites people to add data as files, comments, tags, and links between different bits of information (notably user pro

33. Helft, Miguel (2009), 'YouTube: We're Bigger Than You Thought', The New York Times, 9 October 2009, <http://bits.blogs.nytimes.com/2009/10/09/youtube-were-bigger-than-you-thought/>, and hundreds of thousands of videos are uploaded by users daily YouTube (2009), 'YouTube Fact Sheet', http://www.youtube.com/t/fact_sheet.



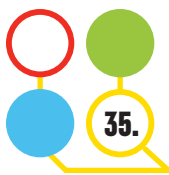
files and video content). Without the responses of users to this open invitation, YouTube would be nothing – there would literally be almost nothing there. YouTube could solicit material from existing media companies – as it does, forming partnerships with numerous well-established corporations – but there is much evidence that YouTube's huge popularity, and dominance in the online video field is due to its emphasis on establishing its framework as one which primarily supports a community of participation and communication amongst everyday users, rather than elite professionals.

2: Agnostic about content

Within this framework, YouTube is entirely agnostic about what contributions can be made (apart from some precautions about offensive or abusive material). The platform is presented, but the opportunities for innovation in content are left open to the users. Some people have used it in ways that mimic established forms or styles, such as the music video, the interview, the comedy sketch, or the product review 'show'. A number of these individuals aspired to enter the mainstream media, and some have done so when their YouTube popularity has brought them to the attention of the traditional industry³⁴. Other contributors, however, are entirely unconcerned about reaching a broad audience. Some use it to share family videos with friends and relatives. Some create what Patricia Lange (2009) has called 'videos of affinity,' which are simply-produced recordings, with little or no postproduction, created purely to connect with a community of friends and acquaintances³⁵.

YouTube videos are not typically the equivalent of a telephone call, of course: a lot of material is made with a great deal of creativity, care and/or ingenuity by users who hope to entertain their friends and also, potentially, attract a wider audience. The press coverage of copyright and piracy issues can lead to the assumption that a majority of the videos on YouTube are clips copied from mainstream media – or put there by professional producers themselves, in a bid to assert control. However, a content analysis of 4,320 popular videos conducted by Jean Burgess and Joshua Green in 2007, found that only 42 per cent of these came from mainstream, broadcast, or established media, whilst just over 50 per cent were original user-created videos.³⁶

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34. Burgess, Jean, & Green, Joshua (2009b), 'The Entrepreneurial Vlogger: Participatory Culture Beyond the Professional–Amateur Divide', in Snickars, Pelle, & Vonderau, Patrick, eds, *The YouTube Reader*, Stockholm: National Library of Sweden.
 35. Lange, Patricia G. (2009), 'Videos of Affinity on YouTube', in Snickars, Pelle, & Vonderau, Patrick, eds, *The YouTube Reader*, Stockholm: National Library of Sweden.
 36. Video blogs (vlogs) accounted for 40 per cent of this non-professional work, and other types of material included user-created music videos (15 per cent), live material such as music performance, sport, and 'slice of life' (13 per cent), non-fiction presentations such as news and reviews (10 per cent), and 'scripted material' – not necessarily scripted as such – such as comedy sketches, animation, and machinima [animation made using video games] (8 per cent). A further 10 per cent were experimental or technically playful videos, where users toyed with various effects.



As these statistics are based on observations of the YouTube site alone, they are not able to tell us the motivations of the creators. However, on the basis of the range of video types detailed in Burgess and Green's (2009) account³⁷, it seems reasonable to suggest that their makers wish to communicate and connect with an audience, often on an emotional or intimate level, to share their knowledge or insights, to entertain and – in a perfectly valid sense – to show off (and, in doing so, to try to connect or have an impact on others).

3: Fostering community

YouTube is more than a video archive; it is, and keenly positions itself as, a community. The tagline 'Broadcast Yourself' – which quickly replaced the original, less engaging slogan 'Your Digital Video Repository'³⁸, – points to the outward-facing, and possibly autobiographical, nature of the anticipated videos. However, YouTube's functionality encourages much more than mere individualised 'look at me' self-exhibition. It actively encourages users to make comments, to subscribe, to give star ratings, to add friends and send messages, and to make videos responding to other videos.

These are not – or certainly not entirely – tacked-on 'social networking' features. Rather, as Jean Burgess and Joshua Green have shown, the users who have managed to become 'YouTube stars' have done so by embracing the community, and by acting as community members themselves. Those video celebrities who have reached a point where they find work in mainstream media have risen to the top of YouTube visibility not by acting as aloof stars, but by being community participants. They invite and respond to comments on the site, make links with others, and refer to community comments, responses and events within the videos themselves. They are actively embedded within the user community.³⁹ By contrast, established stars who have become famous through traditional channels have often met with limited success on YouTube, as the community does not warm to their 'one-way conversation':⁴⁰ The traditional 'broadcast' style of celebrity does not work well in the interactive medium. As Burgess and Green put it⁴¹ 'However charming... or silly the content of their videos might be, what all the entrepreneurial YouTube stars have in common is the fit between their creative practice and the dynamics of YouTube as a platform for participatory culture'.⁴²

Engagement in the community is not just a route to online stardom, of course. Henry Jenkins (2009) suggests that YouTube offers 'strong social incentives' to make and share, and that users are inspired by 'the emotional support of a community eager to see their productions'.⁴³ There is also the gift-giving dimension to YouTube's community: users give and receive home-made video 'gifts' for reasons which are to do with feelings and

37. Burgess, Jean, & Green, Joshua, (2009a), *YouTube: Online Video and Participatory Culture*, Cambridge: Polity, p.38–57
38. Burgess & Green (2009a: 4).
39. Burgess, Jean, & Green, Joshua (2009b), *The Entrepreneurial Vlogger: Participatory Culture Beyond the Professional–Amateur Divide*, in Snickars, Pelle, & Vonderau, Patrick, eds, *The YouTube Reader*, Stockholm: National Library of Sweden.
40. Ibid.
41. Burgess, Jean, & Green, Joshua (2009b: 105).
42. Burgess, Jean & Green, Joshua (2009b: 105).
43. Jenkins, Henry (2009), 'What Happened Before YouTube', in Burgess, Jean, & Green, Joshua, (2009a), *YouTube: Online Video and Participatory Culture*, Cambridge: Polity, p.116

attachments, rather than economics. The notion of the gift economy helps us, in particular, to understand the rewards for participation – such as ‘status’, ‘prestige,’ or ‘esteem,’ which have no (immediate) economic value.⁴⁴

To conclude, YouTube is a platform which offers a framework for participation, but which is open to a very wide variety of uses and contributions. It is agnostic about the content, which means it has been adopted by a wide range of users for a diverse array of purposes. People use YouTube to communicate and connect, to share knowledge and skills, and to entertain. They use the community features of the site to support each other and engage in debates, and to generate the characteristics of a ‘gift economy’. Whilst it is true that the majority of visitors to YouTube are viewing, not producing and participating, there are still literally millions of users who engage with this creative platform every day, and whose relationship with professional media has been fundamentally shifted because of the knowledge that they can be the creators, and not just receivers, of inventive media. Furthermore, this audience of millions fuels creativity further as creations often take on a different meaning when shared with others.

The scientific and artistic dimensions of digital creativity

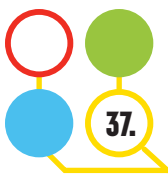
In the report, *Defining Systematic Creativity*,⁴⁵ we established that there are scientific and artistic systems of inquiry, which are equal in value, but are not always united. Systems of science channel creativity towards solving specific questions or problems, as in maths or engineering. Systems of art channel creativity into many different and unique expressions – giving form to our imagination, feelings and identities – as in music or sculpture. It was noted that in the world of physical play, the LEGO® System is one of the few systems capable of channeling both: ‘With LEGO bricks you can bridge a stream, or transport an apple from A to B (scientific creativity) or build a fantasy creature, spaceship or landscape; or, as in LEGO® Serious Play®, create metaphors to represent feelings or identities (artistic creativity)’.⁴⁶

It may be argued that digital environments enable a smoother interface between scientific and artistic creativity. YouTube, for instance – to take the above case study – requires users to engage in both technological and aesthetic challenges to produce and share a compelling video. There is the scientific aspect, which includes video production and postproduction, the choices to be made about video resolution, format and rendering, and the framing of the online presentation within different possible online categories, tags, and so on; and there is the artistic dimension, involving the style, composition,

44. See Jenkins, 2009: 120, and Hyde, Lewis (2007), *The Gift: How the Creative Spirit Transforms the World*, London: Canongate.

45. Ackermann, Edith; Gauntlett, David; & Weckstrom, Cecilia (2009), *Defining systematic creativity: explaining the nature of creativity and how the LEGO system of play relates to it*, Billund: LEGO® Learning Institute.

46. Ibid.



editing choices, music and sound design, humour and many other aspects. These are all quite complex scientific and artistic ‘problems’ – but they are overcome, enthusiastically, by users who have necessarily become comfortable with the diverse challenges of this everyday, popular branch of digital creativity.

Other digital and hybrid environments are similarly likely to unite scientific and artistic forms of creativity. Connecting with and exploring a digital or hybrid system typically requires the application of rational investigation and logical deduction, and often some ingenuity is needed to get a system to do what you intend (scientific creativity); whilst at the same time, to create new things and make your mark on a world, a different kind of orientation is necessary (artistic creativity). In fact, these challenges are not normally distinct; and a combination of scientific and artistic creativity is needed to gain mastery in a digital or hybrid environment.

Lever for designing creative tools and experiences in the digital realm

Prahalad and Ramaswamy (2004)⁴⁷ highlight a set of key principles, or ‘levers’, for innovating experiences. Interestingly, these levers offer a useful framework for defining pre-requisites for experiences that enable creativity in the digital realm. Increasingly, creative experiences in the digital realm can be seen as co-creation efforts, in that they involve a company, institution or individual orchestrating a project, platform or context where other users are invited in to either modify the experience itself or contribute content to the platform, which constitutes something of value to others, as seen in the above example on YouTube.

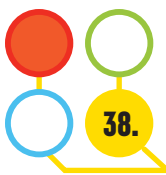
The social dynamic of the digital realm works as a multiplier or accelerator of creativity, both in that it is changing how we may typically go about a creative activity (building on top, modifying, hacking, mashing-up as opposed to starting from scratch) as well as why we might be intrigued to continue our creative exploration (the comments and attention of an audience, derivative works, being part of something bigger). Thus the notion of collaborative creativity and the dynamics of co-creation become essential elements of enabling creativity in the digital realm:

Granularity

Prahalad and Ramaswamy explain that ‘granularity is about giving [individuals] the ability to interact with an experience at any desired level of specificity, immersing herself in the experiences over time in whatever way she chooses. From a company’s perspective, it is the ability to design an experience environment based on events such that the user interactions can occur at different levels of aggregation and richness’⁴⁸. From a creative standpoint, this is essential, as systems and tools encouraging creative exploration must invite users to experiment as well as offering a compelling enough set of tools to capture

47. Prahalad, C.K & Ramaswamy, Venkat (2004). *The Future of Competition - Co-creating Value with Customers*. Boston, MA, Harvard Business School Press.

48. Ibid.



the imagination over time as users become more sophisticated in their contributions. Importantly, making it possible for users to enter the creative activity at their own desired level of granularity is key.

Extensibility

For Prahalad and Ramaswamy, 'extensibility involves exploring how technologies, channels, or modes of delivery, can allow [users] to experience established functions in new ways, as well as create entirely new functionalities themselves'.⁴⁹ YouTube is a fitting example in that it enables a wide variety of themes and content; by opening up its channels, users can embed content on websites as well as experience this content online, on mobile platforms and so on. This line also hints at the importance of open source and platforms, the power of APIs to extend the experience, encouraging mash-ups and novel combinations of media.

Linkage

Prahalad and Ramaswamy state that 'linkage is the recognition that events connect in multiple ways from a [user's] point of view. Therefore, a collection of related events, and not just a single event, affects the quality of the co-creation experience'.⁵⁰ In the physical realm this element is intuitively taken care of by the enduring nature of many creations in this environment, but in the digital realm this element is a crucial component enabling users to return to something previously created, modify or share it with others, or indeed use it as a template to engage in an entirely new creative exploration. A pre-requisite for the 'super-charging' effect of the social dimension, novel ways of linking to both the creation and the experience of creation sustain interest and encourage communities to thrive.

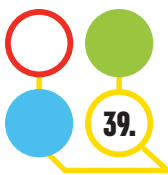
Evolvability

Prahalad and Ramaswamy's concept of evolvability 'involves capturing the learning from co-creation experiences and using it to develop experience environments that shape themselves to [user's] needs and preferences, not the other way around'.⁵¹ Similarly, as tools for making music, desktop publishing, video editing and so on are continuously evolving towards more sophisticated forms of creative tools, while simultaneously becoming (hopefully!) more userfriendly, the other dimension to this is the capacity of a creative tool or experience to remain relevant and a compelling medium for different kinds of creative projects, or indeed for evolving levels of skill or imagination in the kinds of creations possible. Many creative tools in the physical realm enable mastery whilst also being easy to pick up, and similarly in the digital realm, some of the most compelling creative tools are those that enable mastery at a high level, while maintaining a low threshold for entry.

