Curiosity and Experience Design:

Developing the Desire to Know and Explore in Ways That Are Sociable, Embodied, and Playful

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Abstract

Curiosity, as a strong motivator for exploration and discovery, has long been an underexplored but important emotional response in relation to technology. This research considers that it has great potential to improve many aspects of the user experience, especially in today's screen-saturated context. However, engaging curiosity by novelty and uncertainty may exhaust attentional strength and challenge usability. Thus, the purpose of this research is to find ways to foster the human trait of curiosity and avoid its negative effects.

To gain an in-depth understanding of curiosity, the first chapter reviews cross-disciplinary literature to expand its role in improving user experience. This ranges from serving as an attention grabber to including the values that contribute to human survival, thriving, emotional resilience, and personal development. The second chapter identifies problems in the current curiosity-provoking design methods. The chapter also emphasises design for supporting active curiosity and avoiding the creation of purely novel stimuli. This approach is to encourage active curiosity to develop. To this end, the research proceeds to conduct observational studies at a museum to broaden our understanding of factors that influence people's curiosity and exploration within a screen-mediated context. Based on these observations, I identified that there are three conceptual elements: sociability, embodiment, and playfulness.

Through theoretical discussion and reflection upon the design examples, subsequent three chapters explore the relationship between curiosity and each conceptual element. The chapters also suggest several design approaches that embrace curiosity

in relation to its social, embodied, and playful nature. These include creating a sense of co-curiosity, allowing the use of covert and overt curiosity-satisfying strategies, increasing bodily exploration affordances of the screen for linking curiosity with embodiment, using metaphors of the body-screen relationship, and developing possibilities and adding enchanting effects for eliciting playfulness to enrich curiosity.

In essence, this research enhances our understanding of the user experience from the perspective of curiosity, and these design suggestions also help to embrace users' active curiosity in developing sociable, embodied, and playful well-being in the age of ubiquitous screens.

Declaration

I hereby declare that the following:

This thesis is all my own work except where I indicate otherwise by proper use of quotes and references. This thesis represents my own works towards the degree of PhD. This work has not been submitted for any other degree or professional qualification at this University or any other institution.

Shih-Mei Lee

This thesis is dedicated to my father, *Lee, Shu-Chun*, who gave me unconditional love, which nurtures my curiosity and life significantly.

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Introduction

Background contexts

> We live in a world where everything seems possible and as a consequence have lost the sense of wonder.
> — Branko Lukic and Barry M. Katz, 2010, p. 686 (as quoted in Smyth, Speed, & Brynskov, 2011)
>
> How can we design displays that foster a sense of presence and awareness… that enhance a sense of community and togetherness… that enable human bonds to grow and flourish?
> — Stefan Agamanolis, 2003, p. 309

Screens are everywhere. With the rapid progression of display technology, the potential for novel interaction and experience is abounding (e.g., using digital displays for co-creation, open participation, personalised service, situated interaction, and locative knowledge production). However, new opportunities lead to new challenges. Since screens of various kinds now affect many aspects of our lives, design problems and concerns are emerging.

One of the design challenges identified is that most screens are often left unnoticed by people who are nearby or just passing (Huang, Koster, & Borchers, 2008). This phenomenon, brought about by the ubiquity of screens, has been marked as *display blindness* in public display research (Müller et al., 2009),[1] since this phenomenon

[1] Müller et al. (2009) provided a possible explanation for the phenomenon of display blindness, saying that people expect nothing interesting because most screens in public spaces are primarily used for advertising purposes. Consequently, people tend to ignore them.

resembles the problem of Web's banner blindness.[2] In more recent research on interactive devices that are used in public or shared social spaces, this phenomenon has been titled out as *interactive blindness* (Ojala et al., 2012) or *first click problem* (Kukka, Oja, Kostakos, Goncalves, & Ojala, 2013) due to people's low awareness of the interactive functions of the display. If designs cannot overcome the problem of display blindness, the display cannot stand out in a screen-saturated living context.

Before screen-based devices become ubiquitous in everyday life, a display of moving images was a curiosity for many people (Huhtamo, 2006). The 19th century optical recreations and visual devices were unique and interesting at the time.[3] Today, our living space is stuffed full of digital media and technology. They are becoming increasingly more common, subsequently, they are less attractive to viewers. Screens are not a novelty to people anymore. In many cases, screen-based displays are ordinary objects that fade into the background. Before we take a look at what is showing on a screen, it has to compete against its surroundings. Many user experience designers and developers are now facing the challenge of attracting the attention of passers-by, overcoming the habit of technological ignorance, and inviting interaction in everyday contexts.

Several recent studies (e.g., Tikka, Vina, Jacucci, & Korpilahti, 2011) on evaluating interactive design of public installations and applications have repeatedly reminded

[2] Banner blindness refers to the phenomenon that anything that looks like an advertisement can be easily ignored by the web user (see Nielsen, 2013).
[3] See Everyone's Virtual Exhibition (EVE) website for a digital collection of the 19th century optical toys and other pre-cinema optical entertainment (Plunkett, 2008).

designers that digital technology should pique the attention and interest of people in order to initiate the interaction processes and facilitate the transition from spectator to participant. As digital media technology researcher Agamanolis (2003) stated, "Half the battle in designing an interactive situated or public display is designing how the display will invite that interaction" (p. 329). However, few digital media design researchers have down further studies on what factors will draw the attention of passers-by and engage their interests. Huang et al. (2008) also asked this important question: "What aspects of the displays and the environment affect attention?" (p. 229). As designers and researchers of digital media, in today's context of ubiquitous screens, we should ask this question from the first stages of the design process to overcome the problem of display blindness and to enhance people's motivation to approach and interact with the screen.

Apart from this, another impending problem brought by screen ubiquity is what I call *screen fatigue*.[4] In a heavy traffic area (e.g., high streets, shopping malls, and airports), the eyes of passers-by are presented with screens of all kinds, engendering a sense of an emotional dislocation or decentred feeling. As well, small screens, such as mobile phones, wireless tablets and the like, make individuals independent of their immediate surroundings. They keep users in a private cocoon in larger public or shared social spaces (Ito et al., 2007). People now are "alone together" (Turkle,

[4] The term *screen fatigue* is inspired by the term *green fatigue*, which is the result of people getting bored of hearing green living advice.

2011),[5] and screens enable many people to escape from their immediate involvement with co-present people and objects around. Many ever-present screens, from big to small, make us create a passing, intermittent, and incoherent relationship with the physical place and cultural environment. Recall French anthropologist Marc Augé's (1995) idea of a non-place[6] or a scene of the future in the robot film *Wall-E* (2008).[7] Both depict an excessively-screened world with dull or unsettling feelings.

For some, a world of screens is less interesting and enchanting. This results in what sociologist Georg Simmel terms *a blasé attitude*[8] to avoid overstimulated modern life. The ubiquity of screens has caused changes in our perception and reactions to those visual stimuli within our surrounding environment, which results in an inability to properly handle new stimuli and a tendency to apathy. How will designs improve our relationship to the place we live every day and enhance our sense of the presence of people who are part of our everyday life? Agamanolis' (2003) question also

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[5] The phrase '*alone together*' is borrowed from Sherry Turkle's book title *Alone Together: Why We Expect More from Technology and Less from Each Other*, in which Turkle (2011) argued that the increasing use of new media has created new solitudes that keep individuals within their preferred connections without settling relationships and direct human connection.
[6] In his book *Non-Places: An Introduction to Supermodernity*, Augé's (1995) coined the term *non-places* to refer to areas, such as airport, hotels, and motorways, that do not hold significant relation, identity and history to be defined as the anthropological place. By the same token, many of our experiences with screens that are fragmentary, ahistorical, and detached from reality also help develop our sense of non-places.
[7] In *Wall-E* (2008), a computer-animated science-fiction film, the future is full of screens and robots. People are depicted as nearly immobile, lazy, and overweight. They can only sit in their hover chairs and consume what is shown to them on their screen.
[8] In *The Metropolis and Mental Life*, the sociologist Simmel identified the blasé attitude "an indifference toward the distinctions between things" (as quoted in Williams, Robles, & Dourish, 2009). This is formed because too much information causes sensory overloads and exhausts attentional capabilities in the modern urban person.

reminds us, as shown in the second quote at the beginning, that a sense of presence and awareness cultivates a sense of community and strengthens human connections.

More profoundly, the ability to think deeply and creatively seems to become more critical, as suggested by the first of the two quotes at the beginning. One growing concern over the problem of screen ubiquity is that we are losing our sense of wonder. In his book *The Shallows: What the Internet Is Doing to Our Brains*, Nicholas Carr (2011) has argued that the current trend towards the digital media as the main source of knowledge increasingly undermines our intellectual capabilities and critical thinking skills. To some thinkers, digital technology has increasingly dulled our curiosity for advanced thinking and limited our creative potential. It has turned us into shallow thinkers.

A popular Chinese term – *di tou zu* – used in recent years to describe smartphone users also reflects those concerns. This term, which describes a user of mobile screens based on his or her head constantly looking down, conveys a derogatory meaning as it associates the smartphone stance with other similar body postures that imply negative images, such as admitting defeat, frustration, remorse and shame.[9]

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[9] This term *di tou zu* is composed of three traditional Chinese characters 低頭族. The first character *di* (低) literally means 'to low, bow, incline, hand down,' the second character *tou* (頭) literally refers to 'the head.' The first two characters, *di tou* (低頭), combined is used to describe 'one's head looking downward' and also often used in contexts when one admits his or her defeat. The last character *zu* (族) refers to 'a family clan, a tribe, a crowd, a race, a nationality or a group of people behaving in a particular way.' Therefore, this three-character term *di tou zu* can be straightforwardly explained as 'heads down tribe people' to imply that smartphone users who are constantly engaged in their screens lack activity and become disconnected to their immediate surroundings and events that are going on around them. Therefore, this term has been used with a slightly disreputable connotation.

Therefore, people use this term *di tou zu* to call out those who are engrossed with their screen and disconnected to their immediate surroundings and events that are going on around them. Other terms, such as *fa dai zu*,[10] used in China to describe a person who looks dull due to spending excessive screen time, and the word *phubbing*[11] used in English to describe the act of snubbing someone by looking at a phone, are similar examples that imply that screens have made people less intelligent and less involved with the world around them. The emergence of these words reflects those concerns for the negative impact of mobile technology on people in everyday life.

From the above-mentioned design challenges and concerns, whenever we design a digital experience in today's screen-saturated context, we should assume the responsibility for dealing with these worrisome issues. Therefore, it is important for today's user experience designers to invite interaction with the screen, but at the same time, they should increase individuals' awareness of their immediate

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[10] The term *fa dai zu* (simplified Chinese: 发呆族) is sometime used interchangeably with *di tou zu*. The first two characters *fa* (發) *dai* (呆) is a common term used to describe one who appears in a state of gazing or wandering without any particular end in mind in Chinese. The character fa (發) literally means 'sending out, showing, emitting, or issuing something.' In this context, it refers to a certain facial expression. The character *dai* (呆) suggests one looks rather dull, lacking responsiveness, or a bit looks like a fool. This term is a slightly derogatory word since it implies that a user of mobile screens has become aloof, stiff or disconnected of his or her surroundings.

[11] The term *phubbing* means phone snubbing, describing "the act of snubbing someone in a social setting by looking at his or her small screen instead of paying attention," according to the international Stop Phubbing campaign group. See http://stopphubbing.com

surroundings, social relations, and most importantly, users' ability to think beyond the screen.

As I was concerned with the problems caused by ubiquitous screens, I carried out observational studies at Big Screen Edinburgh[12] in the summer of 2011, trying to identify which factors draw people to a screen and engage their interest in a public context. As this 25 square metre giant screen is designed to be a live platform to show localised information, experimental art projects, or major national events, it is expected to engage the public and create social cohesion at a local or national level. However, the observations of people's behaviour around this screen showed a low interaction rate.[13] It seemed to fail to get sufficient interest, except for the promoted national event (see Table 0.1 below).

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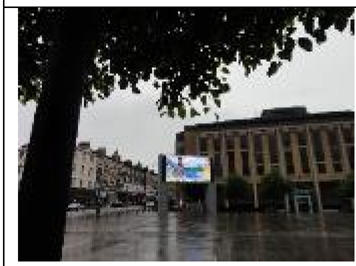
[12] Edinburgh's Big Screen launched in 2009 is part of the BBC Big Screens project, which has installed 22 digital outdoor displays across the UK since 2011 (see http://www.bbc.co.uk/bigscreens/ for more details)

[13] Taylor (2006), who observed people's interaction with BBC Big Screen in Manchester, also reported similar results. The majority of passers-by just walked past and ignored the screen.

Table 0.1 Observational studies at Big Screen Edinburgh in Festival Square

		
22 June 2011 11:50-12:20 Bright sunny day BBC News on the screen 35 passers-by observed Most people just walked through the square without noticing or looking up at the screen. Only 4 people glanced at the screen very briefly while still walking onward without stopping.	14 July 2011 19:20-20:30 Chilly evening Big Screen shows a live relay of the Cinderella opera from the Royal Opera at Covent Garden A crowd of over 30 people gathered. They were mostly sitting in the seats when the program started. Most of them would talk to their group members sitting nearby while watching.	23 July 2011 12:20-12:50 Sunny day BBC News on the screen 12 passers-by observed A few people passed through the square during this period of observation, most of whose attention was not drawn to the big screen. Only 2 men watched the screen intermittently while talking in the square.
		
08 August 2011 12:40-13:00 Cloudy day with light rain BBC programmes on the screen 17 passers-by observed The viewing rate was very low. Just 1 passer-by turned to view the screen very briefly. The majority did not look up at the screen.	15 August 2011 9:10-9:30 Sunny day Festival programmes on the screen 26 passers-by observed Most people ignored the screen, showing no change in their walking pattern. Only 3 passers-by looked up at the screen very briefly when they walked through the square.	22 August 2011 9:10-9:30 Sunny day Festival programmes on the screen 38 passers-by observed Only 1 passer-by appeared interested (stopped and looked up at the screen for about 2 minutes). 5 turned to look for 1 or 2 seconds when passing through the square. The rest paid no attention to it.

Similar trends occur indoors. In August and September 2011, I often stayed in the Edinburgh Central Library and noticed that a newly-installed large interactive kiosk located next to the building's entrance was rarely noticed by visitors. A few people briefly glanced at it as they walked past with no interaction involved. Although this big and new kiosk provided useful information, it barely drew the attention of people. Clearly, the screen cannot demand the attention of people in its own right, even if it has a large and clearly visible viewing regime. The low-interaction rate, but highly situational spectatorship still make design practices for improving user experience against this background unfocused.

Inspired by Flatley's (2009) saying, "only when I am curious can new objects present themselves to me as interesting" (p. 19), I became interested in curiosity.[14] Our willingness to explore and discover the world should have a fundamental importance in attracting our attention and making us actively explore what it presents to us, especially when it comes to what is on screens. As I just mentioned, in today's digital media context, designers are challenged to think of new ways to make their works stand out and to encourage their users' explorative instincts in the world. It is important for designers to nudge people to pay more attention to one work above all others and to stimulate active interest from the start. Our curiosity – the intrinsic desire for novel experience and knowledge – should be an important factor in

[14] At the end of 201l, I first came across this sentence while reading about the notions of affect and mood in *Affective Mapping: Melancholia and the Politics of Modernism*, in which the author Jonathan Flatley (2008) provided a glossary that distinguishes the meanings of affect, emotion, feeling, passion, and mood. Curiosity is used as an exemplar mood by Flatley to denote how our mood can have a proactive, preconditioned effect on the perception of the environmental stimulus. Since then, I became aware of the importance of the emotion of curiosity and carried out more studies on it.

motivating us to explore what is around us in many situations. I was drawn into the study of curiosity and wondered how it preconditions and influences the screen-mediated experience.

In the light of Flatley's (2009) words, I did a quick search on the Internet and in research databases. At that time, I found few studies of user experience design that were concerned with ways in which users' natural curiosity can be used to improve user experience or solve the problems brought about by today's screen-saturated life. However, preliminary research showed that there were a large number of studies on curiosity and related topics from other disciplines. Many studies have shown that curiosity correlates with openness (e.g., Quartel, 2004), care (e.g., Fitzgerald, 1996), creativity (e.g., Rounds, 2004), mindfulness (e.g., Kashdan, Afram, Brown, Birnbeck, & Drvoshanov, 2011), and even general facets of well-being (e.g., Kashdan, 2009). More interestingly, in academic literature, curiosity seems to be a difficult concept to define.[15] My own curiosity was piqued by the complexity of curiosity as a subject.

In addition to that, I was also impressed with some photos from a Wikipedia article on curiosity, showing a group of children gravitated to look at something that piqued their curiosity (see Figure 0.1 and 0.2 below). This reminded me of my own children's delight at their everyday discoveries as well as curiosity's social effects. Furthermore, I discovered there were religious objections to curiosity in the early

[15] This will be described in more detail in the next chapter.

history of Western cultures when curiosity was seen by some as a moral vice.[16] This way of representing humans' curiosity conflicts with my own culture view, and also, that made me aware of the effects of curiosity that play a wider role in societal and cultural groups. All of these discoveries led me to believe that the study of curiosity has the potential to help us better understand human behaviour and enhance the experience of digital media design.

Figure 0.1 (Left) Curious children gather around a photographer, looking at her camera.[17]

Figure 0.2 (Right) Children peer over their shoulders to see the contents of a book.[18]

These initial findings indicate that curiosity is able to link individuals with a screen device as well as play a multifaceted role in enhancing many aspects of everyday experiences. Since many of our current design challenges and problems (i.e., display blindness, over-stimulation, and shallow thinking) point to the increasingly important

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[16] Throughout the medieval period, several religious leaders, most notably St. Augustine, saw curiosity as a sinful desire that distracted people from God, I shall go into more detail in chapter 4. See also Barbara M. Benedict's 2001 book *Curiosity: A Cultural History of Early Modern Inquiry*, in which she explores how curiosity and curious people have been represented as "the mark of a threatening ambition" (p. 2) in English culture from the late 17th to the early 19th centuries.

[17] This photo is retrieved on March 24, 2015, from http://en.wikipedia.org/wiki/Curiosity. Copyright 2009 by Toni Frissell. Reprinted with permission as per http://www.loc.gov/rr/print/res/070_fris.html

[18] This photo is retrieved on March 24, 2015, from http://en.wikipedia.org/wiki/Curiosity. Copyright 2008 by Tommy Wong. Reprinted with permission as per http://creativecommons.org/licenses/by/2.0/deed.en

role of human beings' curiosity in digital media design research, the concept of curiosity deserves more focus. These facts have made me realise that I need to study curiosity if I want to learn ways to improve user experience in todays' screen-saturated culture. Therefore, the focus of this research is exclusively on the theme of human curiosity, and it will look for ways of unleashing its potential to bring benefits into our experience with digital media and technology.

Emerging research on curiosity in digital media design

Curiosity, as Litman (2005) described, is "a desire to know, to see, or to experience that motivates exploratory behaviour directed towards the acquisition of new information" (p. 793).[19] When someone's curiosity is aroused, he or she desires to know more. A curious person is more likely to devote time and effort to the topics that interest him or her. Likewise, it would be more difficult to persuade a less-curious person to get involved with stimuli that cannot excite his or her curiosity.

Since it has such a powerful, emotional, and transformable effect, the concept of curiosity has been studied and exploited by many. For instance, educators nurture it to drive the learning process (e.g., Bruner, 1966; Arnone, 2003; Hulme, Green, & Ladd, 2013); scientists extol its virtue because it led to so many discoveries (e.g.,

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[19] When I was trying to define the concept of curiosity, I found it was not easy to represent it in a single phrase as there are many different ways of classifying it, such as a desire, passion, emotion, motivation, personality trait or others. Therefore, I asked the linguist Francis Gillian for the common usage of this word. According to Gillian's (personal communication, April 24, 2014) corpus research on the word *curiosity*, curiosity is overwhelmingly used in the sense of "a strong feeling of wanting to find out about something." Therefore, I quoted the contemporary curiosity researcher Litman's (2005) definition of curiosity as it is close to people's everyday usage as well as provides linkages to motivation, information seeking behaviour, and knowledge acquisition.

Ted-Ed, 2012; Zewail, 2012); psychologists believe it is essential for one's ability to achieve personal growth, happiness, and a fulfilling life (e.g., Kashdan, 2009, 2010); occupational therapists use it to build relationships in leadership development (e.g., Taberner & Siggins, 2015), and marketers apply it to raise brand awareness (e.g., Menon & Soman, 2005). However, curiosity has not been given much attention in the field of digital media design research until very recently, even though most of us, as designers and researchers, would probably agree that it is an important driving force in our creative and professional process.[20]

Why does this important human trait go underappreciated in the context of user experience design? In the past, designing for curiosity was somehow considered problematic in traditional Human Computer Interface (HCI) studies (Gaver, Beaver, & Benford, 2003; Dalsgaard, 2008). Perhaps this is because the most prevalent way to provoke curiosity is to introduce novelty or to present information deliberately in ways that are different, imprecise, insufficient, non-finalised, conflictive, defective or unexpected.[21] As a consequence, use of those curiosity-provoking tactics could only excite a short-lived novelty effect, but it increases the feelings of obscurity, uncertainty, and speculation, which hamper efficiency, reliability, transparency,

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[20] User experience design critic Donald Norman, for instance, recognises himself as the person with curiosity. He once said: "I'm always curious, I'm always asking why […] I question my own ideas and that's the only way to make progress, always curious, always questioning" (Merholz, 2007, para. 20). Also, a number of articles and studies in the field of design have stated curiosity is one of the important characteristics that user experience designers and researchers should possess. See Miller (2014), and Madrigal and McClain (2010), for examples.

[21] See chapter 2 for a review of current practices for provoking curiosity in digital media design.

clarity, and habitual use of the system. In other words, making users experience curiosity is detrimental to usability.

For a long time, we have dreamed of using technologies and tools to promote curiosity. Computer scientist Alan Kay's ideas for the future use of the encyclopaedia that, which came up about thirty years ago, shows that engaging and satisfying our desire to know more will be needed in a variety of everyday activities.[22] The technological future scenarios Kay envisioned reflect that we often need tools to be in various places, such as home, the work place, leisure settings, or even the wild, to make information readily available, as we could experience curiosity at any time or place. The drawings also indicate that our desire to know and to explore the unknown is always the fundamental driving force or the inspiring source for the development of the technology. With curiosity, we will be more actively interested in the world around us. Indeed, our curiosity has anticipated many of our present-day technologies. Designing for curiosity as a goal of user experience (e.g., enhancing learning, adding enjoyment, and encouraging discoveries and information seeking) has long been important within the development of screen media and technology.

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[22] The drawings of future scenarios by the illustrator Glen Keane in 1982 are conceived by information designer Alan Kay and scientists on the prospects for the future of encyclopaedia technology, see Stein, B. (2012). Back to the Future − in honor of Encyclopedia Britannica giving up its print edition. Retrieved from http://futureofthebook.org/blog/2012/04/11/these_drawi ngs_date_from_1982/. These images first time came to my notice when I read Professor Richard Coyne's (2012) article *How the Internet kills curiosity*, see http://richardcoyne.com/2011/12/10/why_ask/

From a historical perspective on screen media design, human curiosity has long been tangled with the design of many early image-viewing devices. The peepshow box, for example, was a form of popular entertainment provided by itinerant showmen on the streets of central European cities in the 17th century that usually exhibited fanciful images, exotic contents, and even pornographic images to appeal to the public.[23] The emotion of curiosity was triggered by hiding the main attraction within a wooden box. For those whose curiosity had been piqued or those who wanted to experience something beyond their ordinary life, a small hole was designed to play on such curious moods and to satisfy their curiosity. The desire to see what was inside the box was the decisive motivator that turned a man into a peeper, a daydreamer. The peepshow boxes and such apparatuses[24] for showing pictures or moving images of a fantasy world were described by media archaeologist Erkki Huhtamo (2006) "as curious objects and as containers for "curious things"" (p. 7). Clearly, curiosity is a significant emotional response generated when encountering these devices. The idea of exploiting curiosity to excite people's desire to see the unknown, to add pleasure in viewing, to delve into the imagination, or even to peep into a forbidden world, was built into many of the early picture-viewing devices.

In today's digital media context, curiosity still plays an important role in the design of the Internet and screen-based technologies. One of the prevailing metaphors that people use to conceive the digital media is the curiosity cabinet. The curiosity

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[23] See Balzer, 1998

[24] Many of 18th and 19th century picture-viewing machines use the peeping-based interaction approach, e.g., magic lanterns, dioramas, kinetoscopes, mutoscopes, and stereopticons.

cabinet, which emerged in mid-16th century Europe, was originally a room packed with all manner of unusual and extraordinary objects (e.g., exotic animals, specimens, precious stones, manufactured objects, and fantastic architectural proposals). As digital media provides various kinds of information, ranging from interesting news to fantasy games to eccentric films, it is perceived not only as an informative machine but also as a wondrous place that has ability to instil a sense of curiosity and wonder in the user.[25] Therefore, the conceptualisation of the Internet experience has been described by many as the wonders of a modern-day cabinet of curiosities (e.g., Arnold, 2012). The names of the early-developed web browsers, such as Internet Explorer, Navigator, and Safari, connote that idea that the web as a new space for people to expand their horizons in exploration and discovery.[26] In this sense, searching for information on the web is like embarking on a journey to explore and discover what is behind the links (or what is on the unseen pages). In other words, the interactive experience of the web browser is conceived as an exploratory activity.

The classic metaphor of the curiosity cabinet is also found in scholarly discourses and artistic works that address the theme of digital media technologies. For instance, the book *Devices of Wonder: From the World in a Box to Images on a screen* takes the curiosity cabinet metaphor to shape its overall theme. The book title gives an

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[25] As the cabinet of curiosity can provoke a sense of wonder and acquisitiveness in the viewer (i.e. the cabinet owner), it has evolved into a rich metaphor used to symbolise the knowledge resource and inspiration, and now is also widely seen as a precursor to modern-day museums.

[26] See also Ratzan's (2000) study for more details on how the ways people navigate unknown territories affect their perceptions of the Internet and the web.

indication that our long engagement with many media devices from the 17th century to the present day seems to remain emotional and wondrous. Similarly, many digital media artists also apply this metaphor to their works. The project *WonderWalker: A Global Online Wunderkammer*,[27] for instance, reintroduces the idea of the cabinet of curiosity to form a collaborative knowledge map on the Internet.[28] The interactive and networked nature of the Internet allows people to create a map of their own wonders and knowledge structure to share with others. *WonderWalker* reflects that the digital media can not only satisfy our desire to know and explore, but it may also open up opportunities to find new meanings through the reconstruction of the dispersed items into a new order. Through revising classically constructed narratives, *WonderWalker* turns the mind of the media user into the mind of an avid explorer and collector to encourage discovery and creation. This return to the curiosity cabinet is used to underlie the process of making such creative and democratic experiences.

From the above brief review, our relationship with many screen-based media forms from the traditional to the digital has long been understood, designed around, and

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[27] *Wunderkammer* is a German word, which literally means 'wonder chamber.' When the culture of collecting and preserving unusual objects became a growing trend among the peoples of Europe in the Renaissance, names for this form of collections varied. In England and France, it was called *cabinets* or *curiosity cabinets*; in the German speaking countries, it was known as *kammer* or *kabinette*. For a brief history of the cabinet of curiosities, see the article *History of the wunderkammern (cabinet of curiosities)* at http://www.tate.org.uk/learn/online-resources/mark-dion-tate-thames-dig/wunderkammen

[28] The project *WonderWalker: A Global Online Wunderkammer* is created by digital artists Marek Walczak and Martin Wattenberg in 2000. In *WonderWalker*, users are encouraged to become collectors of the curiosities when they traverse in a digital space. Users can then map their own digital curiosities by creating an icon that represents their own findings and make the order of their own icons in the online wunderkammer (see http://www.walkerart.org/gallery9/wunderkammer/ for more details). This work came to my notice from Michelle Henning's (2006) essay *New Media* in the book *A Companion to Museum Studies* edited by Sharon MacDonald, in that Henning (2006) uses this project as an example to illustrate the digital media's potential for improving the museum experience.

extended by a kind of curiosity-related concept and experience. Indeed, the emotion of curiosity plays a very important role when one perceives the technological creation and constructs the screen spectatorship in a viewing context. Today, the role of screens is not just as that of an early peepshow box, simply stirring up a thrill beyond the ordinary life or taking us to witness the fantasy. The screen has become the main interface that people use to interact with ideas and people that are important to us.[29] Many aspects of daily activities, including exploration, communication, learning, and creativity, have close relationships alongside curiosity. Peepshow boxes, phantasmagoria, televisions, computers, and all sorts of modern displays, to some extent, are consumed with curiosity. Without it, we may not feel eager to see what is on a screen or become engaged with the content. But, it also devours our attention and distracts us from other stimuli that might be more important.

Considering the ubiquity of digital screens in today's life, the digital media designer now faces the challenge of thinking about the ways in which the design practices can arouse such emotional feelings to recuperate screens as a wondrous object that engages with its user. While the concept of curiosity has long been used in the screen-based viewing experience, it remains poorly researched. There is no clear discussion of curiosity for improving experience design. As the full range of user experiences (i.e., the role of digital technologies extending from problem solving to entertaining, imagining, socialising and more) has become more important in the

[29] For instance, many first time parents' unforgettable visual memories of their babies are often of the black and white images on the ultrasound screen.

context of everyday living in recent years, curiosity has emerged as a theme in digital media design literature.

A recent trend in public and situated interaction research notices that curiosity is an important motivational factor to draw people's attention to the screen and to invite interaction, though researchers mostly regard it as a motivator used at the initial interaction stage. Seeburger and Foth (2012), in their observational study of mobile screen interaction, identified curiosity as one of the major reasons for people to interact with digital applications to create and share digital content in a public context. According to their analysis, people are curious about new ways of interacting with the displays and thus would like to see what happens next. In another three-year study, the researchers Ojala et al. (2012) also reported that most people's initial interactions (i.e., touching with their research project screen) was due to their curiosity and the novel effect of the deployment of a screen in a given location. As curiosity is as an urge to discover new experiences, a few researchers (e.g., Houben & Weichel, 2013) also suggested that an effective way to overcome the imperative issues of display blindness and display avoidance is by attracting people's curiosity.

As use of digital technologies in urban spaces increases, the design opportunities for explorative, playful, imaginative, interpretive, divergent and aesthetic experience have emerged. A number of researchers in the field of urban informatics have begun to pay attention to ways of designing for awareness and wonderment, and few view curiosity as their central design approach for improving the daily experience of living in a city.[30] In the urban informatics literature, Paulos and Beckman (2006) wrote,

> More than just problem solvers, we are creatures of boundless curiosity: Mixed within our moments of productivity are brief instances of daydreaming. We find ourselves astonished and in awe of not just the extraordinary, but the ordinary. We marvel at mundane everyday experiences and objects that evoke mystery, doubt, and uncertainty. How many newspaper has that person sold today? When was that bus last repaired? How far have I walk today? How many people have ever sat on that bench? Does that woman own a cat? Did a child or adult spit that gum onto the sidewalk? ... How can we design technology to support such wonderment?

Their statement reveals the kind of curiosity they want to provoke in everyday contexts with digital technology. They want to encourage people to become inclined to ask questions about the mundane and the ordinary, and to uncover unexplored possibilities while running the same routine. As technology-mediated interactions are becoming common in mundane activities, more and more design projects' intentions are to increase awareness of ordinary events and the people we encounter within the everyday living space. Curiosity that promotes the individuals' willingness to explore the new in a familiar context becomes an important means for encouraging observation, questioning preconceptions, and challenging assumptions. To nurture a sense of wonder in everyday urban life, a spur of curiosity is the core engine.

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[30] See also Paulos, Jenkins, Joki, and Vora, 2008; Williams, Robles, and Dourish, 2009; de Waal, 2011

A few relevant design ideas that work on our desire to explore the new and unknown have emerged under various names. For instance, designs for inquisitive use (Dalsgaard, 2008), designs for wonderment (Paulos & Beckmann, 2006), designs for reflection and interpretation (Sengers & Gaver, 2006; Odom, Banks, Durrant, Kirk, & Pierce, 2012), defamiliarising the ordinary in design (Paulos & Goodman, 2004; Poirier & Pringle, 2012), instilling qualities of ambiguity with normal everyday objects (Gaver, Beaver, & Benford, 2003; Dalmau, 2003; Bell, Blythe, & Sengers, 2005; Aoki & Woodruff, 2005; Seeburger, 2012), and speculative design (Leahu, Schwenk, & Sengers, 2008) are all related ideas playing on our curious nature to foster engagement and bring out wonderment in the process of digital interaction. Thus, we have seen there has been an emerging interest in the use of curiosity in the field of digital media design.