49. Ibid. P.64.

50. Ibid. P.65.

51. Ibid. P.66.



The potential of digital technologies to support creativity and learning

Digital technologies exhibit specific technical features that enable users to do things, that could not be done as efficiently, or at all, using different tools or media. Features include provisionality or an experimental nature, interactivity, capacity, automatic functions range and speed (DEE, 1998).⁵² In what follows, we look at each feature in terms of what they offer for users. In other words, we translate functionalities into affordances, or 'psychological relevance' for users. Doing so helps pin-down the potential of digital technologies to support human creativity,

- The *provisionality* of Information and Communication Technologies (ICT) enables users to make changes, try out alternatives, and keep a 'trace' of developing ideas. The psychological relevance of this lies in knowing that you can undo a move or revert to earlier versions, which works as a huge incentive to trying out new things. Provisionality gives permission to be creative by allowing users to recover from mistakes. Its psychological equivalent is 'forgiveness', a quality characteristic of transitional objects⁵³, as defined by Winnicott (1971)⁵⁴.
- *Interactivity* is about providing immediate feedback to users. While essential, feedback per se is not necessarily psychologically relevant. The question is: what type of feedback, or guidance, and when? As we know, even the right feedback at a wrong time can knock a person off track. Its psychological equivalent is 'responsiveness'.
- ICTs demonstrate capacity in the ways they provide access to vast amounts of information locally and globally, in different time zones and geographical places. More importantly, capacity is about knowing not only how, but also why and when certain skills might be appropriate in different contexts to solve different problems. Its psychological equivalent is 'context sensitivity'.
- The automatic functions of ICT allow the storing, transforming and displaying of information to be carried out by a system, thus enabling users to read, observe, interrogate, interpret, analyse and synthesise information at higher levels. Its psychological equivalent is 'smarts' (intelligence). When it comes to learning and innovation, however, it's often less about building smart systems (as in AI) than it is about building systems that make us smart.
- The speed and range of digital technology enable users to communicate and collaborate in immediate and dynamic ways during the creative process. Its psychological relevance is to favour 'connectivity on demand' in ways that are smooth and fast. Its psychological equivalent is that of the facilitator-mediator or matchmaker.

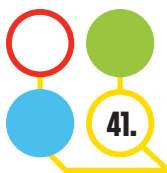
52. Ref: Department for Education and Employment(1998). *Teaching: High Status, High Standards. Requirements for the Courses of Initial Teacher Training*. Circular 4/98. London: DfEE

53. Transitional objects, in Winnicott's sense, are security blankets or comfort objects, such as teddy or a ragged doll that the child carries along, and clings to, especially when moving into unknown territory. Their role is to be resilient enough to 'hold' a child's treatment and be there for them, no matter what. The child can love and hate them, and love them again in their play. Transitional objects are there to survive bad as well as good treatment. They are both malleable and stable, affectively speaking.

54. Winnicott, Donald.W. (1971). *Playing and reality*. London and Paris. Routledge.



Therefore digital technologies cannot of course generate creativity but they can support creative activity and, through connecting us with other creative work, inspire us to take more imaginative steps and bolder leaps. The digital realm fosters play and learning, as discussed in the previous and following chapters, and both of these feed into creativity and help it to take flight. Digital technologies can provide the framework within which creativity can be expressed and developed, and connect this with a community of practice, where the enthusiasm and engagement of others gives creativity and innovation a real push. The artistic and scientific dimensions of creativity can find unity in the digital realm, where an engagement with aesthetics and computing go hand in hand. Most importantly, creativity in all its aspects can reach its full potential when the digital and physical worlds are connected in innovative ways. The choice between online and offline versions of an activity is a false one: the real opportunity lies in connecting the two.



Chapter 4: Learning in the Digital Realm

○ The rise of the knowledge economy and creative society

From the increasing connectivity and the growth of the knowledge economy to the globalisation of markets, the world in which children are growing up is undergoing a profound transformation. Cultural traditions, social symbols and institutions of authority are losing their significance and the family, school, company and parliamentary forums, all long-standing reference points, are being called into question, reformed and reinvented.

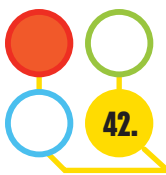
Four simultaneous and powerful societal shifts are currently under way that will give rise to more variety and interdependence:

- **from the uniformity of the mass era to the uniqueness and creativity of a knowledge economy and society.**
- **from rigid and isolated to flexible, open and rule-based markets.**
- **from predominantly agricultural structures to industrial urbanisation.**
- **lastly, from a relatively fragmented world of autonomous societies and regions to the dense interdependencies of an integrated planet.⁵⁵**

These changes result in a more complex place to produce, consume and live than yesterday's industrial society. The key to thriving in the knowledge economy is the capacity to keep learning, produce living knowledge, collaborate and be creative. As mentioned earlier, creativity is the ability to create ideas and things that are new, surprising, and valuable. Systematic creativity is a particular form of creativity that combines logic and reasoning with playfulness and imagination. Creativity, and systematic creativity in particular is important in many different types of activities and disciplines – art, science, design, and engineering⁵⁶ – and will be even more so as the powerful societal transformations driving the growth of the knowledge economy gather further momentum.

55. *The Creative Society of the 21st Century*, OECD, Paris, 2000.

56. Ackermann, Edith; Gauntlett, David and Weckstrom, Cecilia (2008): *Defining Systematic Creativity*, Billund, LEGO® Learning Institute.

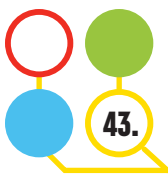


The changing nature of childhood

In many parts of the world, the impact of digital media on education has been one of the key issues in public debate and policymaking over the last two decades. However, little has been made of the challenges posed to education by the preferred modes of engagement and the more varied and often advanced communicative skills and creative media practices developed by young people in their leisure time.

The six related areas mentioned earlier in Chapter 1 pinpoint where the most significant changes are in contrast to previous generations and which provide insights into the 21st century skills a child needs to master in order to thrive and succeed. Each area constitutes a dimension that, together with others, informs how children of today play, learn and create and is a core generational trait that runs across most research findings (Jim Gee, 2009). The dimensions are:

- 1. Sharism - new ways of relating.** A growing precedence of co-creation over individual construction, of 'information brokerage' over personal elaboration.
 - 2. Shifting identities - new ways of being.** Shifting boundaries between what's perceived as me (private) and not-me (public), between where I/mine ends and where you/yours begins, between what gets incorporated (taken in) and projected out (object-ified, seen as 'other').
 - 3. Border-crossing – new ways of moving between worlds.** Moving between physical and digital realms. Expanding territorial borders.
 - 4. Literacies beyond print – new ways of authoring and expression.** Deep changes in what it means to be literate, and as a way of consequence, a literate thinker. From write to notate to annotate, from research to search.
 - 5. A culture of gaming – or 'simuling' – new ways of playing it safe.** A growing expectation that the tools at hand and the worlds to dwell in be responsive and forgiving, and that they let you experience things in their 'unreality' and take risks safely (you are always given a second chance!)
 - 6. A culture of bricoleurs, makers, hackers, and hobbyists – new relationships with things.** New ways of authoring content and making things, of making content and objects 'do things', and of repurposing, recycling, and trading them.
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The changing nature of learning

James Paul Gee (2008) succinctly illustrates the changing nature of contemporary learning theory:

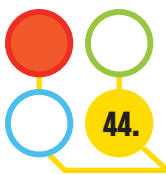
Earlier learning theory argued that the mind works like a calculating device, something like a digital computer. On this view, humans think and learn by manipulating abstract symbols via logiclike rules. Newer work, however argues that people primarily think and learn through experiences they have had, not through abstract calculations and generalisations. People store these experiences in memory [...] and use them to run simulations in their minds to prepare for problem solving in new situations. These simulations help them form hypotheses about how to proceed in the new situation based on past experiences.

Gee⁵⁸ continues with a set of conditions that experiences have to meet to be truly useful for learning:

1. **Goals:** Experiences are most useful for future problem-solving if they are structured by specific goals. Humans mostly recall their experiences in terms of goals, and how these goals did or did not work out.
2. **Reflection:** For experiences to be useful for future problem-solving, they have to be revisited and interpreted.
3. **Interpreting experience means thinking – in action and after action –** about how our goals relate to what we achieve in situation. It means, as well, extracting lessons learned and anticipating when and where those lessons might be useful.
4. **Feedback:** People learn best from their experiences when they get immediate feedback during those experiences so that they can recognise and assess their errors and see where their expectations have failed. It is important that they are encouraged to explain their errors and why their expectations failed, along with what they could have done differently.
5. **Opportunities:** Learners need ample opportunities to apply previous experiences – as interpreted – to similar new situations, so they can ‘debug’ and improve their interpretations of these experiences, gradually generalising them beyond specific contexts.
6. **Learn from others:** Learners need to learn from the interpreted experiences and explanations of other people, including peers and more expert people. Social interaction, discussion, and sharing with peers, as well as mentoring from caring and knowledgeable others, are important. Debriefing after an experience – that is, talking about why and how things worked in the accomplishment of goals – is important.

57. Salen, Katie, ed. (2008). *The Ecology of Games: Connecting Youth, Games and Learning*. MacArthur Foundation Series on Digital Media and Learning. Cambridge, Boston, MIT Press.

58. Ibid. P. 21-22.



Kirsten Drotner (2008) argues that young people's digital practices promote the formation of competencies that are vital to their future, in an economic, social and cultural sense.⁵⁹ Although young people are often amateurs in their digital pursuits, their engagement follows closely the conditions that Gee highlights above. The forms of knowledge that they use and develop through their spontaneous digital practices focus on the learning process rather than the resulting knowledge; they prioritise concrete issues over abstract concepts, experiences over facts and immediacy over delayed results. They are also often motivated more by the sharing of personal problems than by the unravelling of wider social issues.

Recent learning theories rightly stress that while we learn on an individual basis, the learning process needs others in order to materialise. Creating and using content to invite others into dialogue and reflection are ways of creating meaning. Young people's recombinations of image, music, and text or indeed LEGO® bricks and models also nurture nonlinear forms of learning, where they move between rule acquisition and rule modification, between the familiar and the foreign. Making something provides young users with immediate opportunities to reflect on the choices they make. This does not mean that they sit down and deliberate about these choices: rather, they intuitively modify their practices and often share good hints on best practice with their friends. All in all, this is rather different to the processes of learning found in most classrooms. Through engagements with digital media in their leisure time, young people experience the fact that learning can be driven by curiosity, which serves to overcome set-backs and frustrations; it can be a playful process of training and breaking rules and conventions, and its results can be immediately shared and appreciated by peers. Thus the role of the teacher is changing from the sole provider of knowledge to the facilitator: providing contexts for self-directed learning to occur, igniting passion in children to use their creativity to explore and lastly, supporting critical thinking, reflection and connecting of learning to an expanded context.

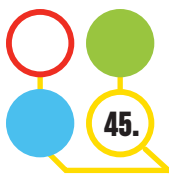
The community of practice as a learning environment

Along similar lines, researchers Jean Lave and Etienne Wenger (1991) stress the importance of informal learning as a process that is situated within 'communities of practice'. Their account draws on the traditions of apprenticeship, where the gradual acquisition of skills learned by emulating the masters was the entry point to social acceptance at the centre of a professional⁶⁰ group.

The epistemic frame hypothesis, as developed by Shaffer et al., further suggests that any community of practice whether children or adults, digital or analogue, forms a culture, and that any culture has a distinctive grammar, or structure, composed of:

59. Drotner, Kirsten. *Leisure is Hard Work: Digital Practices and Future Competencies*. *Youth, Identity and Digital Media*. Edited by David Buckingham. The MacArthur Foundation Series on Digital Media and Learning. Cambridge, MA: The MIT Press, 2008. 167-184.

60. Lave, J; Wenger, E (1991). *Situated Learning, Legitimate Peripheral participation*. Cambridge, UK, Cambridge University Press.



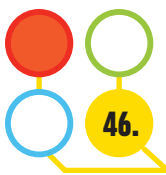
- **Skills:** the things that people within the community do
- **Knowledge:** the understandings that people in a community share
- **Identity:** the ways that members of the community see themselves
- **Values:** the beliefs that members of the community holds
- **Epistemology:** the warrants that justify actions or claims as legitimate within the community.

This ensemble of skills, knowledge, identity, values and epistemology forms the grammar of the community, and the epistemic frame hypothesis claims that:

- An epistemic framework binds together skills, knowledge, identity, values, and epistemology that one takes on as a member of a community of practice (in other words, the grammar that defines a culture is a tightly knitted whole that cannot easily be broken down and re-assembled).
- Such a frame is internalised through the training and induction process by which an individual becomes a member of a community (in other words, it is through affiliation that grammars get internalised. One doesn't just 'have skills').
- Once internalised, the epistemic frame of a community is used when an individual approaches a situation from the point of view (or in the role) of a member of a community (in other words, engineers act like engineers, identify themselves as engineers, are interested in engineering, and know about physics, chemistry and other technical fields. Social scientists act, think and mingle like social scientists, hobbyists like hobbyists, etc).

Each of these groups' skills, affiliations, habits and understandings are made possible by looking at the world in particular ways: by thinking like an 'X' (say a teacher, mathematician, or master builder). As students learn to see the world through the grammar of a particular community, their skills, knowledge, identity, values and epistemology become more closely tied together. The theory of learning behind this view looks not at isolated skills and knowledge, held by individual learners, but at the ways skills and knowledge are structurally linked to one another—and to the values, identity, and ways of making decisions and justifying actions — within given communities of practice. It is a situated approach.

Scholars have seen parallels to these learning routes in current game communities, and indeed computer games have been offered as one of the main alternatives to standard forms of learning, precisely because gaming is perceived to be in tune with future demands of collaboration, strategic thinking, and hit-and-run decision making. Despite gaming remaining the most gendered media practice among young people, Drotner highlights that the important challenge seems to be to develop inclusive contexts of



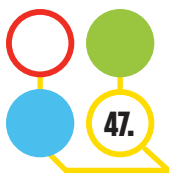
learning at school, contexts that balance dialogue and monologue, security and risk, communal and individual aspects of learning, rather than simply singling out specific genres or media as particularly relevant for innovative learning.

21st century literacies

In 'Confronting the Challenges of Participatory Culture: Media Education for the 21st Century' (2009), Jenkins offers a list of topics that, in his view, educators will have to incorporate in their teachings, to cater for young natives' potential and deliver on new 21st century media-related requirement.

- **Play** — The capacity to experiment with one's surroundings as a form of problem-solving.
- **Performance** — The ability to adopt alternative identities for the purpose of improvisation and discovery.
- **Simulation** — The ability to interpret and construct dynamic models of real-world processes.
- **Appropriation** — The ability to meaningfully sample and remix media content.
- **Multitasking** — The ability to scan one's environment and shift focus as needed to salient details.
- **Distributed Cognition** — The ability to interact meaningfully with tools that expand mental capacities.
- **Collective Intelligence** — The ability to pool knowledge and compare notes with others toward a common goal.
- **Judgment** — The ability to evaluate the reliability and credibility of different information sources.
- **Transmedia Navigation** — The ability to follow the flow of stories and information across multiple modalities.
- **Networking** — The ability to search for, synthesize, and disseminate information.
- **Negotiation** — The ability to travel across diverse communities, discerning and respecting multiple perspectives, and grasping and following alternative norms.

Jenkins's list of competences is at odds with what most of us have been taught in school, or would feel comfortable teaching. It comes as no surprise, then, that most educational initiatives intended for networked, participatory, collaborative knowledge creation and production are still found outside official channels. And while there are some exciting initiatives attempting to embrace these changes, bringing them wholeheartedly into the classroom requires a shift in mindset in parents, educators and policy-makers.



The future of learning

To educators, designing classroom activities almost demands that they break down complex problems into manageable bits, of increasing difficulty, and then scaffolds the path to learning so that students can get it step by step and then generalise to new contexts. At the same time, many teachers sense that they are loosing touch with what today's students like and are good at. To students (and many parents), on the other hand, the picture looks different. According to Kathleen Tyner (2009), at least in the US, we see the following trends.⁶¹

- Teens and their parents think the Internet is vital to completing school projects and has effectively replaced the library on many occasions (usually as a primary resource).
- Teens (78%), when on their own or in focus groups, will also tell you that their schools make poor use of online contents (Pew charitable trust, American life project).
- Even secondary and sometimes elementary school children and their parents apparently expect unrestricted, high-speed access to the net, the ability to upload and download content, and cross-platform access to open-source content.

This 'epistemic' shift in the culture as a whole contributes to what Jenkins (2006) refers to children's increased 'participatory knowledge creation and creative expression'.

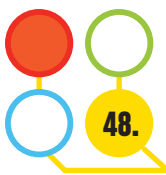
While schools may lag behind, much of the 'digital native' rhetoric also makes it seem as if all young people automatically have a deep understanding of (fluency with) media and computation. This is not always the case. Instead, there are things children are less interested in, or good at, such as being reflective, critical, smart listeners and managing levels of privacy. Below we provide a framework to help parents and educators identify children's strengths and weaknesses, support them in what they might miss out on, if left on their own.

The framework – Implications for the future of learning

In chapter 1, we identified 6 related areas where there is more to the argument than just another variation of the same old generational gap. In this chapter, we focus on the implications of these generational traits on learning and teaching. For each trait, we underline firstly the competences or habits of mind it breeds; secondly, what may be left out [what children may miss out on]; and lastly where today's children may benefit from being taught in engaging ways by caring adults [in order to leverage their potential].

Note that the focus here is less on projected 21st century outcomes than on emerging traits, or learning styles, as exhibited by natives as well as pro-ams, and participatory cultures, as defined by Gee and Jenkins.

61. Tyner, Kathleen (2009): *Audiences, Intertextuality, and New Media Literacy*, in *International Journal of Learning and Media*, Volume 1, Number 2, Cambridge, MA, MIT Press.



1. Sharism - Ways of relating - A growing precedence of co-creation over individual construction.

Upside (What children are good at): Sharism, as a genre of engagement, promotes a culture of participation, as defined by Gee and Jenkins. It leads to rapid exchanges of half-baked ideas among groups of accomplices on a continuous basis. It calls for open relations among trustworthy allies.

Downside (What children may miss out on): It may be hard, at times, to step back, reflect and mull over ideas privately — or to remain critical and stick to one's ideas, even if at odds, or in an 'adversarial' context. It may further be hard, especially for young children, to know whom to trust online.

Support: (How to leverage children's potential): Teach children to strike a balance between being in it together, creatively, happily, while, at the same time, staying reflective, critical, distanced. It's the balance between the two that matters.

2. Shifting identities - Ways of being - Shifting boundaries between what's me (private) and not-me (public), where I/mine ends and you/yours begins (skins, envelope are moving), what gets taken in and projected out.

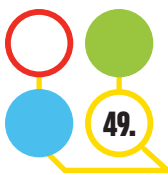
Upside: Fluid identities foster empathy, and switching roles fosters different perspectives, both of which are key to learning. Also, being able to explore different aspects of self through role-play is both profoundly liberating and an exercise in de-centering / re-centering.

Downside: May be hard, at times, to differentiate between what's me/mine and what's you/yours, and hold onto unique aspects of self that prevail over time. In other words, how can one strike a balance between fusion and separation?

Support: Teaching children to regulate their boundaries and remain centered offers a useful counterpoint to liquid selves. Furthermore, teaching children to keep track of who is doing what in collaborative adventures may help them acknowledge others in their differences—and come to know themselves in their uniqueness.

3. Border-crossings – Ways of moving – Seeing what's on the other side. Moving between physical and digital worlds.

Upside: Moving back and forth between worlds, swiftly (surfing, zapping) is useful to hold onto more than one thread at the time, to juggle multiple balls. Navigating unknown terrains and seeing what's beyond one's own backyard is at the core of



what it means to be intelligently connected to the world.

Downside: While moving on is important, feeling anchored also matters. The places we live in and the people we love are holding structures — and depositories— of our experience. These places don't have to be physical or immutable, but they have to let us in, make us feel 'at home'.

Support: Teaching natives new way to settle while on the go, dwell in places, or leave their marks in the spaces they traverse are all useful counterpoints to the thrills of being in constant motion.

4. Literacies beyond print – Ways of saying and conveying something – Deep changes in what it means to be literate, and as a consequence, a literate thinker.

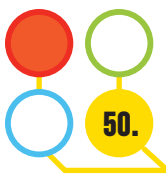
Upside: Children today speak 'in a hundred languages', blending image, sound and text. They chat online, write blogs, and 'text'. They think of writing as quick multi-media 'collages' (which they collectively create, circulate, layer, repurpose); They invent entire new genres of literacies, changing forever how we think about authoring or texts.

Downside: While software-based authoring and quick collaging are as legitimate as hand-writing or solo authoring, a big problem for educators today is to deal with what they perceive as 'plagiarism', students' tendencies to pick up, tag, and pass on fragments of ideas and creations along the pipeline. Indeed, you can't always digest stuff you just borrow and pass on.

Support: Teaching children to 'massage' inputs long enough to own them and, simultaneously, recognise and critically gauge sources is key. Just being a passer of information can't be transformative simply because it doesn't stay with you. Learning to express oneself within the constraints of a given medium (such as writing, film, or painting) with an appreciation of 'its' integrity/constraints may be a liberating exercise to today's children.

5. A culture of gaming – or 'simuling' – Ways of playing it safe. A growing expectation that the tools at hand be responsive and forgiving, that they let you explore things in their 'unreality' (as-if for good) and take risks safely (you are always given a second chance!)

Upside: Interactive environments such as games and simulations offer a rich avenue into systemic thinking, dynamic modeling, and complex problem-solving, most of which natives have become true masters at.



Downside: Not all games are social or enable players to create, tweak and evolve the worlds they dwell in. Games like the Sims have much in common with ‘microworlds’ as defined by Papert. Designed for others (users) to design in, they let you playfully explore options and come up with good moves. Other games can be drill-and-practice in disguise.

Support: Offer students engaging ‘epistemic games’. Have them also play different types of games, compare them, and explain why they like some better than others (more on this in next section)

6. A culture of bricoleurs (hackers, hobbyists) – New relationships with objects and concepts — New ways of making things, of making things ‘do things’, and of undoing, repurposing, mending, and trading things.

Upside: Today’s children know how to take apart, make, and fix objects. They also know how to program content and objects, make them ‘do things’ (or exhibit behaviors) and ‘talk to one another’ (communicate, give each other signals).

Downside: Digital technologies open up endless possibilities to breakdown objects into subparts and reassemble them in an attempt to curtail, or recuperate from this breakdown. Without a bricoleur’s mindset, i.e. a genuine desire to restore, recycle, repurpose, even ‘doers’ can feed a culture of consuming and disposing.

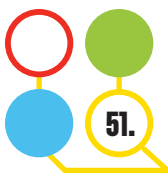
Support: Encourage a sense of ‘caring’ for things and places. Support a found-art approach that combines high-tech and low tech, and explores different ways of repurposing, recycling things. Cater for the ‘bricoleur’ in today’s natural hands-on culture.

To conclude, the genres of engagement that prevail among today’s students are not just about new media practices. Instead, they include new approaches to ‘writing’ or authoring (literacies beyond print) as well as new ways of controlling, sensing, and modeling the world (a culture of simulation, of makers and hobbyists). They also call for agency, mobility, and connectivity — both online and offline.

Guidelines for educators

How to align existing classroom practices and students’ preferences in ways that are beneficial to all? How to help teachers engage today’s children without abdicating their role as educators? Below, and to sum up, a list of 3 rules and 3 recommendations, based on Prensky’s (2005) advice to fellow teachers:





Rules:

- The edgeless school. Build bridges between students' interests and lives in-and-out of school, on- and -off line. Think of school as one place among others where students learn. Re-define its specific mission and responsibility. Embrace children's use of cell-phones, calculators, or computers in schools and rethink what you can do with them as a teacher. It is easier said than done but worth considering.
- New media, new contents: Resist using poorly designed education software that takes the form of an interactive version of schoolbook contents. Instead, start from what the students are interested in and capable of and offer useful hints on how to create variations around their passions in order to achieve 21st century learning goals.
- Becoming media literate: Don't force students into a single mode of sharing and reporting ideas, such as hand-writing, word processors, or even e-mailing, blogging, or 'texting.' Instead, help them explore and discuss — in class — some of the trade-offs of using synchronous vs. a-synchronous and text-based vs. speech-driven channels of interaction. Furthermore text—based versus speech-driven forms of interaction and the ephemeral versus permanent nature of creations and content.

Recommendations : Teach students to be creative and constructive AND reflective and critical.

1. From search to research: Today's students are master browsers and cut-and-pasters. They should also be encouraged to cross-check information, to consult multiple sources, and to read and cite original documents and sources. It is important for children to learn to form their own views on what they hear and read based on their experience, exchanges with others and that which is grounded in research. Young people increasingly see things available to them online as 'free' of ownership and cost. Teaching them how to acknowledge and rate sources is a first step toward web-based productions and research⁶².
2. From respond to own: Today's students are used to the twitch-speed, multi-tasking, active, connected, and quick-payoff world of their video games, MTV, and internet. What's mostly missing is the time to sit back and think (reflect) or, for that matter, to tinker long enough (i.e. mess around, re-write and re-purpose) in order to own (make yours) what they find and collect. Slowing down the pace of the creative process is important: let children mimic and pastiche,

but also give them a chance to iterate, revisit, and refine. Many children like to build and program things. Why not therefore create 'tinkering' studios from low-tech exhibits to robot competitions, where children can build on each other's ideas and then indulge in the art of crafting a quality version of their contributions.⁶³

3. What medium for what end? Today's students swiftly move between channels (they SMS, chat, write, blog), and they creatively use the tools' affordances. Educators can help youngsters appreciate and understand the trade-offs of using synchronous vs. a-synchronous / text-based vs. speech-driven / ephemeral vs. immutable channels of interaction. In 'a-synchronous' channels, like e-mail or blogs, only one of the communicating parties needs to be there at a time; the message is composed and sent at the writer's convenience, and read at the receivers'. This has advantages to anyone who needs to reflect before they write or answer. Email is children's 'reflective' form of communicating.⁶⁴ By contrast, in 'synchronous' channels, like phone, chat, instant messaging and 'texting', interactions are in real time and since texting is slow, children invent ways to speed it up. They'll write 'c' for see, 'u' for you, LOL=laugh out loud ; 'GGPOS' (gotta go parent over shoulder.) The only rule here is to be understood by one's friends. Children write to talk⁶⁵ and talk about how it feels, who prefers what, etc ⁶⁶. What's more, as students mingle online with people they may never meet, it is useful and important to find ways to evaluate whether to trust and believe them. Much has been done in the online world to allow this, and more still need to be done. One of the widely used ways of establishing reputation is through rating systems. If one buys or sells on eBay, you get to rate the opposing buyer and the seller on their promptness, honesty, efficiency. As one is evaluating others' behavior and content, one is also building up one's own reputation. By being honest, following norms, and being thoughtful in comments and posts, one builds up a positive online reputation.⁶⁷

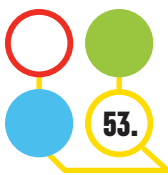
63. Prensky, 2001, p.5-6) and Prensky, M. (2001) 'Digital Natives, Digital Immigrants, Part II: Do They Really Think Differently? On the Horizon (NCB University Press, Vo 6, Dec. 2001)

64. Prensky, Marc (2004). *The emerging on-line life of the digital native*, p.3

65. Ibid. P. 13.

66. Ibid. p. 3-13.

67. Ibid. P. 8-9.

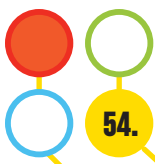


To conclude,

As Drotner underlines at the beginning of the chapter, in their leisure time many children and young people are already busily rehearsing for a future in which the handling of complex media is key. While this may be a good thing, at least to some, such rehearsals are also clearly at odds with today's teacher-centered educational systems, discipline based matters, textbook-based instruction, time schedules, and standardized testing.