Problems with existing studies

As shown above, designing for curiosity is gradually becoming a recognised design strategy for increasing motivation or encouraging inquisitiveness in many areas of digital media design. However, curiosity is a rather elusive concept. It seems to have strong but paradoxical effects in today’s screen-saturated context that not only lead one to explore and wonder but also carries unfavourable entailments, such as distractedness and over-stimulation. Moreover, curiosity takes many different forms, which make developing practical design suggestions difficult. These contradictory effects and complicated issues prompt consideration of the role of curiosity in user experience and the ways to develop it. How can we design for curiosity in practical terms that result in enriching user experience when people interact with a screen-mediated technology?

Some common design principles used for sparking curiosity (e.g., adding novelty, making surprising statement, and asking provocative questions)[31] encourage users to experience curiosity at a given moment, but often unavoidably lead users to become bored when they satisfy their curiosity. More importantly, using novelty may lead to loss of attention, only triggering a shallow exploration, i.e., enhancing novel effects may eventually lead to over-stimulation and endless distractions in a screen-saturated context. Thus, designing an engaging experience through stimulating curiosity may have only a short-term effect. The effects are not strong enough to sustain curiosity for long. In other words, using curiosity-provoking strategies to enhance user experience in the view of traditional HCI remains problematic.

The urban informatics design ideas, as previously mentioned, that enable a user to be more attentive and observant to their environment do not illuminate how to keep the momentum ignited by curiosity in practical terms. As Williams, Robles, and Dourish (2009) pointed out, “While the imagination surely plays an important role in good design, the fleeting nature of these interactions raises questions. Do these experiences of imagination, wonderment, or flânerie involve a deep understanding of strangers, or are they merely voyeuristic?” (p. 6). The general practice of evoking curiosity only produces passive engagement rather than promotes deep and active thinking. In

[31] See chapter 2 for more details.

other words, we should put more effort toward sustaining a person's willingness to act on his or her curiosity, rather than just using curiosity to compel people to seek out the information in a passive stance or move in the direction of shallow understanding and illusion.

Also, as previously mentioned, the social aspect of curiosity should have a beneficial effect on the development of social relations. Although recent interest in creating curiosity in interaction experiences increases, the social aspect of curiosity has not been given much attention. As digital technologies already play a large part in our everyday social activity, digital media designers should not overlook the relationship between curiosity and sociability. Agamanolis (2003), cited in the beginning of this chapter, asked how we could foster human bonding through displays. This is an increasingly important issue, as screens of various kinds have transformed many aspects of our social life. Perhaps it is curiosity's powerful motivational nature in personal discovery that makes the practitioners overlook its multifaceted roles in our everyday life. As inspired by photos from a Wikipedia article on curiosity,[32] curiosity would be a critical element to influence the development of social connections in a screen-mediated context.

As the ubiquity of digital screens stimulate restless curiosity, constantly distract people, and immerse us in a personalised network, it is increasingly important to design in a way that nurtures a willingness to engage our physical, perceptual, and

[32] See the previous section

cognitive exploration of the world and care for those around us. We need a deeper understanding of the multifaceted nature of curiosity and the essential roles it plays in our everyday life before exploiting its effects for enhancing user experience. We still lack practical design suggestions for enhancing curiosity in today's screen-mediated context. This research emphasises its importance for user experience design, aims to enrich our understanding of curiosity, and looks for ways to develop it. Instead of assuming that technology dulls curiosity, this thesis considers human beings' curious nature as an important design resource needed to improve digital user experiences. This thesis argues that it is through appealing to our sense of genuine curiosity user experience can go far beyond passive interest, and this will help mitigate the problems of screen ubiquity.

Therefore, this research specifically delves into understanding the nature of human curiosity and explores what factors influence people's curiosity in the interaction process to develop design approaches for nurturing active curiosity. In essence, this thesis takes curiosity as the main research topic, hoping to help increase our understanding of user experience through curiosity, mediating the current contradictory relationship between our desire to know and digital technologies. I argue developing curiosity in people through digital screens should not be achieved by exploiting novelty effects or by exposing people to surprising questions, as there are already many novel stimuli around us in our everyday life. To avoid making screens only produce quickly satisfied curiosity, designs for curiosity should be more gentle, supportive and appealing, i.e., less compelling, aggressive on attention to waylay the mind. More research needs to be carried out on the nature of human curiosity and broaden the way to develop curiosity in people's exploration and interaction with digital media and technology.

Outline of the thesis

As the concept of curiosity in digital media design research remains unclear and confused, I will first explore curiosity's multifaceted role in our everyday life to clarify the essence of the idea of designing for curiosity in user experience design. Then, I will review current design strategies for using curiosity. Having analysed the limitations and problems of existing design practices for curiosity, I will go on to present observational study of exploratory behaviour, and further identify key areas that influence curiosity in the user interaction process. Based on the observational findings, this thesis will develop practical suggestions for curiosity-provoking design in a screen-mediated context. This thesis is divided into six chapters, and it is organised as follows:

Chapter 1 – Exploring the Role of Curiosity in Everyday Life explores what essential roles curiosity plays in our life. Given that most of us intuitively know how it feels, but what it means to us is a rather complex topic. Therefore, in order to propose the idea of designing for curiosity, we should firstly explore what purpose it serves, why it exists with us, and what rewards we gain from being curious, rather than simply define what it is or exploit its effects to influence users' behaviours and actions. Thus, this chapter will present an overview of the present research on human curiosity from various perspectives to synthesise this theme. Then, I will try to reach a conclusion for why we, as human beings, are so curious, and I will summarise the value of nurturing this human trait to user experience design. The points made in this chapter will serve as a basis for further discussion and reflection on the current design practices for curiosity (as shall be discussed in the next chapter). We can then find ways to strengthen its core values in digital interactive experiences to better handle today's design challenges and concerns.

Chapter 2 – Understanding Curiosity in the Current Experience Design provides an overview of curiosity's applications in a range of digital media contexts, including computer instructional design, interactive storytelling, situated and public displays, and web applications, in order to identify current curiosity-provoking principles and room for improvement. Since many designers who intend to provoke curiosity in the user experience usually draw their ideas from one or more of these early classical studies in psychological literature, the first section will review these classic theoretical models. Through a review of theories on curiosity, it will form a foundation to systematically understand curiosity's underlying mechanisms and offer some directions for thinking about curiosity provoking tactics. The next section will examine how curiosity has been used in many digital media design contexts, followed by an analysis of the problems and limitations resulted from utilising early curiosity theories.

Chapter 3 – Identifying Curiosity Triggers through Observation examines what factors may cause curiosity to develop. As the literature review presented in chapter 2 shows, many approaches that designers use to provoke curiosity are cognitive-based strategies and the designers use curiosity primarily to change user's behaviour, they thus do not truly reflect curiosity's core value in life. Given that curiosity and exploratory behaviour are closely associated, the current design strategies for provoking curiosity rarely concern various forms of exploratory behaviour in a screen-based interaction process. Observing people's exploratory behaviour should provide an important inroad to learn ways of cultivating and sustaining people's active curiosity. Therefore, in chapter 3, I will present the results of several observational studies of visitors' interactions with and around the interactive exhibits at the National Museum of Scotland. Then, based on data analysis, I will list the general patterns in the curiosity exploratory process and will point out the significant factors that facilitate or inhibit the emergence of curiosity.

Following from these observational studies, three overarching themes emerged: social dynamics, embodied practices, and playful affordances. These are considered as having a significant impact on the curiosity process. Therefore, each of them will be a separate theme for continuous exploration. In the rest of this thesis (chapter 4, 5, 6), I will elaborate on these three conceptual elements, one chapter at a time, and I will reflect on what aspects of digital media design could help unleash curiosity's potential in regards to these three factors. The collective aim of these three chapters is to expand curiosity-provoking methods and its value in the digital interaction process.

Chapter 4 – Sociability and Curiosity will point out curiosity's social nature, exploring how it can be provoked and conducive to digital interactive experience and foster participatory cultures. Firstly, I will present a review of the literature on the relationship between sociability and curiosity. This literature review will show that social dynamics is the key to both encourage and inhibit one's curiosity, and curiosity's social nature also helps us empathise with others and their experiences in social activities. I will argue curiosity can be explored as a catalyst that helps cultivate social bonding and interaction, which is important in many of today's digital media contexts. The discussion will also include three case studies of relevant works that enhance collaboration and participation through a sense of social curiosity. Then, the focus will re-centre on the observational findings, to re-think what design approaches support the social nature of curiosity in the visitors' exploration and interaction experience.

Chapter 5 – Embodiment and Curiosity seeks to understand why bodily practices (e.g., tactile interaction, bodily gestures, and embodied knowledge) are important in a curiosity-provoked interaction process. The discussion will elaborate on the concept of embodied curiosity, building up the theoretical connection between the body and curiosity to emphasise the embodied nature of curiosity. This discussion will reference some digital media design works that enhance the desire to explore or create a sense of wonder by incorporating or stimulating bodily behaviour. With the reflection on case studies, the focus will look back at how the design of the observed museum exhibits may enhance or inhibit the need of embodied curiosity.

Chapter 6 – Playfulness and Curiosity will focus on the playful nature of curiosity. Inspired by observational studies, I consider that adding playful elements or allowing a sense of play to emerge in the process of interaction would be an effective way to sustain a sense of curiosity and wonderment. Playful elements and the joy they elicit are important ingredients that help users embrace changes in behaviour and thought or relish the discoveries in the unknown. A sense of playfulness should help in preparing the user's deposition to approach unfamiliarity, thriving in making differentiated interaction patterns, and eliciting creative forms of engagement. This chapter will open with a brief overview of the theories of play, find its link to curiosity, and establish a theoretical underpinning for the importance of playfulness in the exploration and curiosity. Then, the discussion will use two case studies to illustrate this point and provide practical examples for discussion. At the end, I will revisit the observational data and re-examine design elements and practices of the observed exhibits. This will identify what design concepts could help the museum visitors' playful experience grow in their curiosity and exploration. In short, I shall argue that adding a sense of playfulness contributes to the curiosity process for divisive and flexible ways of exploration and imagination.

Based on the above discussion, this thesis will expand the values of curiosity in experience design from only drawing attention and initiating actions to include developing diverse adaptability, contributing to emotional resilience, pursuing personally rewarding interests, exercising imagination, and fostering social interaction. More importantly, by addressing curiosity's embodied, social and playful nature, this thesis will offer a useful understanding of curiosity in regards to these three natural characteristics in the digital interactive process. Finally, I will also reflect on research limitations and will suggest the potential area that would need further research on this or related topics. In essence, this research will expand the traditional formula to provoke curiosity by creating information gaps or using elements with novel or surprising effects, and would suit the need for active curiosity in the face of the abundance of digital media and technology.

Chapter 1: Exploring the Role of Curiosity in Everyday Life

1.1 Introduction

> There is nothing more important or more strange than curiosity.
> — John Lloyd (as quoted in Leslie, 2014, p. 13)

Aristotle (350 B.C.E) starts his *Metaphysics* with this opening line: "ALL men by nature desire to know."[33] The tendency to explore the unknown is an inherent human trait. However, this natural trait seems to elude exact definition as it has been defined and described from various perspectives by many people throughout history. Philosophers would see it as the desire for wisdom (see Baumgarten, 2001), religious thinkers would argue it as a moral vice or virtue (see Harrison, 2001), educators would describe it as the motivator for learning (e.g., Williams & Brow, 2012, pp. 75-88), biologists would see it as a kind of seeking instinct (e.g. Morris, 2005), and positive psychologists would argue it as the engine to promote well-being (e.g., Kashdan, 2009). Most of us intuitively know what it feels like when our curiosity is stimulated; therefore, it is easy to underestimate the difficulty of defining it.

Curiosity, as in Lloyd's remark quoted above, is strange but important in our life. In so many circumstances, many inexplicit feelings are involved in curiosity. It is a

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[33] Many studies and articles on curiosity mentioned this quote or started out with a reference dating back to the times of Aristotle. See the works of Lowenstein (1994) and Tieben and Bekker (2011) for examples.

sheer pleasure to open a gift-wrapped present. It is an addiction to constantly check Facebook updates. It is an anxiety to when not knowing someone's intention to lock on your door.[34] It is an "aha!" moment when an itch of curiosity is scratched.[35] It is a charm to be enchanted by extraordinary natural wonders. It is a feeling of being lost when finding ourselves absorbed in a mystery story.[36] It is a passion to pursue a challenging research topic. It is the unnerving tension when stepping into an unknown territory. It is an impulsive response when we cannot look away from an unusual signal.[37] It is a transgression when wanting to know a forbidden world. Since there are numerous ways to represent curiosity, defining it a rather complex task. In the academic literature on curiosity, several researchers have noted that there is a lack of consensus on the unified definition of curiosity (e.g., Jirout & Klahr, 2012, p.3; Arnone, Small, Chauncey, & McKenna, 2011, p. 185).

This difficulty in delineating the concept of curiosity may arise from its elusive nature: its focus can be converged as well as distracted; the mood derived from it can be delightful as well as disturbing and anxious; its strength can be enduring as well

[34] See also section 2.2.4 Information gap theory of curiosity, in which Loewenstein (1994) defines the feeling of lacking desired knowledge as 'a feeling of deprivation,' thus acquiring needed knowledge can be intrinsically rewarding because it dispels unpleasant states of ignorance.
[35] Using the word *itch* to describe curiosity is from an article *The itch of curiosity*, in which the writer Jonah Lehrer (2010) describes the feeling of curiosity like "a mental itch, a mosquito bite on the brain. We seek out new knowledge because we that's how we scratch the itch" (para. 3).
[36] Recall Mihaly Czikszentmihalyi's concept of flow, which refers to a person who is deeply absorbed in what he or she is doing. Curiosity is identified as one of the key constituent components to achieve and maintain a state of flow (see Rotto, 1994).
[37] Recall the term *investigatory reflex* used by Pavlov, which describes the dog's responses toward any unusual sight or sound. Later, according to Loewenstein (1994), Bühler and others also referred to the same behavioural styles in their observations of human babies' responsive tendency to the new as *curiosity*; however, this kind of orienting reflexes has been later labelled as *attention* since it is not motivated at an emotional level.

as fleeting; its result can be profound as well as futile or superfluous. The 18th century philosopher Edmund Burke (1757) recognised this paradox and impermanence in our curious nature, having written that “curiosity is the most superficial of all the affections; it changes its object perpetually, it has an appetite which is very sharp, but very easily satisfied; and it has always an appearance of giddiness, restlessness, and anxiety.”[38] I wonder why we human beings have such an indefinable curious nature. This question, I think, should be more important than asking what curiosity is when thinking of using technology to engage it, even though looking for the definitive meaning of the concept appears very fundamental to the study of user experience design when taking a specific kind of experience as an intended outcome of the design.

While I was writing up this thesis, I asked students at Edinburgh College of Art (ECA) about their views and experiences on using curiosity in their works via an online questionnaire (see Appendix A: Online survey on curiosity design). Based on the collected data from thirty-three respondents, it is evident that the common understanding of curiosity is inconclusive and multidimensional.[39] Most of the participants associated curiosity with multiple feelings. For instance, one participant selected feelings, including anxiety and uncertainty, imagination and fascination, and interest and playfulness, to represent curiosity. Very few people selected a single

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[38] Loewenstein (1994), who is known for his information gap theory of curiosity (as I shall discuss in section 2.2.4 in chapter 2), also cited Burke’s words on curiosity to point out its five characteristics – intensity, transience, impulsivity, superficiality, and tendency to disappoint when satisfied.
[39] See participants’ answers to the first two questions in Appendix A

term to associate with curiosity. In addition, most respondents who have ever tried to use curiosity in their work thought curiosity was very important.[40] However, the use of curiosity in their works was seemingly not related to their views on curiosity. For instance, one respondent described the role of curiosity in his or her work as keeping people focused and engaged in topics and activities, but chose the words *childlike* and *unfettered* to describe curiosity; another respondent, who viewed curiosity with the negative feelings of anxiety and uncertainty, used curiosity to keep engagement when considering its role in the process of doing his or her artworks. Curiosity's multifaceted and elusive expressive forms do not logically guide designers to use it in the same way they view this concept.

In many areas of digital media design projects, the concept of curiosity remains elusive (as I shall present later in this chapter). Some noticed its motivational effect for grabbing attention, initiating action and fostering engagement; others found the curiosity-provoking practice generated a novelty effect and a pleasurable experience when used in designs for fun and whimsy. As mentioned in the introduction, while satisfying our desire to know, the ubiquity of digital screens has caused paradoxical problems, such as over-stimulation, distractedness, and shallow thinking. The result of being temporarily attracted to and satisfied with everything novel has caused

[40] See the survey data on the question 7: How important is curiosity in your work? According to participants' answers, most people who had used curiosity in their work considered it to be very important. See more details in Appendix A

concern that demands designers and developers of digital media technology to pay more close attention and accept more responsibility when utilising curiosity's effects.