Today, when students are motivated to learn something, they often have the tools to go further in their learning than ever before – sometimes beyond their teachers' ability and knowledge, and even beyond what adults could have done in the past. Children exploit this to the fullest, while ignoring, to an ever larger extent, the things they are not motivated to learn, which, unfortunately, includes most, if not all, of their schoolwork.

We need to be understanding and think about these coming-of-age behaviors on the web so we can help children navigate their new world while, at the same time, teaching them what's needed to grow and thrive in a world where agendas and 'genres of interaction' may clash. It is not enough to feel cosy with soulmates and peers. It is also important – and vitalizing - to learn to live at a crossroad between multiple cultures (new-comers vs old-timers, young vs. old, etc...).



Chapter 5: Connecting the Physical and Virtual Realms

Introduction

The affordances of current technology, the disagreement around its role and whether it has a positive or negative impact in the lives of children, are collectively limiting the discussion around how a reality, enhanced by the affordances of both the physical and virtual realms, may contribute positively to play, learning and creativity. From the ethnographic study⁶⁸ into the changing nature of children's play, it is obvious that children familiar with technology do not distinguish between the two realms; instead play moves seamlessly between the two.

A more useful starting point might be to delve deeper into the emerging field of embodied cognition, and how our ways of thinking are shaped by our bodily interactions within the physical world. Understanding embodied cognition may helpfully pave the way to fleshing out which elements or qualities to translate from the physical LEGO® System in Play into the digital realm for the purposes of play, learning and creativity and vice versa, how the digital realm may enrich existing LEGO play further.

What is embodied cognition?

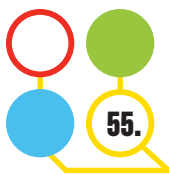
Human cognition emerges from the activity of billions of interconnected neurons in the brain, a biological machine the complexity of which dwarfs every man-made device. Traditionally, cognitive science has viewed the mind as an information processor, similar to a modern computer, which handles incoming information in more or less abstract ways.

In contrast, relatively little attention has been paid to the body and to the ways our thinking is affected by how we move about and act in the physical world. More recently, however, there has been a shift toward ideas of embodiment. The central idea behind the concept of embodied cognition is that intelligence emerges from our interaction with an environment and as a result of sensorimotor activity⁶⁹. As Clark (1998)⁷⁰ puts it: "Biological brains are first and foremost the control systems for biological bodies. Biological bodies move and act in rich real-world surroundings."

68. LEGO Group, The (2008). *Children' Digital World. Ethnographic study.* Billund..

69. Wilson, M. (2002). *Six views of embodied cognition.* *Psychon Bull Rev* 9, 625-36.

70. Clark, A. (1998). Embodied, situated, and distributed cognition. In *A companion to cognitive science* (eds. Bechtel, W & Graham, G), 506-517



While embodied views on human cognition have gained large popularity in recent years, they can be traced back to 19th century psychologists such as William James. In the 20th century, developmental psychologist Jean Piaget emphasized the emergence of cognitive abilities out of a set of early sensorimotor abilities, and the ecological psychology of J. J. Gibson viewed perception in terms of potential interactions with the environment.

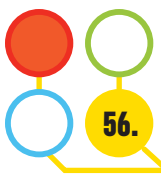
How do we know that human cognition is shaped by our motor actions and by our interactions with objects in the world? An illustrative example comes from a behavioural experiment by Ellis and Tucker.⁷¹ These authors showed that the way we represent everyday objects is influenced by how we interact with them. When we recognise an object, the brain seems to automatically activate the actions associated with that object. For example, when adults indicate whether common objects (e.g., a teapot, a frying pan) are upright or inverted, they react fastest when the response hand is the same as the hand that would be used to grasp the depicted object (e.g., the left hand if the teapot's handle is on the left). In other words, visual recognition and motor actions are intimately linked to each other, which even influences the way in which we use our memories.

A second line of evidence for the idea of embodied cognition comes from modern neuroscience. A large part of our brain, the so-called motor system, is involved in sending commands to the numerous muscles that make our bodies move. In monkeys, some neurons in those motor areas become highly active when the monkey grasps an object such as a cup.⁷² Most importantly, when the monkey only sees the cup without actually grasping and manipulating it, the very same neurons become active as well. Similar findings have been reported in humans who have undergone functional brain imaging while seeing pictures of everyday objects. In sum, both the human and the animal evidence shows that even when we do not engage in any motor action, the brain seems to automatically preactivate plans for potential motor actions upon merely seeing an object. This could be an important mechanism to make us ready for action in any given situation.

However, linking objects with potential actions is not the only way in which we can see embodied cognition in action. If the mind could only select from pre-existing actions when dealing with an object, this would be a major obstacle for creative processes. In this scenario, when being faced with a problem that calls for a creative solution, we would be limited to finding novel combinations of pre-existing actions or ideas, which has been termed combinational creativity. In contrast, more advanced forms of creativity that truly transform the way we see the world can only be achieved if we are not bound to use an object in predetermined ways. If there was a level of representation in addition to merely realistic object properties, we could be much more flexible in our thinking and come up with completely new solutions for a given problem. In support of this claim,

71. Ellis, R & Tucker, M. (2000). *Micro-affordance: the potentiation of components of action by seen objects*. *Br J Psychol* 91 (Pt 4), 451-71.

72. Rizzolatti, G & Fadiga, L. (1998). *Grasping objects and grasping action meanings: the dual role of monkey rostroventral premotor cortex (area F5)*. *Novartis Found Symp* 218, 81-95.



evidence is accumulating that the human brain entertains multiple representations of the world in parallel, and in some of them the objects are not tied to specific actions. Nevertheless, their richness and versatility is likely shaped by our physical interactions with them as we shall see in the following sections.

Five lessons from embodied cognition

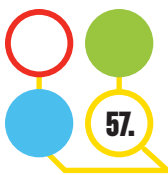
The close links between action, perception and cognition suggest that physical interaction with the world shapes the functioning of the human mind, which has far-reaching implications for the development of a growing child. The following sections provide evidence for this claim from five different vantage points:

1. Be spontaneous

Recent trends in artificial intelligence and robotics attest to the power of embodied cognition. For example, when programming a robot or some other intelligent device, it can be beneficial to mimic the way the human mind develops over time and to start off with a rather clean slate instead of implementing all the knowledge about potential learning tasks and goals in the program right from the start. Little children can discover both the tasks to be learned and the solution to those tasks through their own motor actions that do not even need to have a specific goal. Rather, spontaneous movement can create both the tasks and the opportunities for learning.

The power of movement as a means for exploration and learning is clearly illustrated by experiments in which young infants are placed on their backs with their ankles attached by a ribbon to an overhead mobile. As the infants kick their feet, at first spontaneously, they quickly learn the contingency between their foot kicks and the movements of the mobile. Importantly, the mobile moves in a way that is tightly coupled to the actions: The more the infants kick and the more vigorously they move, the more motion and sound they produce in the mobile. As they gradually discover the control of the mobile, infants initially explore of a wide variety of actions before selecting the optimal patterns to make the interesting events – the movements of the mobile – occur.

The most important lesson from these experiments is that the infants themselves discover the relations through their own exploratory movements. By moving contingently with the mobile, they produce complex and never exactly repeating events that are time-locked with the infants' own actions. Observing the correlations between their own actions and effects in the world enables them to understand



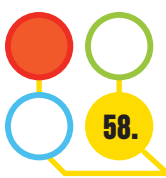
relationships that are only possible to discover by spontaneous action and physical interaction with an object. It is exploration, spontaneous movement that starts the process off. Without spontaneous movement and physical interaction with the mobile, there is nothing to learn from it. Playful exploration can help a child discover the relationships between novel motor actions and their effects on the physical, something that would not have been revealed had the child only carried out established action sequences.

2. Be multimodal

A key aspect of human cognition is that it usually involves multiple senses. In a typical everyday situation we experience the world simultaneously through vision, hearing, smell, touch, proprioception and even balance. Why do we need so many senses? One answer seems to lie in the concept of degeneracy. Degeneracy means that many cognitive processes can be carried out by multiple systems in the brain. This creates redundancy, because the system can function even when one component is lost. For example, because we encounter space through sight, sound, movement, and touch, we can know space even if we lack one modality. Being blind, for example, does not impair spatial abilities; instead, blind children and adults can learn spatial concepts from touch, they can form cognitive maps from body based cues during walking, they can excel in as mathematicians in geometry etc.

A very important benefit from having multimodal experiences is that our senses have the power to educate each other. For example, when we hold a toy made of LEGO® bricks in our hands, we do not only see the toy, but we also experience the weight of the toy, its feel and its solidity. Importantly, these multimodal experiences are time-locked. When we move the toy with our hands, changes in the way the hand feels are time-locked with the changes we see. This creates a powerful learning mechanism: activity in the haptic system of the brain is mapped to the visual system and vice versa. In other words, the two independent mappings of the stimulus – the feel and the sight – provide qualitatively different views on the world, and by being correlated in time, they educate each other. This mapping between vision and touch can enable the system to discover higher-order regularities that go beyond particular modalities.

Why is this mapping between the senses so important, and how does it help a growing child to understand the world? One particularly illustrative example comes from a study of how babies learn to understand transparency. Transparency is a difficult concept, because children need to understand that although they can see



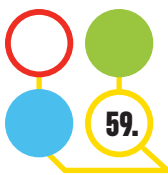
through a transparent surface such as a window, it is nevertheless solid. Diamond⁷³ demonstrated this problem by presenting infants with toys hidden under boxes such that there was an opening on one side. When the box was made of translucent material, 9-months old infants attempted to reach for the toy directly, through the transparent surface, rather than searching for the opening. However, when 8-months-old babies are given a set of transparent buckets to play with at home before being tested at 9 months of age, they will rapidly find the openings and retrieve the object from the transparent boxes. Why? In playing with the containers, which provides the time-locked inputs of seeing and touching, these babies learn to recognise the subtle visual cues that distinguish solid transparent surfaces from no surface at all. Moreover, they discover that surfaces with the visual properties of transparency are solid. So the haptic cues from touching the transparent surfaces educate vision, and vision educated reaching and touch, which ultimately enables the infant to find the openings in transparent containers. These results clearly show how infants' multimodal experiences in the world create knowledge, in this case about openings, object retrieval, and transparent surfaces.

To summarise, interacting with the world through multiple senses generates representations of the world and the objects therein that are rich and multifaceted. The richer these representations are, the easier it will be for us to imagine new ways to use an object or a material. In other words, learning through multiple senses can lay the foundation for our thinking to be flexible, which is an important prerequisite for creativity.

3. Reduce your workload

In the previous section, we have seen that bodily sensations such as those coming from the hands help us understand the world. While profound knowledge about the properties of the world facilitates further learning and creativity, there is another way in which embodied cognition supports both of them. When we are faced with a complex problem that calls for a creative solution, we need to focus as many cognitive resources as possible on the task at hand. Being able to achieve a high degree of concentration on the decisive elements of a problem is one of the characteristics of the so-called Flow state that people can experience when they are working on cutting-edge creative pursuits. However, cognitive limitations such as those of attention and working memory often stand in the way, so we need to reduce the cognitive workload. But can our bodies help us with this?

73. Diamond, A. (1990). *Developmental time course in human infants and infant monkeys and the neural basis of inhibitory control in reaching*. In *The development and neural bases of higher cognitive functions* (ed. Diamond, A), 637-676.



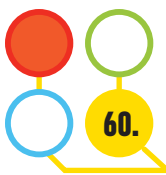
One answer to this question comes from the observation that we often make use of the environment in strategic ways. Rather than attempting to mentally store and manipulate all the relevant details about a situation or a problem, we often physically store and manipulate those details out in the world, in the very situation itself. This strategy can be called concrete offloading, because the objects used for offloading are also the ones we want to manipulate. For example, people often lay out the pieces of something that requires assembly in roughly the order and spatial relationships that they will have in the finished product, or they give directions for how to get somewhere by first turning one's self and the listener in the appropriate direction. The advantage is that actual, physical manipulations save us cognitive work, because we do not need to maintain a solution in our minds.