While most of us recognise curiosity's various effects, we do not really know why we are so curious by nature and what it means to us. To exploit the effects of curiosity or propose strategies for provoking this inherent but elusive human trait, the question about what it is for (i.e., what purposes it serves and what roles it plays in our life) should be explored first. Before proceeding to research how to nurture curiosity in digital media and technology, it is more important to have a clear understanding of what roles curiosity plays in our everyday life and what effects of curiosity we need to encourage in the digital screen saturated age. Therefore, in this chapter, I will take up this question.

What follows is a review of literature across various disciplines to synthesise this chapter, ranging from biological and evolutionary perspectives to brain studies to recent psychological research on curiosity. Based on a wide-ranging review of literature, this chapter will form a tapestry showing the role curiosity plays in our everyday life, and it will consider its implications in experience design. Then, the conclusion will be used as a basis to examine current curiosity design practices and find ways to strengthen its core values in the design of user experience.

1.2 Literature review on curiosity

1.2.1 Biological and evolutionary perspectives

> The human being is a curious creature and that is a good thing ... — Michael Gazzaniga (as quoted in Reio, Petrosko, Wiswell, & Thongsukmag, 2006, p. 117)
>
> One of the most fundamental characteristics of our species *Homo sapiens* is its unquenchable curiosity about the world around it, and about itself and its place in that world in particular.
> — Ian Tattersall, 2003, p. 1

Firstly, the role curiosity plays in our life can be found in early studies of the seeking instinct and exploratory behaviour of animals and human beings. In his 1967 book *The Naked Ape*, the zoologist Desmond Morris proposed that all species on the plant could be roughly distinguished into two major categories: the specialists and the opportunists (Morris, 2005, pp. 88-98). For the specialist species, they have evolved their physical structures and set of behaviours towards one particular survival skill during the course of evolution, which allows them to fill an ecological niche and becomes more competitive with other organisms in a particular stable habitat. These specialists have no disposition to actively explore the environment when their basic needs for survival are fulfilled. Anteaters, porcupines, hedgehogs, skunks, and koalas fall into this category. The opportunist creatures, alternatively, are not adept at one narrow advantage, and they have the tendency to move out of their comfort zone. They possess a high level of curiosity and their behaviour is more conductive to constantly exploration and investigation of their surroundings, which allows them to find more resources for survival and adaptation. Mongooses, lemurs and monkeys could be considered opportunists since they all have the propensity to engage in new behaviours that give them more flexibly to cope with their changing circumstances. In other words, the very nature of curiosity is very organic to the survival of the opportunist species.

In his book *Neophilia: The Tradition of the New*, Lyall Watson (1989) observed two giant felines in the zoo, lions and tigers, and gave a paradigmatic example of the behavioural differences between those who love the new (which Watson refers to as *the neophilic species*) and those who dislike change (in Watson terms, they are called *the neophobic*[41]). Despite the anatomical similarity in biology, lions seem content to lie down and can endure prolonged inactivity within the confines of its comfort zone. The well-fed lions can even produce more offspring in the zoo. Lions would be neophobic. Tigers, on the contrary, have neophilic traits, being quite temperamental and more explorative. They are less able to tolerate boredom in their restricted life (Watson, 1989, pp. 11-14). It appears that life for neophobic creatures is easier and satisfactory. However, from a long-term perspective, the neophilic are much more likely to survive in a wider range of environmental circumstances, because the specialists cannot adapt rapidly when the living conditions and food sources undergo a major change. When the opportunistic species are put under greater biological

[41] According to Maxey (2004), the term *neophobia* is coined by psychologist William James (1842-1910).

pressure by competing with more fellow animals for the limited natural resources of its habitat, they evolve somewhat more quickly than specialists.

We human beings, in Morris (2005, p. 88) and Watson's (1989, p. 12) terms, are "the supreme opportunist." Although we are not equipped with specialised survival skills for one particular environment, we have an unquenchable desire for new experiences and information that helps us gain knowledge and learn the necessary skills. For instance, we do not have extremely sharp vision[42] or keen auditory senses,[43] but our fascination with the beauty of nature has led us to create many incredible pieces of art and music; we do not have strong enough muscles to run faster than many animals, but our interest in exploration and adventure builds all kinds of vehicles to move and travel; we do not have the capability to fly, but our gaze at the stars in the night sky has driven us to build *Curiosity*, NASA's Mars rover, to explore a far-far-away planet. In other words, we are not born with a viable specialisation, but our ability to master and excel is largely driven by our desire to know and explore and by our interaction with the environment. In existing literature, many have argued that our love for the new and different is the greatest human survival skill (e.g., Bruner, 1966, p. 115; Morris, 2005, p. 88; Parker, 1978; Grand, 1998; Voss & Keller, 1983;[44]

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[42] Human beings cannot sense very low light levels while some animals can (see Erichsen & Woodhouse, 2012).
[43] Many animals have a higher range of sounds that humans cannot hear. Rats, for instance, can hear the high-pitched sound.
[44] According to Čavojová & Sollár (2007), Voss and Keller also stressed that the trait of curiosity and the behaviours it induces are important to help human beings adapt to environmental changes.

Gazzaniga, 2005; Gallagher, 2011[45]). As Watson (1989) claimed, curiosity is "the secret of human success" (p. 12).

In the greatest mystery of how we became the present-day humans, our neophilic behavioural trait has been hypothesised to play a crucial role in making our ancestors come out top among the early hominids. In *New: Understanding Our Need for Novelty and Change*, the author Winifred Gallagher (2011), based on genetic evidence and archaeological studies, pointed out that our curious nature is an important competitive trait to ensure the evolutionary success. According to Gallagher (2011), our direct ancestors *Homo sapiens*, who originated about 195,000 years ago in Africa, seem to have physiological functions that are similar to other ancient human beings. For example, *Homo sapiens* and the other earliest known species in the human lineage, such as *Homo habilis* and *Homo erectus*, had shared similar capabilities, including the ability to walk long distances and use tools. However, *Homo sapiens* had more intense exploratory urges and developed more consolidated social relationships that helped with long-run survival. While the living environment in Africa deteriorated, humans began migrating out of Africa into other parts of the world. *Homo sapiens*, with their explorative and neophilic nature, developed a more diverse adaptability to inhabit various places, such as forests, deserts, plains, or mountains (Gallagher, 2011, pp. 15-43).

[45] It is Gallagher's (2011) discussion about the evolutionary origins of curiosity that partly inspired me to think about the true value of human curiosity. Her book *New: Understanding our need for novelty and change* is formative and helpful in my thinking about what human curiosity is for.

Furthermore, when competing with other ancient human species, this neophilic characteristic proved its vital importance for success in hominid evolution. The caveman *Homo neanderthalensis*, who was considered the closest present-day humans' evolutionary relatives but became extinct around 30,000 years ago, had many anatomical characteristics and abilities parallel to that of *Homo sapiens*, such as the brain's size, the ability to use stone tools and the production of cultural artefacts (e.g., faunal material).[46] Some studies even suggested the Neanderthals had more physical advantages over *Homo sapiens*, including strong upper arms, sturdy bone structure, and a slightly larger brain volume than those of *Homo sapiens*. But all of the physical advantages were not enough to guarantee their survival. Researchers, such as Wynn and Coolidge (2012), have suggested that the ways they behaved affected their long term survival.[47] Neanderthals' less neophilic tendencies, such as xenophobia, resistance to change, and predisposition against long-distance travel, resulted in less experimentation with tool making, autonoetic thinking[48], and weak symbolic reasoning. However, *Homo sapiens* seemed more compelled to experience the new, being more social, risk-taking and explorative, which enabled them to take more from the environment and to form larger social groups. At the time, competing with the Neanderthals in the same region, *Homo sapiens* took more competitive advantages for shrinking resources and adaptive to climatic changes during the Ice Age Europe (Gallagher, 2011, pp. 15-43). Obviously, *Homo sapiens*

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[46] For more nuanced accounts of the difference between the Neanderthals and the earliest *Homo sapiens*, see Tattersall (2003).

[47] For more details on Neanderthals' personality traits, see Wynn and Coolidge (2012).

[48] According to Wynn and Coolidge (2012), autonoesis is "a subjective sense of time with a past and a future and an ability to place oneself in the past and future" (p. 43).

became the only extant human being. Our ancestors' curiosity and exploratory tendencies proved its crucial value to the existence of the present-day humans.[49]

Although what doomed the Neanderthals and other early hominids to extinction may not have been a single cause, *Homo sapiens*' strong tendency for novelty, difference, and inventiveness was apparent in prehistoric culture and has been well-demonstrated with archaeological and fossil evidence, such as sophisticated tools, figurative art,[50] music, ritual burial, personal adornment,[51] and symbolic pieces.[52] This set of sensibilities and capacities that *Homo sapiens* and the present-day humans all exhibit are thought to result directly or indirectly from this natural desire to know more. For instance, *Homo sapiens*' pondering about the afterlife led them to create rituals or special ceremonies for the burials of the dead, including more complex symbolic expression shown through their grave goods; however, the Neanderthals, who were less curious about the past and the future, showed no symbolic content in their burials (Wynn & Coolidge, 2012; Tattersall, 2003). For having well-defined tools, *Homo sapiens* would have been more interested in different ways of accomplishing goals and experimenting with tool making. Fine tools were found in their community sites, such as smaller sewing needles and more specialised bows and arrows. The Neanderthals, although they developed advanced tools earlier than

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[49] There are many explanations regarding Neanderthal extinction; however, the intense neophilic behavioural trail of *Home sapiens* remains regarded as one of the most popular explanations (see Wynn & Coolidge, 2012, pp. 167-168).
[50] For example, petroglyphs (rock engravings), symbolic, and abstract designs carved on tools.
[51] For example, using beads and pendants do body ornamentation and express self-awareness.
[52] According to Tattersall (2003), *Homo sapiens* from about 30,000 to 40,000 years ago have begun to make music and create pictures of the world around them, as evident in the magnificent cave paintings at Lascaux and Chauvet in France (also known as the 'Creative Explosion').

Homo sapiens, showed an inability to innovate (Wynn & Coolidge, 2012, pp. 71-72). The sophisticated ability driven by the neophilic trait helped *Homo sapiens* not only become more adaptive to cope with changes in the environment but also thrive in different ways of living.

As the educational psychologist Jerome Bruner (1966) has claimed, “Curiosity is essential to the survival not only of the individual but of the species” (p. 115). Human beings, as the non-specialist in nature, have evolved to survive and thrive in the world through exploration of the new and unknown. In other words, curiosity functions as the survival and thriving skill of the human species. Even today, the story of how we become who we are still has many unsolved mysteries; however, it is hard to deny the fact that our neophilic tendency (i.e., curious nature) has long developed with us and played an essential role in making modern human capability become fully fledged.

1.2.2 Brain studies of curiosity

In recent years, many neuroscientists have begun to explore curiosity’s underlying mechanisms and its relationship to brain activity. From their findings, we can also identify to identify curiosity’s potential benefits and roles in our everyday life.

According to Ratey’s guide to the brain, human beings’ attention has three basic modes: survival mode, curiosity mode, and engagement mode (as cited in Kaufeldt, 2010). When life-threatening stimuli are perceived, humans promptly enter survival mode, which enables us to react and respond instantaneously. When safety ensured, humans pay less attention to ordinary events. Instead, they are more likely to be attracted to novel, different, uncertain, and unfinished stimuli (e.g., an ambiguous image, a strange sound, an unexpected smell, an unclear sight, and a fresh idea). In this mode, the feeling of curiosity has emotional consequences that motivate investigation into the source of uncertainty. Curiosity keeps our attention until we reach the edge of that novel experience. If the focus on the new stimulus is well-sustained or the curiosity is especially well-motivated, it could develop into more engaging experiences. Therefore, curiosity plays a significant role in directing the selection of focus, ranging from very trivial (e.g., checking updates on Facebook and being drawn to the crowd) to deliberative and sustainable activities (e.g., solving problems and carrying out research projects).

To look at it more deeply, how an individual switches amongst these modes is associated with the level of arousal and memory stored in the brain. A high level of arousal fosters agitation, focus and quick reactions to avoid the danger if necessary. Arousal is thought to stem from primitive times when early humans needed to wake instantly and move about to avoid wild animal attacks (Ratey, 2007, p. 115). The research on brains identifies that the arousal state is largely controlled by the brain's reticular activating system, which functions as a gatekeeper to selection which stimuli demand focus (e.g., Force, n.d.; Turner & Knapp, 1995). As the ultimate function of the reticular activating system is survival, it has evolved to process incoming information more efficiently to cope with potential threats by filtering out usual incoming stimuli and being more attentive to changes in one's immediate vicinity. Curiosity, as our natural tendency to engage with the new and different from the external or internal, can trigger the reticular activating system that stimulates arousal and thus aids in attentional engagement and personal survival.

Our brain has evolved as the novelty detection system (Gallagher, 2011) that is essential to our survival because anything new or unknown is potentially harmful. For the survival of opportunist species, the neophilic trait that activates the brain when encountering novelty helps individuals screen out the known information and enables them to respond to changes within their environment more efficiently. The psychological research on novelty effects also confirms that novelty plays a critical stimulating role in our attention. As proven in studies on the weapon focus effect, the presence of guns commands attention that impairs eyewitnesses remember peripheral details of a crime. Guns are similar to unusual objects in people's attention to peripheral details (Gallagher, 2011, p. 29-30; Hope & Wright, 2007). These findings suggest that our brain's attention and curiosity are associated with how striking the incoming information is, i.e., the contrast with the present world. In other words, curiosity engages us through accentuating the difference between what we know and what we want to know, rather than through the fixed properties of stimuli. As Oliver Burkeman (2009) said, "Curiosity is a quality of attention, not a property of specific objects" (para. 4).

The brain as a novelty detector also has important implications on our learning, creativity, and innovation. A new, different, unusual, and unexpected object or idea can actually improve our brain's performance. For example, just having a walk or visiting a new place that creates a moment of discovery can spark curiosity and temporarily invigorate us (Gallagher, 2011, pp. 33-37). Several brain studies have shown that learning new things, either in children or adults, contributes to the brain's flexibility or develops resilience strengths (e.g., Driemeyer, Boyke, Gaser, Buchel, & May, 2008; Ditye et al., 2013). Curiosity, as a strong desire to know and learn, helps our brains remain elastic, so that we can learn new information more quickly. Today, for the same reason, one of the ways people promote creativity, productivity and innovation is to introduce the novel or differentness in their workplaces. In English, the notion of innovation emerged in the mid-16th century means to "make changes in something established" (Innovate, n.d.). The exploration of the new and different gives a quick boost to creativity, productivity, and innovation.

Being a species with extraordinary curiosity, our brains have a strong affinity for novelty to stimulate exploration and learning. To reward our ventures into the unknown, for good or bad, evolution has guided our brains to find this risky act emotionally pleasing.[53] This pleasurable reward is deeply rooted in our primal genetic code and provides evidence that we are hardwired to learn and explore the new in a positive state of mind. Scientists who have investigated the underlying neural processes of curiosity and novelty seeking propose the theory of the brain's reward centre. When faced with novelty, the chemical dopamine is released in the brain, which motivates individuals to seek out with goal-directed behaviour

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[53] As psychologist Todd Kashdan put it, "We are hardwired to experience a rush of excitement when something novel and unpredictable breaks through the routine" (as quoted in Jacobs, 2009).

(Weinschenk, 2012) and makes people feel pleasure (Schweizer, 2006).[54] The curiosity-triggered experience gives us temporary pleasure and sometimes the feeling of exhilaration. However, dopamine can also be released when we experience good food, sex, alcohol, drugs, gambling, or even when we read scary stories. This also provides an explanation as to why people sometimes find the feeling of curiosity to be addictive, much like taking drugs. Some may say that the allure of unanswered questions is as compulsive as that of drugs. Our inquisitive impulse has a curious relationship with dangerously addictive stimuli.

According to Weinschenk (2012), other dopamine blockers called the opioid system govern satisfaction that makes us feel satisfied and fulfilled, so the thrill of experiencing novelty will end. More importantly, the dopamine system is stronger than the opioid system; that is to say, we tend to experience curiosity even after our need for novelty is fulfilled (Weinschenk, 2012; Litman, 2005). The previously-mentioned Watson's (1989) studies also echo this view. Neophilic species with high levels of curiosity, such as tigers, are more explorative and less able to endure prolonged inactivity. Recalling behavioural psychologists' research on curiosity in the 19th century, they performed experiments on animals to understand curiosity and exploration. Researchers, such as James Olds and Peter Milner (as cited in Weinschenk, 2012), found that rats would willingly receive shocks in order to explore new things, even if the exploration is not related to food, and monkeys would

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[54] In recent scientific research, the genes that control the release of dopamine have been called *the novelty-seeking genes* (Schweizer, 2006).

still try to solve puzzles where no extrinsic rewards are provided. In another study, monkeys locked up in cages would keep opening windows only to see the world outside the cage (Piccone, 1999). Neophilic species are less able to endure inactivity. Extending this logic, the desire to know more rather than simply being satisfied with current knowledge is important for evolutionary development.

From an evolutionary perspective, we would become less adaptable if we only become habituated to novelty. Curiosity helps us resist rigid adaptation. Although the pleasure that discovery brings lasts for only a short period of time, it allows us to suspend the quest. Otherwise, we would constantly be on the move. In other words, we would always be in search of the next adventure and become chronically restless. Therefore, even though we evolved to be restless creatures, we cannot afford constant stimulation or else we would not accomplish anything. As the brain is aroused by, and then becomes adapted to, the new stimuli, the thrilling sense of curiosity fades quickly.[55] As a consequence, individuals will shift their attention to the next discovery. Also, since people will eventually lose interest in previously discovered stimuli, they seek new stimuli out and learn to better allocate time and energy. In other words, we learn new knowledge with intrinsic pleasure and become adapted to the change with appropriate resilience. The positive emotional reward is how we overcome anxiety, foster our interaction with the environment, and develop diverse adaptation.

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[55] This is because the inhibiting system works to conserve the brain's energy as the stimulus becomes familiar.

Therefore, human beings are equipped with the best physical and psychological rewards to promote exploratory behaviour and to be more open to the unknown. The more humans explore, the more knowledge and experience they can gain. Some experiences may appear to have no immediate practical application, but they could be stored in the memory, which allows one to retrieve them later. Resolving curiosity helps people broaden their understanding of the world, and accumulatively and progressively improves their ability to predict the future, which are all important benefits for human beings' survival. As the brain of a non-specialist species is not fixed at the start, we have the potential to learn skills necessary to excel in, and adapt to, our living space. As Bruner (1966) stated, "our specialisation as a species is a specialisation for learning" (p. 113).

In short, through focusing on novelty and differences, our brain can more efficiently deal with incoming information. Through intrinsic pleasurable rewards, we have a positive motivation to follow curiosity, overcome the fear of uncertainty, and deal with anxiety when venturing into the unknown. The feeling of satisfaction helps the curious brain work under mounting stress. From these neuropsychological points-of-view, our brain information processing models and physiological feedback allow us to efficiently and actively explore the unknown with positive emotions. The curious brain is one of the most effective learning mechanisms. Through exploration and learning, people stand the better chance of surviving and thriving in a constantly changing environment.

1.2.3 Personal development perspectives

Recent studies from the field of psychology also provide important insights into curiosity's multifaceted nature and its link to personal growth and development.

As for curiosity's diverse nature, studies of behavioural psychology found that animals and human babies that had experienced the lower level of sensory curiosity within an impoverished environment at an early age would have impaired abilities to learn later in life (Bruner, 1966, p. 166). Children who have a culturally diverse experience (i.e., having been exposed to different ways of life, including languages, foods, clothing, etc.) develop and learn more flexibly and optimally later in life (Butcher, 2007, p. 113-114). These studies reveal that the functions of early childhood curiosity make young children experience novelty have long-term effects on personal growth and development. Although children's curiosity for new impressions may increase the potential danger, their struggles with wide-ranging experiences help them sort out their relationships with the world and foster competence. In short, the more opportunities a child has to be exposed to difference, the more experiences he or she gains, which later become important assets.

In adults, researchers have also discovered that creative performance can be benefit from multicultural exposure (e.g., Leung, Maddux, Galinsky, & Chiu, 2008; Leung & Chiu, 2010). The ongoing research examining the underlying cognitive process also confirms that individuals who are actively involved in unusual or unexpected experiences are pushed outside the realm of normality and thus leads to more flexible and creative thinking (Ritter et al., 2012). These findings also reinforce brain studies, as mentioned in the previous section, that learning new things can continually strengthen the brain's plasticity (i.e., new experiences enhance the development of creativity). The implications of these findings point out that curiosity leads to diverse experiences, which enhance cognitive flexibility and aid in future creativity.[56] Having been evolved as supreme opportunists, curiosity's diverse nature motivates us to seek out new experiences or frequently try out different activities.

However, such modes of curiosity are often experienced briefly. The thrill of curiosity fades quickly much of the time. In neurological terms, as described previously, curiosity is caused by just a small dose of dopamine coursing through the brain. It seems, in many cases, to be unproductive or a waste of time and energy. Distraction (or diversion, futility, superficiality, aimlessness) is thought to result from being attracted to novelty temporarily. It seems futile. However, as discussed in the previous section, the very nature of curious emotions is to make us experience what is unknown, so it ceases when we reach the edge of the new experience. In other words, we stop feeling curious when we become used to the new stimulus; therefore, we move onto the next unknown stimulus and expand our knowledge base.

From the perspective of creativity and inventiveness, curiosity's diverse nature broadens our understanding of the world. Curiosity seems, as described by the

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[56] See also Rounds' (2004) article *Strategies for the Curiosity-Driven Museum Visitor*, in which he regards curiosity as the foundation of creativity and suggests that "We best enhance our potential for creativity by acquiring a large and diverse store of 'useless' information." (p. 394).

aforementioned Edmund Burke, to keep us flying, restless, and all-consuming; but, as our life experiences extend, we plant more seeds for future competition. Its harvest, including creativity, flexibility, and diverse adaptation, pays the cost. In short, although sometimes we cannot see the immediate advantages of fleeting curiosity, diverse experience, as seen above, is essential to our ability to build knowledge and boost creative capacity.

Furthermore, as for curiosity's enduring nature, our cultural knowledge already shows its relationship with learning and specialisation. An oriental centuries-old tradition *zhuā zhōu* that consists of presenting many symbolic objects for the baby to catch on its one-year-old birthday to predict future career choices is an example. This ritual shows that the ancients know our preferences and reactions to new stimuli can become longstanding interests that lasts a lifetime.[57] In English, among the obsolete meanings of the very word *curiosity*, some definitions, including proficiency, skill, and connoisseurship used in around the 17th and 18th centuries (Curiosity, n.d.), also reflect people's awareness of curiosity's relationship to long-term activities and

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[57] *zhuā zhōu* (Chinese: 抓周; *zhuā* [抓] is 'to grab, pick, or scratch', and the character *zhōu* [周] means 'the recurring date of a past event') is an interesting popular ritual practiced by many Chinese ethnic groups for predicting one's career choices at the child's first birthday. At the baby's first birthday, the adult places several items (each one symbolises different meanings) in front of the child for him or her to grasp. The first thing the child grasps (or the thing that most interests the child) is used to predict his or her future profession. For example, holding a book symbolises the child is suitable for developing an academic career; touching an abacus says one can excel in counting or doing business; grabbing a ruler predicts the child's talent in architectural design. With changes in technology, the items for *zhuā zhōu* also have different styles. Today people may add the mobile device (symbolising computer engineer), microphone (symbolising singer) or others to predict a child's future. This ritual taps into the child's natural curiosity to presage affinity for future jobs or lifelong interests. As such, this tradition also suggests that one's success (or proficiency) in a certain field is led by his or her natural curiosity. Note: It is also known as 'becoming one year old ceremony,' but some people translate it in English as 'draw lots.'

learning. It makes sense that proficiency and elaborate workmanship can be attained by careful application, if people persistently and steadily employ their attention to the activities that excite them. This cultural knowledge reflects our understanding that individual preference for the selection of objects of curiosity can be developed into a more enduring desire to master skills or develop a deeper understanding of subjects.

In history, many famous anecdotes of great discoveries often start with a small question, which further evidences this point. For example, the most famous story of Newton and the apple. Sir Isaac Newton saw an apple fall from a tree and asked, “Why should that apple always descend perpendicularly to the ground …” (The Royal Society, n.d.). Exploration of this question led him to discover the law of universal gravitation and pushed modern physics to a new frontier. Others, like James Watt’s question about the force of steam escaping from the spout and the Wright brothers’ wondering why man cannot soar in the sky like a bird, are similar stories that remind us that great accomplishments grow from a pure desire to know (Sussman, 2009, pp. 8-12). Many famous historical figures also tend to attribute their success to this simple human nature. As Albert Einstein has famously said of himself, “I have no special talent. I am only passionately curious.” In other words, small, pure wonders discovered in every day might develop into quests for something that is meaningful to our lives.

Human beings’ curiosity has this enduring quality that distinguishes us from other neophilic species. Morris (2005) observed the picture-making behaviour of human babies and young chimpanzees’, noting that chimpanzees could not advance their drawing skills and lost their interest in novelty around the age of three.[58] Many non-human primates' exploratory urges reduce significantly as they grow and mature. Of all the neophilic creatures, the human beings' curiosity can be strengthened and progress to a more complex stage over the lifespan. In a study of ape's linguistic capability, researchers found that orangutans can learn some vocabulary for basic communication but they show no curiosity about what lies beyond their present understanding of its surrounding (Leslie, 2014). Human beings are given many advantages, such as big brains and the ability to communicate in detail with others, that help our curiosity go further than other neophilic species. For most neophilic species, the search for information is only triggered by an urgent impulse to know (i.e., the immediate stimuli needed for an immediate survival). As human beings have learned to think in great abstractions, we can wonder and speculate about things that might not exist.[59] This leads to both the survival and thriving of our species. For the obvious truth, we cannot know what we will need in the future; curiosity leads us to look beyond what has happened, lets us challenge and advance what we have learned, and thereby, in turn, helps survival and development.

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[58] According to Morris' (2005) observation of children's drawing, when a young child is faced with paper and pen for the first time, they do not look forward to interesting results. But when he or she accidentally discovers that the contact of pen and paper produces a dot, a mark, or a line that can actually follow their hands' movement, it delights their eyes and triggers curiosity. The children can get sheer joy from the free, messy visual impacts, and enjoy having control of changing the reality of the paper (p. 90).

[59] Ratey (2007) also noted that as *Homo sapiens* possessed symbolic capacity to develop abstract thoughts, novel ideas from within his or her own thoughts could be a good trigger to stimulate arousal (p. 115).

Apparently, this intellectual stimulation aroused from within has been viewed as a unique characteristic of human beings' curiosity. Many terms have been coined in the area of curiosity research for such unique characteristics. For example, in his 1980 book *Principles of Psychology*, William James used *metaphysical wonder* to label the type of curiosity aroused by our incidental thoughts (James, 1890).[60] Also, Daniel Berlyne, who is regarded as one of the most influential scholars in the field of curiosity studies, defines humans' desire to know as *epistemic curiosity* to distinguish it from *perceptual curiosity*, which is provoked by specific novel stimuli (Berlyne, 1954).[61] And Ian Leslie, the author of the *book Curious: the Desire to Know and Why Your Future Depends on It*, also describes humans' desire to know more than the present need as *the fourth drive* (as the first three drives are for food, sex, and shelter to survive), and emphasises it is the unique characteristic of human curiosity (Leslie, 2014, pp. 1-22).

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[60] In *Principles of Psychology*, James proposed two classic kinds of curiosity. The first unnamed kind of curiosity is mostly biological in nature. As influenced by the evolutionary view that exploratory behaviour arises from survival and biological needs, this kind of curiosity is regarded as an instinctive motivation that motivates living beings to approach and explore new objects in the environment with all its senses, whereas the antagonistic emotion fear leads it to retreat from the potential danger related to that exploration. The second kind, James conceived, as said, is *metaphysical wonder* (or a *scientific curiosity*) with which the "philosophic brain responds to an inconsistency or a gap in its knowledge, just as the musical brain responds to a discord in what it hears" (James, 1890, p. 430; as also quoted in Edelman, 1997; Borowske, 2005). Although his classification of curiosity is not cited to this day in design literature, James provides a basic form to discuss the multifaceted nature of curiosity from its conceptual distinctive dimensions, and his cognitive-based explanation of how scientific curiosity is elicited anticipates Loewenstein's information gap theory (as shall be explained in the next chapter) which has a wide range of applications in many areas of digital media design.

[61] Berlyne extended James's two types of curiosity into a four-fold classification by locating it along two dimensions: one spanning perceptual and epistemic curiosity, and the other extending between diversive and specific behaviour (as shall be explained in the next chapter). Epistemic curiosity is defined as a "drive to know" (p. 187) and is reducible by "knowledge rehearsal," which somehow corresponds with James' scientific curiosity (Berlyne, 1954, as also quoted in Mittman and Terrell, 1964). For a review of Berlyne's theory of curiosity, see Loewenstein (1994).

The exploratory behaviours of human beings thrive with wonder, fascination, and inquiry into something beyond the present. This is also reflected in our engagement with art. In research of what engages viewers' interest in photography, the visual elements that imply something existing outside the image or imply a mythology beyond our understanding can effectively stir our desire to see unseen presences (Suler, 2013).[62] From an evolutionary standpoint, this innate desire to know beyond present needs is critical. The urge triggered within our own thoughts, not from the perceptual stimuli or from the environment, is an important driving force for us to explore new horizons to see if there are more resources, which is what underpinned the early human beings' venture out of Africa.

Being curious beyond the immediate to engage in long-term intellectual pursuit certainly plays a crucial role in human beings' survival and thriving. From the point-of-view of human motivation, such drives that can be sustained without perceivable immediate feedback are kinds of intrinsic motivation. In psychological studies on the reasons for human behaviour, motivation is often defined as the force that activates goal-oriented behaviour to satisfy needs (e.g., the need to feel competent, the need for relatedness, the need to know, and the need for novelty and change),[63] and its sources have been generally categorised as either intrinsic or extrinsic. By definition, intrinsic motivations are aroused by one's own internal satisfaction or fulfilment

62 Also recall the mystery of Mona Lisa's smile, see Gaver et al. (2003) for a brief discussion
63 See Huitt, 2011

rather than by external rewards (e.g., money, promotion, positive feedback, pleasing someone else, and avoiding a punishment).

Psychologists, such as Blarer (as cited in Edelman, 1997), Beswick (2000) and Litman (2005), recognised curiosity as one of the fundamental intrinsic motivations of human behaviour. This innate motivational force ensures that our reward for exploring the unknown is intrinsic to the curiosity process. In other words, the value of resolving curiosity is not placed on the result of a task. The late Apple founder Steve Jobs, for instance, learned about serif and san serif typefaces just out of a pure fascination with their beauty, but this experience, ten years later, became the excellent font design used in the first personal computers.[64] In many priceless inventions and discoveries in human history, inventors and creators were often simply driven by curiosity as there was little or no perceived usefulness at the time they pursued their answers. So, this non-utilitarian, intrinsic motivation encourages our exploration of the unknown for its own sake, the pursuit of any quest that interests us, which is of vital significance to human survival and development.

In short, curiosity has both a fleeting and enduring nature, from diversifying our experiences through exploring the new and different, to deepening learning and mastery for curiosity's own sake. How wide and how deep we can exercise our curious brain gradually shapes many experiences of our lives. Many experiences motivated by intrinsic curiosity-driven exploration provide the building blocks upon

[64] This story is from Steve Jobs' commencement address delivered to the graduates of Stanford University in 2005 (see Apple History Channel, 2006).

which we form the foundation to find meanings within our lives. Our inquisitiveness often simply starts with pure curiosity. This instinctive motivation is somewhat neutral, which can help us speculate more widely and find answers from a wider point-of-view. Which answers satisfy one's curiosity and when to cease that quest is linked to how we assess the importance or relevance of the question. I think the quality of the answers we find continuously in everyday life can have the accumulated effect on developing the quality of well-being.[65]

1.3 Conclusion: rethinking the role of curiosity in the age of ubiquitous screens

> Why do people - in different parts of the world and in various epochs - insert a focusing lens or a convergent mirror, a flickering monitor or a tiny-screen "wearable" between themselves and their environment?
> — Barbara Maria Stafford, 2002, p. 2

> New media's greatest promise is to be found not in appliances and devices, kiosks and touch screens, but in the part it plays in a return to curiosity.
> — Michelle Henning, 2006, p. 316

From all of the above, curiosity plays many important roles in our life, unlike other species that just want to know what it is in their immediate environment for day-to-day survival. Being human is to wonder about how the world is, and to ask why and to imagine what if. With its wonders motivated from within and positive emotional

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[65] Kashdan (2009, 2010) also asserted this view. In his book *Curious? Discover the Missing Ingredient to a Fulfilling Life*, Kashdan (2009) saw curiosity as the engine of growth, arguing that one can find meaning and happiness in life by exercising his or her innate sense of curiosity.

rewards, we experience more self-directed, open-ended exploration and gain feelings of satisfaction.