Although off-loading seems to apply most usefully to spatial tasks, potential uses are far broader than this. Actions such as diagramming or building models represent a different use of the environment, because the cognitive system uses external resources to achieve a solution whose actual application will occur at a later time and place, if at all. This type of off-loading has been termed symbolic off-loading, and it can be applied to spatial tasks, as in the case of arranging tokens on a board to represent the players of a football team. Alternatively, symbolic offloading can also support performance in nonspatial tasks. When the purpose of the activity is no longer directly linked to the situation, it also need not be directly linked to spatial problems. Rather, physical objects such as LEGO® bricks, and even the way we arrange them spatially, can be used to represent abstract, non-spatial domains of thought, for example the organisational structure of a large company. The success of LEGO Serious Play attests to the power behind this decoupling strategy.

Whatever type of offloading we use in a given situation, they all provide the benefit of freeing up cognitive resources that can then be used for other activities such as reasoning, problem solving etc. In addition, manipulating the environment in a strategic way often helps with dealing with very complex or abstract problems by providing information in a more holistic format. For example, when someone tells us about a difficult problem, we need to construct a mental model of this problem from serial input – the consecutive words and sentences the speaker has used. In contrast, building and finally seeing a physical model of the same problem provides us with an image that can be apprehended rapidly and intuitively, thanks to the highly parallel way in which our visual system processes information.

4. Learn from motor actions

Up to now, we have treated off-loading, whether concrete or symbolic, as something planned, something we deliberately use to reduce our workload. However,



through a transparent surface such as a window, it is nevertheless solid. Diamond⁷³ demonstrated this problem by presenting infants with toys hidden off-loading can also be seen in more automatic behaviours such as gesturing while speaking⁷⁴. Gesturing seems to serve important cognitive functions for the speaker, helping to grease the wheels of the thought process that the speaker is trying to express.

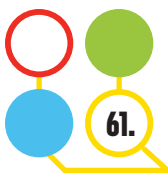
The gestures that we make while talking encode meaning differently from speech. Gestures convey an idea more holistically, whereas language is a serial process that requires a certain grammatical structure. As with deliberate offloading, automatic gestures that may or may not involve objects seem to lighten cognitive load, so learners can invest more resources in the task at hand. Interestingly, speakers gesture even when they know their gestures cannot be seen (i.e. congenitally blind speakers gesture when talking to blind listeners⁷⁵).

However, while we might intuitively think that gestures should help to convey the information we want to express with language, this is not always the case. Many experiments with children and adults have shown that there are certain situations when gestures and words are not in line with each other. How can this be, and what function does it serve?

Church and Goldin-Meadow⁷⁶ asked children whether the amount of water in two identical glasses was the same. Then they poured the water of one of the glasses into a low, wide dish and asked the same question again. Many children said that the amounts of water are initially the same but differ after the pouring. When asked to explain this answer, the children focused on the height of the water in both speech and gesture, saying the amount of water is different because one is tall and one is low, while using their hands to demonstrate the height of the water in the dish and then in the glass. So these children conveyed the same information in gesture and speech. However, other children gave the same explanation in speech but a different one with their gestures: They produced two-handed gestures representing the width of the dish, followed by a narrower one-handed gesture representing the width of the glass. These children obviously focused on width in gesture but on height in speech – they produced a gesture–speech mismatch.

Children who produce mismatches in this task have information relevant to solving the task at their fingertips. They have noticed (albeit unconsciously) that the dish is short and wide but the glass is tall and narrow, a crucial insight into conservation. Indeed, these children are particularly prone to learning, because when they are given instruction, they are more likely to make progress on the task than children who do not produce gesture-speech mismatches. This phenomenon is robust and has been demonstrated in learners of all ages on a wide variety of tasks. How do those mismatches facilitate learning?

73. Diamond, A. (1990). *Developmental time course in human infants and infant monkeys and the neural basis of inhibitory control in reaching*. In *The development and neural bases of higher cognitive functions* (ed. Diamond, A), 637-676.
74. Goldin-Meadow, S & Wagner, SM. (2005). *How our hands help us learn*. *Trends Cogn Sci* 9, 234-41.
75. Iverson, JM & Goldin-Meadow, S. (1998). *Why people gesture when they speak*. *Nature* 396, 228.
76. Church, RB & Goldin-Meadow, S. (1986). *The mismatch between gesture and speech as an index of transitional knowledge*. *Cognition* 23, 43-71.



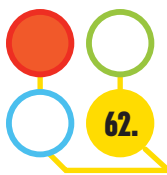
There are two ways in which children can learn from their gesture-speech mismatches. First, when they reveal information about their cognitive status through their gestures, others (i.e. parents or teachers) often glean information from those gestures and alter their input to the children accordingly. The children can benefit from this altered input: for example, teachers who watch children explain how they solve math problems pick up on information that their students produce in gesture and not in speech, often translating that information into their own speech⁷⁷. In addition, they give different types of instruction to children who produce mismatches than to children who produce only matches, and children who produce mismatches tend to learn better.

Importantly, these children do not simply learn because they are ready to do so, but it is the teachers' spontaneous adjustments that promote learning. In other words, children use their hands to reveal their cognitive state to their listeners who, in turn, use their hands to provide specific instructions that accelerate the learning process. This acceleration can happen in two ways: on the one hand, children can get direct info from the gestures per se; on the other hand they tend to imitate them, which lightens their cognitive load and hence frees up resources that can be used on the task at hand.

The second way in which gesture-speech mismatches can facilitate learning is by creating a state of cognitive uncertainty. Children who produce a mismatch are expressing two ideas – one in gesture and a different one in speech. What this means is that they have information in their repertoires that they know but cannot articulate. As a consequence, when children see their hands reveal an idea that is different from the one they expressed in speech, they can (i) get access to information that is inaccessible to conscious deliberation and (ii) experience a conflict that is key to further learning. The extant literature on learning without awareness has not only shown that we often express subconscious knowledge in our motor actions, but also that as soon as we become aware of a conflict between this knowledge and the one we can verbalise, we engage in explicit search processes to resolve that conflict and find the solution to a given problem.

Finally, while we have so far focused on gestures, which are rather automatic motor actions, we can also learn from motor actions that somebody else instructs us to perform. In a recent study, participants attempted to solve a classical insight problem while occasionally taking exercise breaks during which they moved their arms either in a manner that was related to the problem's solution or in a manner inconsistent with the solution⁷⁸. Although most of the participants were unaware of the relationship between their arm movement exercises and the problem-solving task, the participants who moved their arms in a manner that suggested the problem's solution were more likely to solve the problem than were those who moved their arms in other ways. Consistent with embodied theories of cognition, these findings show that along with the more automatic gestures, deliberate

77. Goldin-Meadow, S, Kim, S et al. (1999) *What the teacher's hands tell the student's mind about math*. *J Educ Psychol* 91, 720-730.
78. Thomas, LE & Lleras, A. (2009). *Swinging into thought: Directed movement guides insight in problem solving*. *Psychon Bull Rev* 16, 719-23.



actions can also influence our thinking and promote learning. An important implication of these findings is that we can obviously guide people toward insight by directing their motor actions.

5. Use a tool

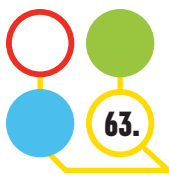
The previous sections have focused on how we interact with the physical world that surrounds us by using and manipulating objects in a direct way. For example, when children play with LEGO® bricks, they may manipulate the bricks to build objects, houses or creatures. However, they may also use LEGO materials in a more indirect way. By using pre-existing tools or even by making a new one from simple bricks they can often make certain actions easier (i.e. grasping a slippery object with pliers), they can achieve very complex goals (damming water to create a lake), or they can even find novel solutions to a problem that seemed absolutely intractable before. Interestingly, even though the ability to manufacture and use tools is not unique to humans, we create and transform our environment to a degree unparalleled in other animal species, which makes sophisticated tool use one of the features that makes us human.

While interacting manually with an object already poses considerable challenges for the motor system of our brain, tool use introduces a whole new set of difficulties.⁷⁹ To learn how to use a tool, the brain needs to associate an initial action on an object (i.e. grasp and hold pliers) with subsequent actions that the tool offers (e.g. grasp an object). Thus, when the use of a tool is learned, a distal goal is coded on top of a proximal one. This learning is made possible by the remarkable plasticity of the brain. For example, when monkeys learn how to use pliers, the pattern of activity in the motor system gradually changes, such that in the end the pliers are being treated as if they were an artificial hand.⁸⁰

When children want to use a tool they have never seen before, they need to master three essential challenges. First, they need to understand the causal relations between the tool's physical features and the outcomes of its use. For example, when using pliers, they must understand that closing the two handles of the pliers causes the front end to close as well, which can be exploited to grasp or crush an object. Second, they need to identify and master the tool's usage. This is not a trivial problem, because any tool can be operated in countless ways, and when children observe others use a given tool, their actions typically involve many elements that are irrelevant for creating the outcome. Finally, children need to identify the specific goals that can be achieved with their tool-using actions. While grasping with pliers usually works well if the target object is made of solid LEGO® bricks, pliers are less effective for grasping a scoop of whipped cream.

79. Hernik, M & Csibra, G. (2009). *Functional understanding facilitates learning about tools in human children*. *Curr Opin Neurobiol* 19, 34-8.

80. Umiltà, MA, Escola, L et al. (2008). *When pliers become fingers in the monkey motor system*. *Proc Natl Acad Sci U S A* 105, 2209-13.



How do children learn about the function of a tool they have never seen before? Two major strategies help them master this challenge. On the one hand, they reason to figure out what a tool is good for. Looking at a tool, grasping it with the hands and manipulating it in various ways reveals a tool's physical features and its overall appearance (i.e. shape, hardness, sharpness etc.), which often tells them a lot about its function. For instance, when crossing a narrow bridge fitted with either elastic or rigid handrails, children as young as 16 months take elasticity of the handrails into account and prefer the one with the rigid handrails.⁸⁰

Unfortunately, our modern culture contains many tools whose functions cannot easily be inferred from their appearance (i.e. a remote control). Understanding such tools is even more difficult for children, but by observing and imitating others when they use such tools, they gradually learn about their functions as well. The human brain possesses a specialized neural system – the so-called mirror neuron system⁸² – that is equally active when we perform a motor action, say grasping a cup, and when we see somebody else grasp that cup. This system is crucial for mapping the bodily motions of others onto our own body, which enables us to mimic actions and ultimately learn from imitation.

While learning about novel tools can be a difficult task for children and adults, manufacturing a new tool to solve a problem is even more challenging. Building a tool requires us not only to determine what parts we will need and how to assemble them in a systematic way, but primarily we need to imagine how its parts could act together, how they would react to manipulations by the user and how they would behave when getting in contact with other objects. While some people try to visualise such solutions whereas others use more analytical approaches, both strategies have in common that they can only be successful if we have a very detailed knowledge about the materials and objects that the tool will be made of. As we have seen earlier, it is learning about the world from multiple senses (i.e. via manual exploration) that helps us to create such rich and multifaceted object representations.

Summary

While generations of researchers have considered human cognition to be relatively independent from the body, converging evidence from psychology and neuroscience has made the scientific pendulum swing towards more embodied views. These theories emphasise that cognitive processes such as learning and memory are strongly influenced by the way we use our bodies to interact with the physical world. Importantly, the shaping of the mind by bodily actions and sensations starts from the very first moments of our lives and is hence crucial for the successful development of a growing child.

81. Berger, SE, Adolph, KE et al. (2005). *Out of the toolbox: toddlers differentiate wobbly and wooden handrails*. Child Dev 76, 1294-307.
82. Iacoboni, M. (2009). *Imitation, empathy, and mirror neurons*. Annu Rev Psychol 60, 653-70.



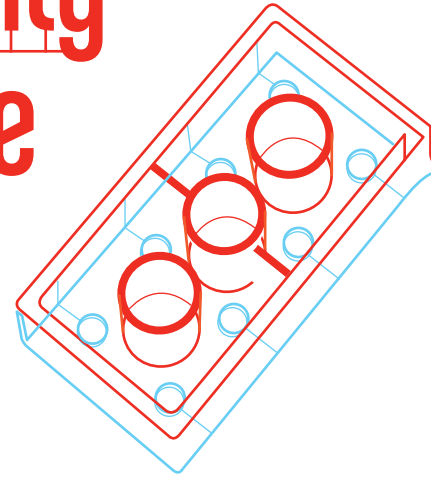
Making contact with the physical world by spontaneous, exploratory movements is one of the first ways in which babies learn about the effects their actions can have on the external world. Moreover, they can start to discover all kinds of properties an interesting object has, a process that goes on throughout our lives. When interacting with an object, i.e. when a child plays with a toy, involving multiple senses gives rise to rich and multifaceted representations. Such richness can open up infinite possibilities of how to use an object, because the more we know about it, the more ways we can imagine to use it. In other words, multimodal experiences can be a powerful tool for fostering creativity and to aid problem solving.

Learning and creativity reach optimal levels when we can focus all our cognitive resources on a given problem. Our motor actions help to achieve this state of mind, as we can offload cognitive work onto the environment. In addition, automatic motor actions such as our own gesturing or the gesturing of others can help us discover critical information that is not consciously available. In many situations, both gesturing and motor actions we are instructed to perform can tell us something we are not aware of, which can be the crucial bit of information to gain insight into a given problem.

Finally, motor actions that shape our thinking can also encompass the sophisticated use and manufacturing of tools, which is a uniquely human ability. For children to learn how to effectively use a novel tool they can use their multimodal experiences with the tool and they can imitate the tool-related actions of others. The latter is based on a specialised system in the brain, which provides us with a powerful mechanism to copy other's movements and hence extract meaning from a complex world.