In the exploration of the roles of human curiosity in everyday life, the first part of this chapter starts with the evolutionary advantage to the supreme opportunists, and then refers to paleoanthropological studies to argue that curiosity was the primal force that developed modern human capabilities and cultural behaviours. From biological and evolutionary perspectives, humans have evolved into the supreme opportunists. They are not born with all of the knowledge and skills that are needed for inhabitation. Curiosity is an important means to acquire information and skills for the survival of the opportunist species. More importantly, it helps our species develop diverse adaptability to cope with changes in the environment. In essence, the survival and thriving of the human species is through exploration and interaction with the world around, through re-adjusting behaviours and thoughts, rather than through fixed specialisation.

Based on the findings of brain studies, our brain has evolved to attend to the new and different in the living environment for effectively learning, memorising, and being creative; through its underlying pleasurable rewards, we build emotional resilience to cope with negative emotional states and exhaustion and to be more open and capable of seeking out spontaneous and self-directed exploration. Other studies also reveal that our affinity for newness helps us expand our experience and go further into a subject to master a certain skill and knowledge. Curiosity that diversifies experiences not only has benefits for growing creativity and innovation but also influences personal growth opportunities. The divisiveness that often results in distraction and futility should be more appreciated and less blamed. But this is not to say that the design approaches for provoking curiosity have the privilege of creating distractions. We should instead be more attentive to its accumulated detrimental effect in our everyday life, as many aspects of our life have been shaped by screens.

Understanding curiosity's multifaceted nature and benefits is important to expand our applications in enhancing and enriching user experiences. A growing numbers of researchers have even claimed that the importance of curiosity in human life is relevant to nearly all aspects of everyday activities (e.g., Kashdan & Fincham, 2012, p. 483; Taflinger, 1996; Peterson & Seligman, 2004, pp. 125-141). In my survey on curiosity, design students who have utilised the effect of curiosity in their works mostly used it to motivate the initial exploration of their works. Then, they centred their design strategies on creating novelty, adding surprising elements, and asking questions.[66] Unfortunately, the support for sustaining a self-directed willingness to act on curiosity is overlooked, and the role of curiosity playing in cultivating self-directed experiences and influencing personal development is underexplored. If we have a wider and deeper exploration of curiosity's roles in our life, we can understand the implications of our everyday interactions with digital media for the need to know in our life and broaden the ways of fostering this human trait.

[66] See the answers to the question 8 and 9 in Appendix A

The question posed by Stafford (2002), cited at the beginning of this section, reminds us that human beings have always developed technology to reinvent the relationship with the world beyond the immediate environment. It has been used to accomplish voyages, to experience wonderments, and to glimpse the potential for more possibilities and opportunities. As mentioned above, this intellectual need is unique to human beings' curiosity. This innate nature for wanting to know more is rooted biologically and evolutionarily, engaging all mankind all over the world to create and advance tools to satisfy this need. The development of screen-based media can be viewed as a part of a longer history of human curiosity. Today, curiosity's multiple effects in everyday life are becoming ever more significant as the screens have been used in many aspects of our life and living space. Since everyday activities are increasingly shaped by screens of all kinds, the design for digital experience cannot overlook our curious nature.

However, as described in the introductory chapter, many people are concerned that our screens increasingly disengage us from the world and the people around us, even though they engage our curiosity more often. Social media updates and the expanding amount of digital information at our fingertips are constantly stimulating our curiosity. However, with it being too easy to make new discoveries and too instantaneous to access the answers by a few clicks or taps on a screen, our curiosity is soon to be satisfied and ceased to be explored further. The digital technology makes one tired and weary in these fast cycles of arousing by and adapting to the new (Leslie, 2014, p. 30). Many people today would learn a little bit of everything, but fail to truly master a certain area. Thus, we have seen many technology commentators criticise this superficiality (e.g., Carr, 2010). The power of curiosity is merely used to seek the present pleasure rather than to help engage with cognitively demanding work. It seems so many curiosity-related experiences becoming superficial and shallow. The designers who intend to use technologies to exploit curiosity's effects should think how to retain curiosity's essential values for being human in the first place. Or, we should ask how to design to avoid the potentially detrimental effect of digital technology on our attention spans when using them to appeal to our curiosity.

Henning's (2006) calling to return to curiosity, quoted at the beginning of this section, points out the greatest prospect of digital media and technology for unleashing curiosity. That is, to take us to learn deeper into what we find is interesting and meaningful in our life. That being said, human beings are not evolved to be specialists. Our brain is not designed to focus on something from the moment we were born (i.e., we are not born with a set purpose). To find the meaning of life is left for each of us to find out through the course of life. Curiosity that sparks the desire to know for its own sake (without external rewards) provides a sense of intrinsic purpose and value. This self-directed urge plays an important role in our growth and development. Through interactions with the people and places around us, our potential to become specialised is realised. As put by Stanford (2012), "Evolution made us the ultimate learning machines, and the ultimate learning machines need a healthy dash of curiosity to help us take full advantage of this learning capacity" (2012, section 3, para. 5).[67] As the supreme opportunists, we are obligated to learn wider and deeper, to develop and create, and to let our inborn potential flourish. A person's curiosity is an opening to new vistas of thought and experience. Through curiosity, new experience is gained. Curiosity is stimulated without external rewards, encouraging us to learn anything that interests us.

In this chapter, I have presented many roles of curiosity in our life, as stated by Gallagher (2011), that "help us adapt to, learn about, or create the new things that matter, while dismissing the rest as distractions" (p. 2). I argue that experience design for screen media should give more effort to properly hone those strengths of human beings' curiosity for fostering deep thought and active, self-motivated enquiry, not to exploit this great asset merely for thrills. The role of digital media is not to give instant gratification by driving away the feeling of boredom or by finding an answer. This only quells curiosity. It does not unleash its strengths. As curiosity is the quintessential skill for thriving and developing, provoking this state of mind for exploration, discovery and creation through a screen-mediated interface should help us adapt to and cope with today's complex technological place.

All in all, although we cannot truly find a single definition to fully represent curiosity, it is important for digital media designers and developers to understand its roles and values in our life. Human curiosity is not solely for survival, but also for

[67] In this article, Stanford (2012) also gives an interesting discovery from the artificial science. He stated "even the best learning algorithms fall down if they are not encouraged to explore a little" (2012, section 3, para. 1).

thriving. Our attention reframed by the novelty-oriented brain does not merely concern our survival. We are the only species on earth that possessed the desire to know more than the present need. Humans’ curious nature can develop into wonderment, fascination and perseverance. When we want to take this human nature as a design goal of experience to instil in user in this age of ubiquitous screens, we have to recognise the essential role curiosity plays in our life and be aware of the impacts made by amplifying any of its effects in everyday life. Our designs would be more meaningful if we recognise the true value of being curious.

Chapter 2: Understanding Curiosity in the Current Experience Design

2.1 Introduction

> Whenever research mentions experience design, the word curiosity is rarely mentioned, nor the hidden aspect of a user experience. When looking closer at research on curiosity, we find that it is important when describing human behaviour and the ‘feel good’ experience.
> — Therese Nilsson, 2011

As shown in chapter 1, many studies have illustrated that human curiosity has the potential to play many roles in our everyday life, not limited to grabbing people’s attention. The function of being curious is not only to compel one to explore the unknown, it is through curiosity to thrive in different circumstances, adapt to change with pleasurable rewards and appropriate resilience, look beyond the present for its own sake, and engage in long-term intellectual pursuits. Multidisciplinary research efforts have clarified the important roles of our elusive nature. However, how to unleash its potential seems to be unexplored by many designers and developers of digital media.

In my survey of ECA student designers’ experiences using curiosity, as mentioned in chapter 1, most respondents agreed that digital technology can give a boost to curiosity rather than dull it.[68] In many designers’ outlook, the impact of digital

[68] See Appendix A: Online survey on curiosity design for the answers to Questions 4: Do you agree that digital media dulls our curiosity due to the ready availability of online information, including

technology on our curiosity remains positive. However, only a few respondents have explicitly applied this important human trait in their works, and the strategies they used to provoke curiosity are mainly limited to using novelties and adding surprising elements,[69] which will only produce a short-term effect on grabbing attention. This indicates that the ways of provoking and cultivating curiosity have not yet fully developed for creating self-directed activity and sustaining deeper engagement.

As mentioned in the introduction, the use of curiosity has a long history in the design of screen-based media. The 17th century media peepshow box that used peeping as its interaction style remains an effective way to trigger curiosity in the digital age. The design uses a box to hide the main attraction from the view of the observer and offers a tiny hole for accessing a hidden view. This seems to be a natural and effective way of inducing curiosity. However, there was little research on why it works well in engaging our curious nature before it was used as curiosity-provoking practice in interaction design. In many cases, designers can make their work trigger curiosity without guidelines for doing it because it is common sense that human nature would be drawn to unknown or new things. But a lack of comprehensive studies on how curiosity works may limit our ability to harness its power and expand its potential for wider application as digital technologies are increasingly used in many aspects of our life.

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mobile media (mobile phones, social networks, the Internet, tablets, etc.)? and Question 5: Do you agree that digital technology gives a boost to curiosity and enables you to be more creative?

[69] See Appendix A: Online survey on curiosity design for the answers to Question 8: Which of the following strategies have you used to provoke people's curiosity in your work?

Although curiosity has been noticed since ancient times, early attention was mostly drawn to discussing curiosity's moral status. Many were concerned with the right to explore forbidden knowledge, because some condemned its seemingly uncontrollable impulse. The more comprehensive theoretical explanations of curiosity's underlying mechanisms and its related behaviours began to be developed in the mid-20th century by psychologists and others from the related disciplines.[70] Psychologists made more systematic approaches to classify its multiple characteristics and identify curiosity's underlying cause. Their works later provided a theoretical foundation for a number of designers who exploited the effects of curiosity in the user experience (as I shall discuss later on in this chapter). However, the research on user experience regarding curiosity, as shown by Nilsson's (2011) remark cited at the beginning of this chapter, remains unclear and convoluted, although it is a gradually known source of motivation in user experience design.

The goal of this chapter is to investigate how the concept of curiosity has been used and created in digital media contexts and to identify any of the problems and limitations in current design practices. As mentioned above, although the use of curiosity for motivating spectatorship appeared a long time ago, design research on

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[70] Given that curiosity was recognised as a major driving force in learning and children's cognitive development, many researchers at that time focused on the curiosity of children and young adults (see Cavojova & Sollar, 2007). But later, there was a gradual decline of interest in psychology because the major curiosity theories remained inconclusive, if not contradictory (Edelman, 1997; Spielberger & Starr, 2012). Then, the emergence of digital technology was one of the reasons that led to regain interest in curiosity (Keller, 2010). However, many research efforts were then given to develop psychometric measuring instruments and standardised scales (e.g. Melbourne Curiosity Inventory) to objectify the amount of curiosity in order to evaluate the relationship between curiosity and other human capabilities and activities (e.g. using the level of an individual's curiosity traits to predict his or her future academic performance).

how to provoke and sustain curiosity has not yet been well developed. The few scattered studies (which I shall explore later in this chapter) that focus on provoking curiosity or related concepts as a goal to enhance user experience usually draw their theoretical knowledge from psychological studies of curiosity to identify curiosity-provoking principles and create curiosity triggers. Thus, this chapter will first conduct a literature review in psychology on several classic theories of curiosity that have been adopted by digital media designers for enhancing the user experience. Then, the focus shifts to the digital media design literature, examining how the concept of curiosity has been discussed and used to affect user experience in a range of contexts, from computer learning, interactive storytelling, online marketing and applications, and situated interactions with public displays. After this review of a range of design contexts that have used curiosity-provoking strategies, the final section will conclude and reflect on the problems and limitations in current design practices for cultivating curiosity.

2.2 Theories of curiosity

In academic literature, several theories have been proposed to explain curiosity's underlying mechanisms. These theories are used for provoking curiosity in design and other areas. Therefore, understanding these theoretical accounts of curiosity's underlying mechanism can help to find the proper tactics to incorporate into experience design. Before examining how curiosity could be created and used in digital design contexts, it is essential to learn these theoretical models of curiosity in depth in order to identify any room for improvement in design practices for developing curiosity in users. The following section will give a brief overview of these classical theories of curiosity, including drive-based theory, optimal arousal theory, dual process theory, and information gap theory (presented in chronological order).

2.2.1 Drive-based theory

In the drive-based theory, the notion of curiosity is more physiological-based, much like thirst and hunger for water and food, which need information to satisfy when it is aroused by the external environmental stimulus. This perspective views the nature of stimulated curiosity as uncomfortable state of arousal,[71] and thus the reduction of curiosity is rewarding. In other words, when our curiosity is provoked, for example, by an unusual noise, we feel an urge to investigate what caused that sound in order to reduce uncertainty.

This perspective helps to explain why the feeling of curiosity that is triggered by sensory inputs (i.e., external stimuli) is imperative as an irresistible force, and how it is often mixed with negative emotions, such as agitation, anxiety, and fear. Curiosity is triggered as a means to drive organisms to explore the unknown and resolve uncertainty to avoid potential threats to the survival of the species. Therefore, in such cases, curiosity-driven behaviour, such as exploration, inspection, sustained attention, and investigation of the relevant stimuli, has no need to persist when the

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[71] This view is similar to that from the aforementioned brain studies, in which curiosity is a sensation that increases the level of arousal in the brain to reframe attention for processing unknown information. See section 1.2.2 in chapter 1.

potential threat is clear. However, since this view frames the physiological activation of curiosity as a negative state, the drive-based accounts fail to explain why people voluntary expose themselves to curiosity such as by spending time solving crossword puzzles or reading murder mysteries (Loewenstein, 1994).

2.2.2 Optimal stimulation theory

As just mentioned, the drive-based theory of curiosity is unsatisfactory in explaining the situations where people actively search for curiosity without the presence of the external stimuli. Berlyne and others, based on Piaget's theory of disequilibrium and Festinger's cognitive dissonance (as cited in Leslie, 2014), postulated the existence of a homeostatic model of curiosity to improve drive-based theory. The underlying mechanism is that curiosity is triggered when the individual's optimal level of physiological arousal changes.[72] When it drops below the optimal level, an individual becomes bored and feels compelled to explore and interact with his or her environment or with other people in order to increase stimulation.[73] When the stimuli are too unusual, one experiences anxiety and attempts to find ways of avoiding it in order to maintain a preferred optimal level. In other words, our exploratory behaviour is motivated to either boost or reduce the non-optimal level of arousal in order to maintain a state of equilibrium.

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[72] Also referred to as the pleasurable, intermediate tonus level.
[73] This theory might provide the rationale for understanding the saying by Dorothy Parker: "The cure for boredom is curiosity."

With many empirical studies and observations, researchers suggest that stimuli with the following characteristics have the potential to increase the arousal level of epistemic curiosity[74]: novelty, surprise, uncertainty, complexity, redundancy, orderliness, difference, ambiguity, indistinctness, unfamiliarity, incongruity, irregularity, information density and the like (Cupchik & Berlyne, 1979). All of those characteristics of visual stimuli have been termed by Berlyne as *collative properties*, and can be summed under the principle factor of what he called *conceptual conflict*. The exploration irritated by a novel stimulus has the goal of resolving conceptual conflict and thus returns one back to a pleasurable, moderate, and balanced physiological state. Other researchers also proposed other stimuli properties that trigger curiosity, such as Hunt's violation of expectations, and Hebb's ambiguity (as cited in Markey & Loewenstein, n.d., p. 231). Berlyne's theory of determining factors in a stimulus (i.e., collative properties) has received considerable support in later studies of curiosity. However, this theory has the same flaws as the drive-based theory. It maintains that the activation of curiosity suggests that the individual is in a negative state-of-mind.

Building on the optimal arousal theory, other camps in psychology propose that curiosity is a positive experience. Extending the work of Berlyne and others, Day (1982, as cited in Borowske, 2005) represents the optimal level of arousal as a *zone of curiosity*, in which an organism tends to activate exploratory behaviour and becomes interested (i.e., the core of curiosity is characterised by approaching,

[74] For Berlyne's concept of epistemic curiosity, see chapter 1, footnote 61.

exploration, excitement and interest). At a very low level of stimulation (i.e., being in a *zone of relaxation*), one is unmotivated and intends to seek out novelty or sensational experiences to increase the arousal state. If the stimulation is too complex, one moves into a *zone of anxiety*, which encourages one to avoid the source of curiosity. Although this view has a lack of focus on the factors that explain object-specific curiosity, it explains why curiosity-seeking behaviour (i.e., novelty-seeking behaviour), which sometimes is thought of as superfluous, is necessary for balancing an emotionally positive state.

2.2.3 Dual process theory

As influenced by the evolutionary view that exploratory behaviour arises from survival and biological needs, some researchers, such as McDougall (as cited in Spielberger & Starr, 2012, p. 225), grounded their theory in William James's antagonistic view of curiosity and anxiety. In *Principles of Psychology*, James (1980) saw one kind of curiosity as an instinctive motivation that pushes a living being to approach and explore new objects in their environment with all of their senses, whereas the antagonistic emotion fear leads it to retreat from the potential danger related to that exploration.[75]

Given that both curiosity and anxiety are elicited by novel or unknown stimuli or uncertain ideas, the dual process theory interprets curiosity as defined and expressed in an organism's willingness to approach the source of stimulus, whereas anxiety

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[75] See also footnote 60 for James' classification of curiosity.

leads to avoidance and withdrawal. Internal anxiety, trepidation, fear, and other unpleasant emotions form a counterweight to restrain impulsive curiosity and produce avoidance behaviour, such as fighting, fleeting, and withdrawing. A sensible fear of the new or other unpleasant emotions (i.e., neophobia) helps us be more careful and prudent when encountering uncertainty. This is crucially important for human survival. A number of recent studies also suggested that the relationship between our need for novelty and our need for safety decides our approach and avoidance behaviours (Kashdan, 2009).

With regards to Berlyne's optimal arousal theory, specific exploration aroused by curiosity combines with anxiety when encountering the new, which increases the confusion about whether curiosity feels pleasant or aversive. In the dual process theory, curiosity and anxiety are thought of as two incompatible motivations that result from an approach-avoidance conflict. The aversive state of fear is viewed not as an inherent characteristic of curiosity, but as an accompanying emotional state when the level of curiosity arousal is too high. As Ramona and Morris described, "there is a perpetual struggle going on inside the brain, between the fear of the new (neophobia) and the love of the new (neophilia)" (as quoted in Neophobia, n.d.). This constant tug-of-war is always involved in our decision-making process. The result of the approach and avoidance behaviour is an important mechanism in the brain for survival and thriving.

In short, the dual process theory provides a simplified explanation to understand the tug-and-tow conflict in exploratory behaviour patterns, but the reasoning behind curiosity-seeking behaviour is ignored.

2.2.4 Information gap theory

In the late 20th century, a number of researchers (e.g., Beswick and Rauterberg, as cited in Arnone and Small, 1995), taking ideas from gestalt psychology,[76] proposed different accounts about the foundation of curiosity. They put more emphasis on human reasoning and information processes to explain why our curiosity tends to be object-specific. The cognitive-based views interpret curiosity mostly from an information processing perspective, suggesting that curiosity increases when we perceive something that is new, unusual, odd, or random in our knowledge structure. This is because human beings have a tendency to try to make sense of the world. As Gilovich describes, “We are predisposed to see order, pattern, and meaning in the world, and we find randomness, chaos, and meaninglessness unsatisfying. Human nature abhors a lack of predictability and the absence of meaning” (as quoted in Loewenstein, 1994, p. 83).

Under cognitive-based views, our cognitive system prefers coherence. The situation that is different from our existing worldview or knowledge may result in exploratory behaviour or reactions to resolve the feelings of uncertainty in order to restore

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[76] According to Jirout and Klahr (2012), gestalt psychologists argue that curiosity is motived by “the need for sense making, i.e. that organizing knowledge into “coherent wholes” is motivating” (p. 129).

cognitive coherence. An optimal amount of incongruity triggers an inquisitive mind and exploration; apparent incongruity will result in avoidance to prevent the feeling of fear. Conversely, curiosity is unlikely to be triggered if the scale of an incongruity is too small, because people usually feel that they already know too much about the subject. In essence, this theory represents the relationship between incongruity and information seeking exploration as an inverted U-shaped curve.

The behavioural economist George Loewenstein (1994), who is one of the key theorists in this area, attempted to advance the cognitive-based theory and proposed what he called the information gap theory of curiosity.[77] As its name suggests, curiosity arises when perceiving “a discrepancy between what one knows and what one wishes to know” (p. 87). The concept of an information gap is somewhat similar to both James’ metaphysical wonder and Berlyne’s conceptual conflict. However, the key difference from the others’ accounts is that Loewenstein’s view takes both the presence and the absence of information into account with curiosity. The information gap theory highlights the tiny bits of information about a topic that create an awareness of ignorance, which triggers the desire to want to know more.[78] This tells us something important about curiosity; our curiosity is unlikely to be aroused by something that we are completely unfamiliar with.

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[77] It is also referred to as the knowledge gap theory.

[78] The neurological research on curiosity by Kang et al. (2009, as quoted in Heick, 2013) also provides a similar view, stating that “the desired level of knowledge increases sharply with a small increase in knowledge, so that the gap between this desired level and the actual knowledge grows.”

Loewenstein (1994) also takes other factors, such as an individual's competence in resolving curiosity and the relevance of the missing content to one's prior knowledge, into consideration about the curiosity resolution process. The intensity of the feeling of curiosity correlates with the chances of getting the missing information to fill the information gap. As soon as people feel competent enough to close information gaps, their curiosity becomes stronger. As the user experience design theorist Stephen Anderson (2011) puts it simply, "If I know eight of ten items, I'm more curious about the remaining two than if I only know two of ten things" (p. 82). In other words, in order to maximise curiosity, the information gap should manageable enough that a person feels confident in their ability to close it.[79] This concept is also echoed in Silva's discussion of trait curiosity,[80] which suggests the level of curiosity depends on the appraisal of stimuli and the appraisal of the ability to cope with the situation (Silva, 2008). In addition, some clues that help one make a judgement about the value of resolving that curiosity also increase the desire to close the information gap. The perceived relevance of the information gap influences the willingness to close the gap.

[79] Min Jeong Kang's (2009) brain imaging study also contributes relevant data to support this point.
[80] Trait curiosity is a kind of curiosity, proposed by Berlyne's colleague Hy I. Day, that is based on the distinction between curiosity as a trait and curiosity as a state. Trait curiosity, according to Day (1971), is a relatively stable personality characteristic pertaining to one's lifelong tendency towards new experiences. This classifies the individual's innate difference in tolerating and assimilating curiosity. State curiosity, in contrast, is relatively transient, describing the feeling aroused by a particular external factor. In other words, Day's state curiosity concept is similar to Berlyne's perceptual-specific curiosity. The concept of trait and state curiosity has been used widely in explaining individual differences in responses to a novel situation and how unique an external stimulation is to an individual.

In short, this theory depicts curiosity as a feeling of lacking desired knowledge and also tells us how the intensity of curiosity relates to desired knowledge level and achieving competence in closing a gap. It also explains why different people have their curiosity aroused by different stimuli. The more we know about a subject, the more we become aware of the information gaps in that topic area. The information gap theory of curiosity provides an operational account to predict one's state of being curious and helps in explaining object-specific curiosity. However, these accounts have limitations when applying them to justify other associated emotions, such as boredom and anxiety.[81]

2.2.5 Summary

To sum up, we have seen that researchers have struggled to reach a consensus on curiosity's underlying causes. Although no single theory alone can fully explain curiosity's elusive forms, explaining the process of curiosity reveals some common ideas.

Firstly, curiosity is inextricably linked to conflict emotions, such as mild anxiety and unpleasant feelings. To make the encounter with curiosity stimuli more appropriate and manageable, most theories, including drive-based theory, optimal stimulation theory and dual process theory, draw on both curiosity and anxiety to explain living beings' behaviour and responses. Also, the role of unpleasant emotions is important to Lowenstein's information gap theory, in which the experience of curiosity (i.e.,

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[81] See Silvia (2006, p. 51), for further commentary on the limitations of the information gap theory

perceiving information gaps) is represented as a feeling of deprivation that has motivational consequences to activate the information seeking behaviour in order to reduce it. Therefore, filling information gaps to satisfy curiosity and eliminate negative feelings can lead one to experience positive feelings in the process of interactive experience. In short, this understanding of curiosity explains the paradoxical feelings of our initial excitement and discomfort arising from encountering uncertainty and performing novel activities.

Secondly, curiosity is co-dependent on both external stimuli and internal sensations. Our curiosity could be aroused as a response to the outside world (e.g., we became curious when stumbling upon an unusual sight), or it can simply originate inside us when a fresh idea or thought comes up (e.g., we might be wondering about why the sky is blue).[82] In the view of the drive-based theory, the urge to investigate the source of curiosity is a way to reduce the feelings of uncertainty that originate from the environment. However, as said, this early proposed theory could not explain why we voluntarily expose ourselves to curiosity-induced activities. Other theoretical accounts of curiosity, including optimal arousal theory and the information gap theory, take individual’s internal state into account. For example, according to optimal arousal theory, Berlyne’s diversive curiosity occurs when an individual feels bored (i.e., when an individual’s arousal state drops below an optimal level, he or she becomes more active to seek out novelties). In the information gap theory, our interest in the absent information is correlated with a person’s prior knowledge and

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[82] See also section 1.2.3 in chapter 1

appraisal of his or her coping ability to fill the information gap. Therefore, how curiosity is motivated involves not just the environment but also our internal information processing and experience.[83]

Finally, the notion of exploratory behaviour is central to many of these curiosity theories. Our nature is hardwired with a desire for new experiences. Biological factors have predisposed human beings to act in a certain way. Drawing from the drive-based theory, the defining feature of human curiosity is an uncomfortable sensation that drives us to explore the environment. From the perspective of the optimal arousal theory, curiosity is represented as a positive emotion. The inquisitive exploratory behaviour may perform best when stimulation is not too low or too high, so the paradoxical effects of curiosity receive a proper explanation. In what Day (1982) calls a zone of curiosity, one's performance, including attention to the stimulus, would be more efficient to gather the information and resolve curiosity. Otherwise, the performance would be inefficient, and perhaps the affective reaction will be led in the negative direction into a zone of anxiety; adversely, in below optimum conditions, one will be in a zone of relaxation in which the feeling of boredom and novelty-seeking behaviour would occur.

Those theories provide some basis for user experience design and help in deciding different types of motivational strategies to stimulate different kinds of curiosity and exploratory behaviour. For instance, when operationalising environmental

[83] See Edelman (1997) *Curiosity and Exploration* for the debate over whether curiosity is externally or internally stimulated.

stimulation for a person who is in a zone of boredom or idleness, a design practice can encourage exploratory behaviour by introducing a certain level of the stimulus with Berlyne’s collative properties as curiosity arousers in his or her environment. For attracting a user into a specific area of a design, the notions of competence and relevance can apply to the ways of crafting specific curiosity (e.g., adding the familiar information to increase a person’s relevance to an information gap).

In short, although the intent of this section is not to recount those psychological studies, a review of these theoretical accounts lays important groundwork before looking for the ways of cultivating curiosity in digital media design and provides the basis for evaluating current design strategies for provoking curiosity (which will be discussed in the following section).

2.3 Overview of curiosity’s applications in a range of digital media contexts

2.3.1 Computer-based learning

In early user interface design literature, Thomas W. Malone was among the first to clearly address using curiosity in digital design practices to make learning through computers more interesting. Malone (1980, 1981) analysed computer game players’ experiences and identified three major intrinsic motivators: challenge (i.e., competitiveness), fantasy, and curiosity. These motivators can potentially be used to increase the appeal of the system and enhance the experience. In his discussion of curiosity, Malone (1980) included Berlyne’s idea of conceptual conflict as a lack of consistency in one’s existing knowledge structures, and further added the other two kinds of cognitive-based curiosity-evoking qualities – incompleteness and the absence of parsimony – in his idea of designing an intrinsically motivating computer-mediated environment. Based on the information process perspective, Malone (1981) interpreted curiosity as "a desire to bring better 'form' to one's knowledge structures" (p. 68) and gave the following guidelines for designers to trigger a user's curiosity: (1) using audio and visual effects to create compelling digital content in order to intrigue sensory curiosity; (2) presenting the information in a way that makes one's knowledge structure seem incomplete, inconsistent, and unparsimonious in order to elicit cognitive curiosity (Malone, 1981).

Because curiosity has a role in driving the growth of knowledge, its value in the design of a computer-based learning system is obvious. Provoking curiosity gradually became one of the most important motivational approaches in the early computer-mediated learning environment. A number of researchers in the field of computer-based instructional design also pay attention to how to utilise curiosity to affect a user's learning. In their discussion, curiosity is often associated with many concepts, such as attention, interest, and engagement. In the well-known motivational design model ARCS (which stands for Attention, Relevance, Confidence, Satisfaction), John Keller (1999) recognised the important role that curiosity plays in gaining someone's attention, which is the first component of the ARCS model. Instructional design theorist Marilyn P. Arnone (2005) based her curiosity theory analysis for instructional design on the ARCS model, arguing that "inquiry arousal is the most important factor for maintaining and sustaining attention" (p. 52). In her discussion of ways to provoke and sustain curiosity, Arnone (1995) recommended introducing elements that have new, odd, contradictory, mysterious, or incongruous properties at the appropriate level in educational materials. A number of motivational researchers further recognise that the motivational effects of curiosity are not only associated with stimulating attention, but are also involved in all the subsequent components of the ARCS model in the learning process (Arnone, 1995; Arnone & Small, 1995; Rotto, 1994). In short, researchers in instructional design become interested in ways of prolonging curiosity's effect in order to lead a person to learn something in considerable depth.

Because the purpose of provoking curiosity-driven learning in instructional computer design is for education, researchers focus on ways to turn a transient curiosity into a persistent one. As Arnone et al. (2011) asked, "How do we maintain momentum ignited by curiosity and interest and keep students purposefully engaged?" (p. 182). To make curiosity become more persistent throughout all stages of the interaction process, some concepts, such as interest and engagement, are usually used synonymously with curiosity by the researcher. However, I argue there is still a basic difference between designing for interest and designing for curiosity. Sustaining interest concerns preference, known knowledge, and familiarity, which is a fundamentally different need than human curiosity. Curiosity, as discussed in chapter 1, is the need for newness, or for seeking out changes in the environment. Sustaining curiosity requires the unknown to progressively become known in order to keep one interested. Therefore, it is unavoidable to have overlapping strategies for engaging interest.

In short, those works help in designing attention-getting strategies and sustaining the curious user's desire to move into and stay in what Csikszentmihalyi calls the flow state. However, the use of curiosity becomes highly intertwined with that of other concepts like interest and engagement. In other words, learning how to provoke and sustain curiosity in the digital learning context is closely related to studying attention-getting strategies, having less concern on how to motivate people to seek out and explore the unknown for its own sake.

2.3.2 Interactive storytelling

Moving to the storytelling design, curiosity has been identified as one of the key user responses that are likely to occur in interactive storytelling contexts (Klimmt, Vermeulen, & Vorderer, 2011). A number of researchers have begun to explore curiosity's effects on the interactive storytelling experience. Hoeken and van Vliet (2000), for instance, pointed out three different emotions used in the narrative structure that could influence the reader's affective response and cognitive processing of a story. In their findings, keeping a reader in suspense and revealing the outcome at the end of a story can hold a reader's attention; showing the ending at the beginning of a story while still making it vague enough to trigger the reader's interest can bring a reader's attention to certain information with respect to the outcome; adding surprising events at the end of a story can increase the appreciation of the story and cause the reader to reassess his or her previous knowledge of the story.

From a curiosity perspective, these three storytelling techniques can be explained as different forms of curiosity. A suspenseful story can be thought of as an unresolved curiosity, which keeps a reader in a state of uncertainty, causing him or her to become more curious about the remaining information and stay focused until the end of the story. It is similar to the function of movie trailers that show a few suspenseful and mysterious scenes to motivate the potential customer to find out more details about the movie. Showing the ending of the story at the beginning is a way to impose prior knowledge and build expectation, which creates a gap in a reader’s knowledge. The classic murder mystery that opens with a crime scene to make people wonder who the murderer is and how it happened is an example. By setting up anticipatory curiosity and the expectation of discovery in the reader’s mind from the early stage, the narrative generates focused questions and hypotheses that make the reader aware of the relevance of the incoming information. Therefore, it helps in the processing of information while reading the story. As a reader proceeds in the narrative, the information gap helps one stay engaged in order to discover the relevant information to answer self-generated hypotheses and close the information gap through a process of elimination. Finally, the manipulation of story structure by deliberately leaving an information gap open at the end of the story is a way to make the reader continue to wonder about what is left untold through his or her own imagination and interpretation.