In conclusion, while embodied views on human cognition would stress the importance of multimodal experiences for learning and development, the widespread intrusion of digital media into our daily lives can affect those experiences. Moreover, learning and creativity also benefit from social interactions and communication, both of which also change in the digital age. It will therefore be most important to determine the impact of these technological developments on the development and functioning of the human mind.

Chapter 6: Enabling Systematic Creativity and Learning in the Digital Realm

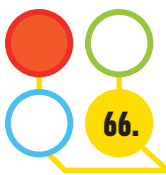


Introduction

Many toys and indeed online experiences support creativity by encouraging playfulness and imagination – clay for molding sculptures, crayons for drawing pictures. However, for experiences to support systematic creativity, they must also encourage logic and reasoning by:

- Providing logical and consistent constraints that children can understand and master.
- Offering a system of parts that children can combine (and recombine) in organized ways. By encouraging imagination and playfulness along with logic and reasoning, experiences, whether digital and/or physical, can provide both the structure and the freedom that children need for systematic creativity.

In this chapter we will draw upon the arguments established in previous chapters to highlight some of the essential qualities of systems and platforms to maximise opportunities for play, learning and creativity, and discuss how these function in the digital realm. Then we will go on to show how the values of systematic creativity, which lie at the heart of the LEGO® System, connect with play, learning and creativity in the digital realm.



The ten creative features of the LEGO® System, translated into the digital realm

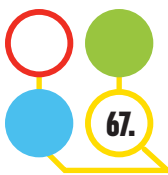
In the report *Defining Systematic Creativity*, we noted that the LEGO System embraces both the scientific and artistic kinds of creativity, enabling individuals to engage both of these modes of play and learning in an 'enriched dialogue'. In particular we listed ten features of LEGO which enable this dialogue to grow. Here they are listed with notes on how these features relate to the digital realm:

1. An interconnecting set of parts: connections come easily and sometimes in unexpected ways.

Much as LEGO bricks enable adhere to a common platform, yet enable endless combinations where the same parts can be used in many different ways – the challenge for the digital realm is to not only design for interconnection, but also for Linkage, enabling multiple creative experiences to connect over time and be modified, as physical bricks can be assembled, be played with, modified and re-assembled endlessly. A digital system should be equally transparent in that it should be easy to understand how things work, and what the consequences are for assembly and disassembly, but also make the most of the affordances in the digital realm by making it easy to record creations, create assembly instructions for them, share them with others and re-use them in a multitude of contexts, organised around the individual and not the Company.

2. A low entry level for skills: anyone can pick up LEGO bricks and make something satisfactory.

It is especially important that a digital system can provide the correct level of Granularity for users to engage at their level of specificity and complexity, making it easy to get started. The LEGO System in Play has building systems of varying complexity and age-related granularity: DUPLO® for toddlers, LEGO bricks for children 5 years and above, and TECHNIC® for ages 8 and above, as well as a proven system for age marking products and making it easy for users to determine the level of complexity of a LEGO model purely from the size of the box. In the digital realm this is harder to achieve, yet essential, as an off-putting beginning can mean that a 'Flow' experience can never be achieved. Any digital LEGO products should be as easy to pick up as the bricks themselves – complexity can follow later.



3. A medium for mastery: the system can be used to create both very simple and very complex constructions.

A digital LEGO System has to be easy to pick up but must also allow and enable complexity. Designing the system for Evolvability means that the experience should be able to evolve as users become more sophisticated in their creations, activating more detailed tools and functionality for creation and manipulation. In the physical realm, users attempt bigger models, more nuanced themes and subjects, more complex functionality or greater detail in their journey towards mastering the LEGO build system. In the digital realm meaningful dimensions need to exist for similar progress towards mastery. The balance of both a low threshold coupled with a high ceiling to provide scope for progression and mastery is essential.

4. The ability to create something where previously there was nothing – coupled with the lack of need for preparation and planning:

as they say in LEGO Serious Play, 'If you start building, it will come'. In the physical world, we playfully pick up pieces which 'happen to come to hand' and put them together to see if it seems to work, or if something interesting begins to appear. Choosing from an on-screen menu of parts could be more deliberative, less playful; therefore the design of a digital system should encourage 'random' combinations and serendipity, rather than forcing overly planned choices. A low entry level, along with consistent 'studs' and 'tubes' – the ways in which different components fit together are a prerequisite for this. The LEGO System encompasses over 7000 elements, yet users are not required to internalise each and every element in order to begin creating. The consistent and obvious way of connecting bricks enable an intuitive experience of assembling both familiar and previously unseen bricks. Similarly, in the digital realm, you must be able to 'throw things together' rather than having to plan the project first, encouraging experimentation on safe grounds and inventing new uses for familiar components. The key for the digital realm may in fact be the separation between the brick (as a volume) and its connectors, in that the content can be anything, as long as the means for 'connecting' the content is consistent.

5. An open system with infinite possibilities. It can grow in all directions and the parts can be combined in limitless ways.

Designing for Extensibility, making novel combinations, mashups, and sharing of content and creations possible, is a critical enabler of this. As discussed previously, the accelerator of infinite possibilities in the digital realm is the social dimension of online communities, thus an open system with infinite possibilities in the digital realm is closely tied to the ability of the platform to cater for community contributions and participation.



6. A belief in the potential of children and adults and their natural imagination – that anyone can make and express whatever they want to, through the system.

In addition to the 'low threshold and high ceiling' another equally important dimension is the 'wide walls' - supporting a wide range and diversity of creative exploration in a wide variety of styles. The natural imagination is very powerful and it is paramount that a digital LEGO® System should recognise this.

7. A belief in the value of creative play, and a respect for play as a powerful vehicle for learning and exploration.

LEGO play is playful learning, it is transformative in that it helps children of all ages to develop new ideas and see the world in new ways. Thus a LEGO System in the digital realm should enable playfulness and imagination to coexist with logic and reasoning, creating contexts for these to combine in pursuit of learning and exploration, alongside creative expression and play.

8. A supportive environment in which different ideas can be tried out and experimented with, with no negative consequences. On the contrary, it is common that one good idea leads to another.

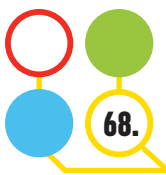
The system must be supportive and playful: it should be easy to try new things and there should be no way to make a mistake. This encourages play, exploration, tinkering and experimentation. Equally, users should be encouraged to take their time.

9. The LEGO System grows with the person, from the youngest child to the adult user

A digital LEGO System should appeal to quite young children and have the capacity to grow with the user and be appealing to adults. Alternatively, there could be different 'interconnected' digital offerings, as with DUPLO®, LEGO bricks and TECHNIC® and the move from one to the other should be seamless and intuitive.

10. The LEGO® System also grows beyond the person: at all levels of engagement with LEGO products, from DUPLO® to the world of the Adult Fan Of LEGO (AFOL), LEGO bricks are a social tool, fostering connection and collaboration.

A digital LEGO System should enable connections, interaction, collaboration, the giving of digital gifts, and connecting personal activity into a wider world of creativity.



Lessons for Design

The five lessons from embodied cognition outlined in chapter five pinpoint qualities of the physical LEGO System in Play that are essential for Systematic Creativity. These qualities are worth recapping and exploring in terms of their potential to enrich hybrid or digitally augmented play, combining the virtual and physical realms in an expanded play experience.

Supporting spontaneity

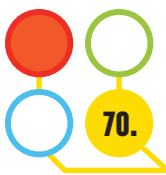
The examples in chapter five speak to the need of a system with an inherent logic, a set of constraints that can be grasped, yet able to support endless possibilities. Much like the inherent logic of LEGO bricks, the virtually limitless ways of combining the bricks point to their capacity to support spontaneous exploration of shapes, ideas, functionality and things. Similarly when thinking about digitally augmented play, learning or creativity, the underlying 'logic' needs to be obvious enough to enable the 'low threshold' or the right first step, while similarly making it possible to explore many themes, ideas or combinations with the same materials or tools (wide walls).

Supporting multimodality

The LEGO bricks themselves embody their functionality through distinct shapes, connectors, colour and weight, collectively engaging multiple senses when partaking in a building activity. This presents a strong argument for exploring creative materials that adhere to a system and have both a physical and digital manifestation, enriched by both. Equally, bricks and building tools in the virtual realm may benefit from closely mimicking physical attributes of bricks or exploring novel haptic interfaces that enable richer interaction and control than traditional mouse and keyboard control, as well as ways of engaging our other senses.

Supporting reduction of workload

The physical building experience of picking out elements and placing them somewhere visible, even before one needs the particular element is a concrete example of how we make use of the environment in strategic ways when building with LEGO bricks. This quality may be a useful to explore in the digital realm too, enabling organising, storing and sorting of components, tools or indeed ideas in ways familiar to the physical realm.



Equally, supporting the creation of models that represent abstract, non-spatial domains of thought - for instance the organisational structure of a company, is important to secure these in the digital realm in order to safeguard the full creative promise of the LEGO® System.

Supporting motor actions

Haptics (grabbing) and gesturing (waving, signaling) – and more generally hands-on, physical immersion and body language – are important in reducing our mental workload when expressing ourselves, and equally appears to play a role in learning. Gestures prove useful for more intuitive control of digital realms, augmented functionality or indeed for programming complex movement and behaviour and a way for younger children to understand and express their ideas or learning more readily. In a digital context, it would be worth while exploring the potential of interactive motion capture systems that allow for body movements to be mapped onto a virtual being, thus revealing the full spectrum of a child's movements to all the participants in the virtual world.

Supporting using a tool

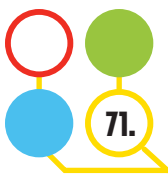
Tools are useful for expanding our reach, mediating our action, making certain actions simpler, achieving complex goals, or even finding novel solutions to seemingly intractable problems. Tools require not only learning to control them, but also learning what the tool is useful for. Thus supporting tool use involves both encouraging experimentation with the tool on safe grounds, as well as making the tool itself self-explanatory. In a LEGO® context an essential part of this is creating consistency between similar tools in the digital realm, making it easy to learn from others using the tool, to imitate their tool using actions and, wherever possible, to create links to what children may already be familiar with to make it easier to guess what a tool is and how it works.

While learning about tools can be difficult, manufacturing a new one to solve the problem is even more challenging. The LEGO System makes it relatively easy to assemble bricks in a systematic way as we are familiar with how the parts fit and act together, yet designing any kind of tool from scratch can only be successful if we have very detailed knowledge about the materials and objects the tool will be made of. The more we can enable multimodality, supporting gestures and indeed creating a close link to the behaviour of physical LEGO bricks, the greater the opportunity for children to not only be creative in their use of tools, but equally, enable the creation of new, surprising and valuable tools.

Lessons for designers

Designing for systems and platforms

Systems and platforms establish the framework in which creative activity can take place. It is not because digital creativity is associated with technology, and terms like 'computer



systems' and 'online platforms,' that we are discussing systems and platforms here. On the contrary, all forms of creativity are underpinned by some kind of system or platform. For example, oil painting is seen as a form of free expression – which it is – but it is an activity typically located on a canvas, of a particular size and shape chosen by the artist, and the oil paints have particular qualities which have a direct influence on both the production process and the outcome. To a significant extent, every oil painting is an exploration of what can be achieved within the limits of particular materials and tools. Similarly, most music is composed within the framework of an established musical culture, using particular instruments, sounds and notation which provide the system and the affordances which both enable and shape the end result.

Particular kinds of systems and platforms are therefore more or less likely to support opportunities for play, learning and creativity. The better ones will foster the relevant mindsets behind the process – curiosity, mental readiness, confidence, positive framing and commitment – so that it is possible for individuals to become self-directed in their learning and creativity, and more likely to achieve the 'Flow' state of intense, rewarding engagement⁸³. For this to happen, there should be a balance between challenge and ability, as well as between stability and change in order to create optimal conditions for self-directed learning and creativity. This is as true in the digital realm, of course, as everywhere else.

Designing for emotional well-being

The drivers behind play in the digital realm, friendship and interest-driven genres of engagement suggest that although the reason to engage in the digital realm may be friendship- or interest-driven, emotions are the ultimate reward for online participation.

The most coveted emotional responses, according to Castranova, are pride, curiosity, love, and feeling smart. Castranova goes as far as suggesting that people deliberately turn to computer games in order to produce the emotional high associated with accomplishing something concrete, feeling capable, and being recognised for their successes.

Clay Shirky(2008)⁸⁴ proposes three basic emotional motivations to contribute to a participatory system:

- a chance to exercise some unused mental capacities – the emotion of feeling smart.
- 'vanity' - the pleasure of changing something in the world, just to one's imprint on it.
- 'desire to do a good thing' – the most surprising, and the most obvious.

83. Ackermann, Edith; Gauntlett, David; & Weckstrom, Cecilia (2009), *Defining systematic creativity: explaining the nature of creativity and how the LEGO System of Play relates to it*, Billund: LEGO® Learning Institute.

84. Shirky, Clay (2008). *Here Comes Everybody- The power of organising without organisations*. London, Penguin.



Therefore we can see that enabling the formation of vibrant communities, around friendship or interest, or both - supporting the emotions of pride, curiosity, love and feeling smart as well as the above emotional motivations – are key to ensuring that the social dimension of online creativity can thrive.

If the platform had different qualities and restrictions, it would have consequences for the whole site, not just in terms of numbers of videos or views, but in the very character of the material and the community. If videos had to be between 10 and 20 minutes in length, or if they had to be animated, or if the site was inaccessible to users of certain equipment, or if 'Most discussed' was not one of the organising variables, any of these things would affect the nature of the 'invitation' to users to participate.

However, sites such as YouTube are not highly usable for younger children (such as those aged between 4 and 9 years). In chapter three we noted the concern that this group was well able to consume online content but lacked the child-friendly applications that would enable them to be 'writers' as well as 'readers'.

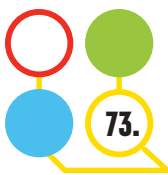
Designing for diverse players

We saw in chapter two that different systems and platforms are changing the nature of play. In particular, the 'hybrid' systems which enable play to cross between the digital and physical realms, and which support the desire to live out stories, add a new dimension to play and help to foster the sense of an 'always-on' playground.

We also saw that there are different modes of engagement with participatory systems, such as the 'achievement' orientation – also known as 'geeking out' (an intense and committed approach), the 'social' orientation – also known as 'hanging out' (a more relaxed and sociable or collaborative attitude), and the 'immersion' orientation – also known as 'messaging around' (a non-competitive mode of exploration). By enabling or discouraging different kinds of behaviour, systems will seem more or less appealing to different kinds of players. Significantly however, McGonigal argues persuasively that a functioning community needs all of these kinds of participants. Therefore consideration of all these orientations should be built into the design of systems and platforms.

Designing for learners

In chapter 4 we considered recent research which indicated that the way in which people think and learn is not through abstract calculation, but is based on experiences – things that have actually happened to them. The problem-solving simulations run by the brain are, perhaps unsurprisingly, remixed versions of what has happened to us before. This means that the traditional school learning methods, such as reading information from a



book, are limited in that they do not constitute a memorable experience. The focus on broad, general facts about the world can be equally disengaging, since young people prefer to connect with personal problems and personal solutions. These can then be linked to broader issues in a way which relates to the self and therefore has more meaning.

Young people learn, then, through experiences, and through activity and reflection on things that they can relate to. This is further enhanced when the learning takes place within a community of practice – that is, a group of people with a shared interest or passion, who encourage each other and help to develop the less experienced learners through the shared values, perspectives and enthusiasm which bind the community.

As we saw in chapter four, this kind of experience is especially powerful for learning when it involves goals, reflection, feedback from others, opportunities to apply previous experiences, and to learn from others. Importantly, this kind of learning doesn't have to happen in school – indeed, it more often happens through enthusiastic participation in online or offline communities of people with shared interests. Learning is then decoupled from school experiences, and perhaps one of the challenges we face in this century is to re-embed the passion for learning which can take place out of school back into the classroom context.

Supporting play, learning and creativity in the digital realm – the LEGO® way

'Digital' per se, we have seen, is not synonymous with enjoyable and rewarding play experience. Action at a distance and remote-control have been with us long before cyber-toys and electronic remotes filled our homes. What's new is the ways we can cross the lines between physical and virtual, between the embodied and dis-embodied. Beyond online games and virtual habitats, examples of rich crossovers include 'smart physical toys, location-based and mobile toys'.

'Smart physical toys': Tangible playthings with digital power!

What is unique about cyber-toys, especially as they become an integral part of children's lives, is that they open up an entirely new arena within which action at a distance and location-based relationships with intelligent artifacts (or things that do things) can be explored in a new light, thus changing the ways we act in the world, project what makes us human, and sustain relational bonds beyond borders. No doubt, the capabilities of today's digital 'automatons' are rapidly evolving—from being simply animated to becoming toy robots—and so is our relationship with them. The LEGO Group has pioneered this field through its MINDSTORMS® programmable robotic system adding behaviour, functionality and intelligence to the LEGO platform.



Location-based and mobile toys: Mobility and ubiquity at once.

As FutureLab has noted: The places and spaces in which we live, learn, work, relax and relate to others have many layers of meaning to us; in experience, perceptions, memories and meetings. In recent years, digital technologies have been developed, which bring together both physical and virtual experiences of space, affording new opportunities for exploration, play, reflection and encounters with others'. (Futurelab Series 2007. p. 8).⁸⁵

Mobile devices, such as cellphones, PDAs and GPS offer portability, social interactivity, context sensitivity, and connectivity, and can be used to capture, compose and communicate creative offerings to physical settings.⁸⁶

Examples of location-based systems and their potential for creativity and learning include: Squidsoup's Come Closer⁸⁷; Futurelab's MobiMissions, Fountaineers, La Piazza, and Mudlarking⁸⁸. The sharing and mapping of local knowledge in a community and physical spaces have also been explored in projects, such as Urban Tapestries and Social Tapestries, by Proboscis.⁸⁹

A good toy is a toy that can 'grow' with us, allowing us to rethink who we are, what makes us unique, and how we differ from others (animate or inanimate). In today's digital world, reinventing ourselves calls for spaces where we can safely explore the nuances between physical impact, action at a distance, psychological manipulation, remote-control, orders, and requests. Animated toys, as well as location-based and mobile playthings constitute one arena that can provide just such types of spaces.

85. Excerpt from FutureLab Series (2007) : *'Creativity, technology and learning –a review of recent literature.* FutureLab, Bristol. Report 4 Update (www.futurelab.org.uk/litreviews),p.8.

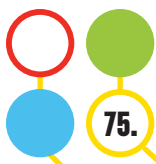
86. Ibid. P.8.

87. Ibid. P.8.

88. www.squidsoup.org/comecloser

89. www.futurelab.org.uk/projects

www.socialtapestries.net



Chapter 7: Conclusion

Introduction

There are timeless elements to growing up, regardless of the technological context we find ourselves in. They are the need for nurture, developmental trends, and the processes for forming identity and assimilating culture. The content and context of one's identity or culture may change with generations, but the act of growing up doesn't.

What is changing are the ways of relating to one another, where sharing and collaborating is increasingly a means of establishing a relationship rather than something that happens as a consequence of the relationship. The potential to be perpetually connected and part of multiple domains simultaneously is paving the way to new ways of being, identities which are an amalgamation of our virtual and physical selves, and not merely a translation of one into the other.

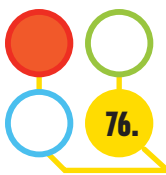
As our notions of self and connecting to others is changing, so are the ways we choose to express ourselves. In this report we have considered digital creativity from a number of perspectives, such as play, learning, and creativity itself. Similarly to the physical realm, creativity in the digital realm is simply the ability to generate ideas and contributions that are new, surprising and valuable within a digital context.

The six faces of digital creativity

Increasingly, connecting to others in the digital realm involves passing things on, noting, annotating, linking and tagging – becoming content curators as much as content creators. As we begin experimenting with mixing and mashing up content we also expect the tools and platforms at hand to provide unlimited steps of undo, and easy ways to build on top. This experimental nature of much of digital creativity is giving rise to six interconnected faces of digital creativity:

THE CONNECTOR:

Making connections between diverse domains has always been one aspect of creativity, but digital creativity makes connections especially important. Social connections within and between different platforms enable creativity to 'Flow'



adding value to individual creativity when it becomes part of a group endeavour. Furthermore, the richest connections are between the virtual and the physical worlds, where hybrid or mashup systems enable people's creative engagements to shift from the physical world into digital realms, and then back again.

THE GIVER:

The online digital realm fosters communities and enables collaborations, where a primary activity is the giving of gifts – the donation of experience, ideas and knowledge to a group or community. Because digital creativity is so readily shareable, it encourages a process where one person's work builds on that of another, and where ideas and expertise are more freely shared. The experience of giving and sharing produces an encouraging emotional buzz within communities of practice, helping participants to reach new heights of creative innovation.

THE ARTIST:

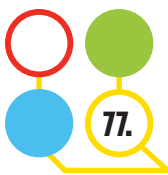
Although associated with technological platforms, digital creativity is just as artistic and expressive as any other form of creativity. Digital creativity embraces ideas which would be just as central to bohemian painters in Paris as to IT professionals in San Francisco: the creative community, inspiration from peers and from nature, serendipity and social relationships. It also offers new opportunities for expressive communication, as we begin to break down the division between 'online' and 'offline' to open up connected worlds of play, learning, and creativity.

THE SCIENTIST:

Digital creativity takes place in computer systems which are usually quite easy to use and understand, but we should not underestimate the technical literacy we have developed in order to achieve these 'easy' tasks. Setting up and using electronic systems fosters scientific and problem-solving skills, and logical thinking. The emerging challenges to connect digital and real-life environments offer a particular opportunity for scientific innovation allied with more traditional creative ingenuity.

THE BRICOLEUR:

The digital world opens doors to a vast library of images, sounds, and ideas which have already been created, and which can become the components of new projects. It supports a culture of bricoleurs – makers, hackers, and hobbyists – who put content and objects together in new ways, repurposing, recycling, mending and trading. This potentially fosters a new way of thinking about how artifacts can be transformed and repurposed, both online and in the physical world.



THE ACTIVIST:

The nature of online social networks makes it easier to gather like-minded people – and to stimulate them to action. Digital creativity can therefore include an activist mode – not necessarily about ‘political’ issues, but groups of enthusiasts wanting to get their voices heard, wanting to see more of their kind of interest represented in the media and elsewhere, wanting to raise awareness of their enthusiasms, activities and preferences.

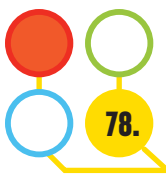
Playing, learning and creating while growing up digital

These changes in how we relate to one another and to content is manifested in the friendship- and interest-driven modes of engagement, which influence how children play in the digital realm. In the friendship mode of engagement, digital content is the discussion starter, the token or ‘gift’ exchanged between friends to stimulate contact, dialogue and togetherness. In the interest-driven mode of engagement, the interest drives the nature of online engagement and even the social relationships formed.

Play serves to bridge the virtual and physical in four different ways –

- *Making an imaginary world come alive*, for instance through MMOGs and games. The more compelling ones are in a dynamic state of evolution as players are continuously changing what the world is and how it is manifested, creating a dynamic reality as opposed to playing within a set script.
- *Smart things* such as sensing devices and talking dolls are compelling ways to explore the borderline between what we make something do and what it does out of its own volition.
- *Play in mixed realities* is about using the digital realm to augment physical play, as examples like GPS treasure hunts illustrate. Equally, physical means of controlling virtual worlds, as the example of the Nintendo Wii illustrates, make for compelling and immersive play experiences, involving our entire bodies and senses.
- *One reality* - these two worlds do not exist separately from one another, but are increasingly one and the same with play experiences which evolve for traversing back and forth between both worlds. Stories and storytelling provide convenient red threads for knitting together virtual and physical universes, but so do interests and friends.

Whether it be ‘messaging around’ or taking a deeper involvement and engaging with a community of practice, motivations for engagement may differ, but in all cases the social element plays a central role in both accelerating and deepening the experience, and – in



the case of the interest-driven modes of engagement – the social dimension is essential to fuel the journey towards mastery.

What makes play, participation and creating in the digital realm ‘fun,’ we have seen, is an economy of emotions, where pride, curiosity, love and feeling smart are the ultimate rewards for participation. The pleasures of accomplishment and the feeling of competence are basic drivers in online communities, while the desire to make a mark on the world, and to do a good thing, are not to be underestimated. In all cases, whether it be play, creativity or learning – the ability to get in ‘Flow’ is an essential prerequisite for continued engagement. The ingredients of Flow – immediate feedback, clear objectives, visible failure states, a staged set of challenges and the lack of time pressure – are essential in creating contexts for maximum possible engagement.

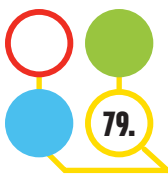
Similarities and differences between physical and virtual play, learning and creativity

The primary motivations for creativity remain similar regardless of context, but the digital realm makes it easier to collaborate and share; it can remove the constraint of materials, it can be small and mobile, with possibly a lower environmental impact and less face-to-face social interaction. We identified a third realm of creativity, that of the hybrid, or mashup creativity, which brings the two worlds together. This realm adds a fruitful tension between real-life hands-on creativity and the less physical, often screen-based virtual worlds. The comparison of non-digital with digital does not necessarily show that online activity is ‘better’ or more convenient. Instead we should aspire to a powerful collaborative interface between the physical and the digital, enabling people to come together using a combination of physical and digital tools and environments, to create new ideas, art, play and knowledge.

YouTube is an example of an application and platform that fosters digital creativity. Three principles that underpin YouTube are essential for the success of any digital platform for creativity: first it provides a framework for participation, but then, second, the system is open to any kind of content that will fit into the framework. Third, it fosters a community, which is central to all the activity that takes place. While it is true that the majority of visitors to YouTube are viewing, not producing and participating, literally millions of users contribute content every day, and for this the audience of viewers is essential in fueling the creativity of the authors.

We identified four principles that not only are essential for innovating experiences, but provide a useful framework for approaching designing experiences that enable creativity in the digital realm. They are:

- **Granularity:** making it possible for users to choose the level of specificity when engaging with an experience, recognising that these may be different at different times and contexts.



- **Extensibility:** allowing users to extend their experience through other technologies, channels, modes of engagement as well as create entirely new functionalities themselves.
- **Linkage:** connecting related events in multiple ways from a user's point of view and over time, in addition to making it easy for users to invent new ways of doing this themselves.
- **Evolvability:** shaping experiences around users' needs and preferences, not the other way around and enabling an evolution of the experience as users' levels of sophistication increase.

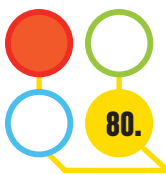
The strength of the digital realm to support play, creativity and learning rests on the principles of *provisionality* – users can make changes, try alternatives and keep a record of developing ideas, *interactivity* – receiving immediate response to creations and contributions, the capacity to house and access vast amounts of information locally and globally, the *automatic functions* for aggregating, analysing and synthesising vast quantities of information at higher levels and the *speed and range* of sharing and collaborating.

From a learning perspective, the ability of the digital realm to support learning experiences depends on whether the learning experience can embody the literacies above while being structured by *specific goals*, providing opportunities to *reflect and interpret* alone and with others, receiving immediate *feedback* and having numerous *opportunities* to apply learnings in new contexts and lastly, making it possible to *learn from others*.

These offer a compelling challenge to educators to rethink learning and curriculums to incorporate the above literacies and build on them for enriched learning experiences. Moving towards a notion of the edgeless school, appropriating new media and supporting children in becoming media literate are important roles for the teacher as facilitator to embrace. Equally in the midst of the plethora of content, the challenge is to teach students to be creative and constructive alongside being reflective and critical.

The essence of digital creativity

- An opportunity to create and to share ideas and artifacts that are (in some way) new, surprising or valuable to a connected group.
- An opportunity to generate, combine, explore or transform an expression of ideas or emotions.

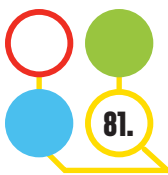


- An ability to collaborate, giving power to creativity as people come together to make things, or put their individual creations together in a new environment.
- An integration of offline activity with online social networks and communities.
- An accessible and easy set of tools; encouraging tinkering and experimentation.
- Freedom from unnecessary constraints on materials or time.
- A form of gift economy, where elements can be shared, and support for the free exchange of ideas and kindness.
- A degree of recognition for contributions (although not necessarily reward).
- An opportunity for the user to customise and make their mark on the system.
- An effective connection between the physical and virtual worlds, encouraging an active, 'hands on' orientation to the space and ideas.
- The freedom for people to do what they want to do, and to invent their own uses, rather than be told what to do.

A digital LEGO® System in Play

The challenge for a LEGO System in the digital realm is not only the provision of an inter-connecting set of parts able to support a multitude of creations in the digital realm, but also in the hybrid realm where the virtual and physical meet. Furthermore, it is not only the parts that need to connect, but increasingly creative moments and experiences over time, making it easy to retrace steps and share creations. This is intuitively possible by the physical, tangible nature of the LEGO bricks, combined with building instructions. To make the most of the qualities in the digital realm, it should be as easy to produce creations, pick them apart, share them with others and reuse them in a multitude of creative context. A platform in the digital realm should be able to support both the interconnection of parts and creations, as well as linkage over time, and across communities.

A low entry level means age-appropriate tools, but equally it means easy ways to decipher the level of complexity of each entry point and pick one that is personally relevant. The importance lies in the variety of entry points: purely enabling the right first step, although essential to kick-start the process of being in Flow, is not enough to sustain engagement over time. In the physical realm this has been solved by providing building systems and a multitude of products of varying complexity that share the same core



idea of predictable connections and assembly – logic therefore dictates that the digital realm cannot be treated differently if a digital System in Play is to maintain a meaningful relationship to the physical LEGO® System in Play.

The dimension of mastery is as important to the LEGO System in Play as is the low threshold of initial entry. For a digital System to be capable of evolving with users' ability to create more sophisticated content there needs to be meaningful dimensions for progress in the digital realm to enable endless ideas. Furthermore, enabling spontaneity in digital creations is perhaps the single hardest quality to replicate. Whereas in the physical world we can playfully pick up pieces and unlock ideas and give shape to our thoughts by experimenting with the bricks in our hands, to be truthful to the promise of the LEGO System in Play, it is essential we match the spontaneous element also in the digital realm.

LEGO play is Playful Learning, it is transformative in that it helps children of all ages develop new ideas and see the world in new ways. Thus a LEGO System in the digital realm needs to ensure that playfulness and imagination coexists with logic and reasoning – creating contexts for these to combine in pursuit of learning and exploration alongside creative expression and play. The system must therefore be supportive and playful: it should be easy to try new things and there should be no way to make a 'mistake'. This encourages play, exploration, tinkering and experimentation. Equally, users should be encouraged to take their time. A digital LEGO System should therefore enable connections, interaction, collaboration, giving digital gifts, and connecting personal activity into a wider world of creativity.

The positive emotions such as pride, curiosity, love and feeling smart, the ultimate rewards for online participation, are frequently referenced when children and adult fans talk about building with LEGO bricks. The LEGO System in Play is a language of creativity alive with a vibrant community of fans and a strong commitment by the LEGO Group to foster play, creativity and learning. The fan community and the LEGO Group together form the wider context for the LEGO values of imagination, creativity, fun, learning, caring and quality to be manifested. In the digital realm, these 'soft' qualities are as important to address as are the technical and software functionality, enabling users to feel the emotional high of accomplishing something concrete, feeling capable and being recognised for their successes.

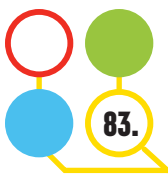
The diversity of users are key in sustaining thriving communities, therefore a digital LEGO System must address a wide range of motivations for play and engagement. Importantly, the digital System can become a strong learning platform only if it helps structure learning experiences in terms of goals, it enables reflection, feedback and learning from others, opportunities to apply previous experiences.



An important dimension of the LEGO® System in Play is its physical nature, which means that thinking can happen and be supported by manipulating physical bricks. This involves multiple senses, which has been shown to support learning and thinking. Therefore the real promise of a digital LEGO System lies in its ability to connect meaningfully to the physical world, building on top of the benefits of the physical LEGO System in Play, thus enriching it through the affordances of the digital.

The digital realm can enrich creative LEGO experiences by:

- Providing multiple entry-points to a creative experience, the granularity of which is personally relevant to the user.
- Linking experiences across time and multiple touch-points, from an individual and/or group or affiliation point of view.
- Connecting multiple media and creations around the user, and/or a chosen group or affiliation.
- Enabling the act of creating to evolve with increasing levels of user sophistication and supporting this progress towards mastery with personally relevant inspiration and content based on one's previous creations, stated interests, alongside inspiration from one's groups and affiliations.
- Enabling users to extend the scope of their creations by bridging different touch-points, channels, technologies and the virtual and physical, supporting creative exploration in a wide range, diversity and variety of styles.
- Referencing, commenting, modifying, combining and building on top of creations made by self and others, in real-time as well as previously, inspiring new ways of creating and expressing as well as connecting to others.
- Enabling users to document their creations in a multitude of ways, for instance through photos, video, animation, 3D and new hybrid forms of media and keep track of these by topic, occasion, location, participants, medium, timeline and other personally relevant forms of recall.
- Bridging play in the virtual and physical realms through virtual worlds with physical manifestations, and vice versa, smart objects, augmented reality and play scenarios for moving back and forth between the virtual and the physical.
- Connecting users with a global community of creatives through creations, shared interests and collaboration, which provides the fuel to continued engagement and creative exploration.



Crucially, these qualities need to be captured in a core idea around the nature of the digital connectors, enabling a diversity of experiences to flourish, while the process of construction remains consistent from a user's point of view. The difficulty of creating an enduring method of connection between creative components in the digital realm is not to be underestimated, as this involves far more than a visual reference to the physical studs and tubes of the LEGO® System.

It is more about mirroring the experience of the engineering brilliance behind 'clutch power' – the ability of LEGO bricks to be joined easily or disassembled easily, yet stay connected firmly, even in young hands – and the uncomplicated route to unlocking imagination and creativity through this easy and natural combination of elements. In the digital realm, the nature and quality of media can be wide and complex as well as bridge the virtual and physical realms – therefore connectors, rather than the content, may serve as the point of consistency across media, channels and technologies, allowing the content 'between' the connectors to vary. Given the rate of technical and software development, the important thing is to conclude on the rationale and method of connection, while leaving the technical side open to exploit innovations in this realm.

A 21st Century LEGO System in Play

A holistic LEGO System enabling creative experiences that embrace the affordances of both the physical and virtual is a compelling vision for the 21st Century.

a sea of literature [is emerging] that shows less commonly how ideas develop between the arts and sciences than what results when they do. Thomas Kuhn, in *The Structure of Scientific Revolutions*, and Jacob Bronowski in *Science and Human Values*, describe how artistic aptitude, often more than arduous application of the scientific method, leads to scientific revolutions, as when Johannes Kepler made his breakthrough scientific discoveries in astronomy by optimising what he viewed as the harmony of celestial bodies with musical notes [...] (Edwards, 2008)

There may be aesthetic aims that require application or understanding of the scientific method [...] or there may be scientific aims that require the application or understanding of the aesthetic method [...] Either way, the fused method that results, at once aesthetic and scientific – intuitive and deductive, sensual and analytical, comfortable with uncertainty and able to frame a problem, embracing nature in its complexity and able to simplify to nature in its essence – is what I call artscience.⁹⁰

We call it Systematic Creativity – the ability to use logic and reasoning alongside playfulness and imagination to generate ideas and artifacts that are new, surprising and valuable. The LEGO System blends the qualities of artistic and scientific disciplines to provide a creative medium facilitating creativity and innovation capable of drawing on

both. Therefore a 21st Century LEGO® System in Play should draw on the qualities of both the physical and virtual realms, making it possible to connect the artistic and scientific modes of enquiry across the virtual and physical realms, as illustrated in Figure A below:

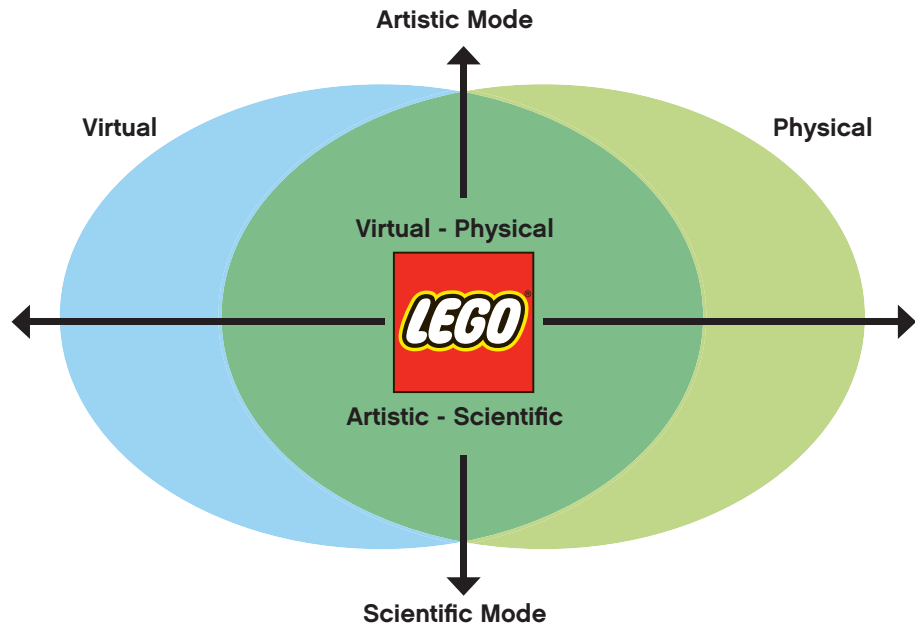
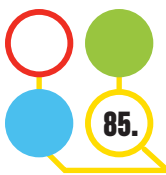


Figure A.

More simply put: just as the LEGO System in Play as manifested in the physical LEGO brick makes it possible for playfulness and imagination to combine with logic and reasoning in the act of constructing something, equally it should be possible to combine playful and imaginative expressions with logic and reasoning across realms in pursuit of constructing creative expressions enriched by the affordances of both realms.

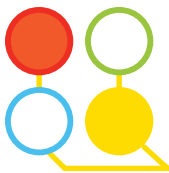
A holistic LEGO System bridging the virtual and physical alongside the artistic and scientific modes of inquiry has the capacity to form the foundation for developing the critical 21st Century literacies as highlighted in chapter four:

- **Play** — The capacity to experiment with one’s surroundings as a form of problem-solving.
- **Performance** — The ability to adopt alternative identities for improvisation and discovery.
- **Simulation** — The ability to interpret and construct dynamic models of real-world processes.



- **Appropriation** — The ability to meaningfully sample and remix media content.
- **Multitasking** — The ability to scan one's environment and shift focus as needed to salient details.
- **Distributed Cognition** — The ability to interact meaningfully with tools that expand mental capacities.
- **Collective Intelligence** — The ability to pool knowledge and compare notes with others, working towards a common goal.
- **Judgment** — The ability to evaluate the reliability and credibility of different information sources.
- **Transmedia Navigation** — The ability to follow the flow of stories and information across multiple modalities.
- **Networking** — The ability to search for, synthesize, and disseminate information.
- **Negotiation** — The ability to travel across diverse communities, discerning and respecting multiple perspectives and grasping and following alternative norms.

This vision is already beginning to materialise through examples like LEGO® MINDSTORMS®, enabling behaviour and functionality in physical LEGO models through incorporating intelligent bricks that can be programmed in the digital realm. Conversely, LEGO® Design By Me® makes it possible to build something virtually and receive the very bricks to build the model in the physical realm. As the LEGO Group continues on its journey to invent the future of play, the LEGO idea, once simply conceived in the form of a brick, when coupled with the qualities of the digital realm, proves to be a powerful metaphor and tool for the kind of creativity possible in the 21st Century.



LEGO® Learning Institute

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