Other researchers, such as Roth, Vorderer, and Klimmt (2009), studied how conventional entertainment media brings about pleasurable experiences, and identified how curiosity, amongst the other four experiential dimensions,[84] can increase temporary physiological activity and produce pleasure when it is resolved. One notable implication coming from this study is that the designers of interactive storytelling have shown exploiting curiosity's intrinsic self-rewarding effect to create a chain of pleasurable feelings through generating circles of increased curiosity and resolved curiosity (i.e., opening and closing the information gaps as the story unfolds).

Though there has been little research relating to the area of curiosity in interactive storytelling, proficient storytellers are masters of using the desire for unknown information and the joy derived from the self-motivated process to keep the audience engaged through the rest of the story. In interactive storytelling design research, the reader's curiosity gains its importance in the story's structural design and the reading experience. However, we only have a weak understanding of how to elicit curiosity and explorative behaviour in encounters with the interactive medium itself.

2.3.3 Online applications

With the rise of the Internet, the natural motivation to quickly explore and learn about future events gradually gained researchers' attention for web based media and applications. Menon and Soman (2005), for instance, drew on the work of Berlyne

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[84] The four experiential dimensions are suspense, aesthetic pleasantness, self-enhancement, and flow.

and Loewenstein, provided four design recommendations for provoking curiosity to enhance the advertising effectiveness on the Internet, including (1) highlighting a knowledge gap to generate curiosity (e.g., asking questions), making information appear incongruous, and violating expectations; (2) providing a clue (i.e., additional information) to guide elaboration and subsequent learning for curiosity resolution; (3) giving the assurance of receiving the missing information within sufficient time; (4) using the measures of advertising effectiveness on the basis of consumer elaboration and learning.

Curiosity has also been noted as one of the effective interaction techniques in web application design. Jennifer Tidwell (2005), for instance, in her book *Designing Interfaces: Patterns for Effective Interaction Design* discussed the notion of “intriguing branches” for keeping the user’s attention on the website (pp. 27-49). Tidwell (2005) took a web page design from the Museum of Modern Art (MoMA) to exemplify how intriguing branches work. According to her analysis, MoMA’s webpage exhibits less detailed textual information in favour of more visuals to encourage the website’s visitors to explore more behind the links.[85] In addition, Tidwell (2005) suggested using active phrases like ‘*Learn more...?*’ as psychological trigger words to arouse people’s curiosity for navigating help-related content; this is because people tend to ignore links labelled as *Help*. Today, many websites use intriguing branches to expand a user’s curiosity based on what he or she is currently focused on, such as Pandora Internet Radio offering similar artists and album

[85] MoMA’s current website remains a similar design, see http://www.moma.org/explore/exhibitions

information related to the song the user is listening to, and the web album Flickr using side strips to show related content in order to stimulate the viewer to further explore other images. Tidwell (2005) explains the reason why intriguing branches work, saying that

> People are curious. If they see something that looks interesting, and they have the time and initiative to check it out. Web surfing would never have become popular without this natural curiosity and willingness to follow links into the unknown... You can exploit the users' natural curiosity to get them into a place where they can learn what they need. (p. 47)

Encouraging users' curiosity in web application design is also discussed and expanded further by Stephen Anderson (2011) and others. In his book, *Seductive Interaction Design: Creating Playful, Fun, and Effective User Experiences,* Anderson (2011) took insights from Loewenstein's information gap theory and Berlyne's classification of curiosity. He suggests a number of ways to create a curiosity-provoking context to engage the online user. Since Anderson is concerned with design solutions to meet business goals, his focus is on a perceptual-specific type of curiosity that can lead users to perform certain tasks. Based primarily on the works of Berlyne and Loewenstein, Anderson (2011) instructed designers and developers of digital media to create information gaps by deliberately withholding messages or introducing partial information in order to elicit a perceptual-specific kind of curiosity that can direct a user's actions[86]

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[86] Anderson (2011) gives some examples of web applications that are designed around this idea. The professional networking site LinkedIn increases the chance of members registering as a paid member by revealing partial but very relevant information. The web analytics company Quantcast uses a

In addition, applying the concept of curiosity as an individual personality trait (i.e., trait curiosity) to attract people who are more prone to seek novelty has also become a way to engage the user about individual difference. For instance, in *Webs of Influence: The Psychology of Online Persuasion*, the author Nathalie Nahai (2012) applies personality research to the web design and develops four themes (i.e., explorer, builder, negotiator, and director) to characterise online services in order to attract different user groups in terms of their temperament styles. Reflecting on trait curiosity, Nahai (2012) illustrated one theme 'The Online Explorer' to appeal to the people who tend to be more adventurous and less able to tolerate the feeling of boredom. In Nahai's (2012) discussion, social media, such as StumbleUpon, Foursquare, and Instagram, are examples that attract *online explorers* by engaging their desire for novel and unusual experiences.

In short, curiosity is becoming an increasingly important design strategy for intriguing interest and nudging a user's action in online contexts.[87] However, the design practices for provoking curiosity mainly rely on the cognitive-based approach (i.e., through information processing and reasoning) and the creation of novel stimuli

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translucent sticker to cover information that users would fully know on a paid account. Video subscription service Netflix's collective film rental recommendation system gathers the rental customer's film preference by teasing them with information on the other two films derived from others' rental preference (Anderson, 2011, pp. 79-86).

[87] See also an article 'POP UX! Clued Into Curiosity,' in which user experience designer Andrew Zusman describes curiosity as "a powerful weapon in the user experience design arsenal" (Zusman, 2013). He suggests that designers should craft information gags to create a specific flow to direct users' action.

to engage curious emotion, which drives user actions but might change active explorers into passive watchers in their adventure of the World Wilde Web.

2.3.4 Situated interactions

In recent studies of situated and public displays (e.g., digital bulletin boards in a community and interactive tabletops in a tourist information centre), curiosity has been identified as one of the initial psychological factors that accounts for pedestrians' behavioural change (i.e., changing from being a passer-by to an onlooker to an active user) in response to a screen-mediated situation. Given that people tend not to notice most screens, recent research projects designed for social interactions in public spaces also isolated curiosity as a crucial motivational factor in overcoming the screen blindness problem[88] to enhance the awareness of the interactive capability of a screen installation. For example, in one study, the researchers Ojala et al. (2012) attributed a substantial amount of outdoor screen usage to the curiosity of passers-by. Michelis (2009) also drew upon aforementioned motivating principles for computer instructional design by Malone, taking curiosity as one of the building blocks for motivating interaction and exploration in public spaces.

Few design researchers in this field have taken curiosity as their central design strategy to explore its effects on interaction in a public setting (e.g., Sato et al., 2010;

[88] This phenomenon has been called *display blindness* or is also referred to as *interactive blindness*. See the introduction.

Sato, Takeuchi, & Okude, 2011; Seeburger, 2012). Dalsgaard and Dindler (2009) used peepholes as a means of inviting people to interact with the installations in the museum. In *Requirements and design space for interactive public displays*, researchers regarded curiosity as one of the motivational factors to invite interaction, and suggested that the desired behaviour for the interaction can be initially motivated through the interplay of surprising and constructive elements (Müller, Alt, Schmidt, & Michelis, 2010). Houben and Weichel (2013), in their paper *Overcoming Interaction Blindness through Curiosity Objects*, proposed using curiosity-provoking objects to grab attention and elicit a few seconds of exploration. They also found that their practice of placing a curious object – the World's Most Useless Machine – in an interaction zone made changes in the flow of people's movement and increased activity with the display.

A few recent studies on curiosity in situated interaction design have experimented with the effects of curiosity arousals in user interaction. In a study on curiosity and interaction, Tieben, Bekker, and Schouten (2011) identified five main evokers of curiosity: novelty, partial exposure, complexity, uncertainty, and conflict. They created five curiosity-provoking scenarios, each focused on a different curiosity evoker, to evaluate how different kinds of stimuli would affect people.[89] In their discussion, the role of curiosity is "a strong motivator for behaviour" (Tieben et al.,

[89] These five curiosity-provoking scenarios include: an out-of-context situation (i.e. novelty), fragmented sounds (i.e. partial exposure), uncorrelated interaction through sound (i.e. complexity), distorted sequences (i.e. uncertainty), and cognitive distortion scenario (i.e. conflict). See Tieben, Bekker, & Schouten, 2011.

2011, p. 361) through which people's exploratory behaviour can be provoked to interact with an interactive sound installation in a public space. The findings of their work suggest that novelty had the most significant effect on users' behaviour in the initial phase of perception, but the effects is short-lived. Although there is some doubt about the validity of comparing the effectiveness of different curiosity stimulus characteristics, their study is one of the first few attempts in digital media to explore various cognitive-based factors in an actual interactive context.

In very recent studies, researchers have identified the honeypot effect as one of the most significant phenomena to attract attention and curiosity in a display (e.g., Brignull & Rogers, 2003; Fatah gen. Schieck & Fan, 2012). The term honeypot, as a metaphor, is used to describe something that is attractive, something which draws people to it like how bees fly to a pot of honey in droves.[90] The honeypot effect, when applied to public screen media interactions, means that the physical presence of current user forms a honeypot effect, drawing the curiosity and attention of the people in the vicinity to a screen, which in turn may make the honeypot effect more significant and trigger the curiosity of many more. Thus, the public display becomes a honeypot site and serves as "an effective social catalyst" (Müller, Eberle, & Tollmar, 2014) to attract the crowd. When researchers discussed screen blindness as a design challenge for public screen-based interaction in the face of an abundance of

[90] Another similar Chinese metaphor for the collective power of attractive things is a magnet. People attract people like iron filings around a magnet.

screens in our living space, the idea of using the honeypot effect to capture people's curiosity and reduce screen blindness was proposed.

Since people's presence around a screen has been identified as an effective curiosity trigger, a few recent studies use demonstrations to elicit the honeypot effect to increase people's interactions with the screen. For instance, in an observational study, three people were deployed around a public screen in order to attract the attention of passers-by and encourage them to engage with the screen while they carried out their research observations (Behrens et al., 2013). In another study of large public displays, the researchers used a helper to attract the first few users (Brignull & Rogers, 2003). However, the practice of exploiting the honeypot effect requires constant presence near the screen. This is not feasible in many situations, and may quickly deplete one's attentional strength. The honeypot effect, while useful, fails to provide insights on how to keep viewers' initial interest and have a more strong effect at the emotional and cognitive level (i.e., using the honeypot effect may only draw people to the screen, making them reflectively look at the screen). We should think of other approaches to utilise social effects on curiosity, and we need to put more effort into making curiosity more engaging.

In brief, digital screens deployed in a public context have enabled many new forms of interactions and social activities, and many recent studies have increasingly recognised the importance of curiosity in the initial stage of motivating people to interact with the public screen. However, the question of how to provoke curiosity and then sustain it has not yet been well researched. As Houben and Weichel (2013) pointed out creating the novelty effect can only trigger a shallow exploration. Inviting interaction by exploiting novelty and ambiguity to draw people in, Brignull and Rogers (2003) also argued, may only be a short-term solution. In conclusion, even though a few studies have noticed that situational and social factors have a significant impact on the curiosity of the collocated people, they do not understand the reason why.

2.3.5 Summary

As said in the beginning, there are relatively few digital media designers who are concerned with user experience from a curiosity perspective. However, based on a wider review of literature and relevant findings from many areas of digital media design, curiosity in user experience is becoming understood. A review of the literature in digital media design shows that a large part of the design principles is drawn from psychological theories of curiosity. In particular, Berlyne's concept of collative properties[91] and Loewenstein's information gap theory[92] seem to be the most useful and inspiring for designers to develop curiosity in user experience.

Overall, I recapitulate all the possible curiosity-provoking strategies below:

- Crafting curiosity triggers

  As the literature and theories show, there are many ways to craft external stimuli as triggers to provoke curiosity. Some triggers are derived from

[91] See section 2.2.2
[92] See section 2.2.4

classical theories of curiosity in psychology, including Berlyne's concept of collative variables (i.e., novelty, complexity, surprise, uncertainty, conflict), and Loewenstein's information gap theory. Other similar conceptual elements noted in the previously mentioned studies also include ambiguity, inconsistency, unpredictability, incompleteness, unparsimony, partial exposure, idea incompatibility, etc.

These conceptual elements have been proposed and implemented to provoke users' curiosity in many areas of digital interactive design. The list of curiosity triggers might be endless as long as ways of presenting information make one feel being out of his or her usual comfort zone or breaks common-sense assumptions. Although some researchers try to identify which kinds of curiosity triggers are the most effective (e.g., Zhang & Zhai, 2010; Tieben et al., 2011), this thesis suggests that they are all important with varied use. Like storytelling techniques using curiosity in different narrative structures, different modes of curiosity have different advantages and effects in different phases of the interaction process.

- Making the effect of curiosity triggers at a moderate level

  According to the optimal arousal theory and other cognitive-based theories of curiosity, the level of curiosity and inquisitive exploratory behaviour performs best when stimulation (i.e., the curiosity trigger) is not too low and not too high. For instance, if the size of an information gap is too large, one would avoid the question or withdraw because achieving competence in closing the gap would cause an increase in anxiety and pressure. If the gap is too small, however, one may ignore it as one feels content with the relevant information, thus there is no need to eliminate ambiguity. In other words, although the new and the unknown trigger curiosity, we are less likely to be curious about the things that we have no prior knowledge in. In a similar vein, the more we know about a subject, the more often or intensely we want to find out more. To provoke curiosity, as Müller et al. (2010) suggest, “the interaction shouldn’t be designed in a way that is either too complex or too trivial” (p. 4). Therefore, it is important to evaluate a user’s prior knowledge to ensure that the curiosity trigger acts at a moderate level. It is advisable to craft a curiosity trigger with respect to the user’s existing knowledge (or add a small amount of information to impose prior knowledge) to make the information gap a more manageable.

- Providing an interesting scent

  As discussed in chapter 1, human beings’ curiosity operates not only at an attentional level for survival, but also at an emotional and cognitive level. Our curiosity is not like that of other non-human opportunistic species that simply respond to any new or unusual sight or sound within the environment. We typically make judgements about the incoming information (e.g., not every unread email and message would make the recipient curious enough to read). As discovered by brain researchers, curiosity responds best when the trigger (i.e., a cue) signals pleasurable rewards or genuine interest. It is like a tantalising olfactory scent that triggers the desire to know what the dishes taste like. An email from a good friend or a link that implies something that fits the recipient's interest would most likely trigger the desire to click and read. From the information gap theory perspective, the perceived relevance of the information gap influences the willingness to close the gap (i.e., to reach the desired knowledge level). In other words, setting up a positive expectation of the desired discovery in the user's mind from the early stage could effectively draw one in to follow the interesting scent and to act on curiosity.

- Generating circles of increased curiosity and resolved curiosity

  In the design of the structure of narrative, making cycles of opening and closing information gaps (i.e., cycles of having desire to know what will happen next and enjoying the pleasure of little discovery) has been recognised as an effective tactic to keeping the audience engaged as the story unfolds. The findings of brain studies on the dopamine system also give this design strategy a scientific basis. Although our curiosity system is evolved to be restless, the pleasure that new experiences evokes only lasts for a very short period of time. The brain needs to suspend its quest for a while to avoid chronic restlessness. Generating circles of increased curiosity and resolved curiosity in the story plot arrangement helps set up a current of curiosity that subsequently draws in the user. This has the practical implication of crafting an experiential quality of curiosity in the process of digital interaction to lead

> people to become more engrossed as they know a little more about a topic or a novel situation. Curiosity is insatiable if sustained properly.

While the above strategies for crafting curiosity triggers make good bait to draw in the user to a curiosity-driven situation, there is still room for improvement. Although many curiosity triggers have been suggested, they are similar in the way of driving the user to experience something on screens based on taking them out of the known territory. However, how these curiosity triggers could help a user relate to a screen in the exploratory process is underexplored. Moreover, in studies of public display, deploying people to stimulate the passer-by's curiosity also suggests other situational and social factors are not yet well-explored. Therefore, the following section will continue to elaborate on the limitations and problems on the current use of curiosity in digital media design.

2.4 Limitations and problems

2.4.1 Lacking insights into supporting curiosity when encountering a screen

> What we miss are design recommendations for evoking curiosity in *encounters* with interactive systems. How can we make people who *encounter* an interactive system curious, and how can we elicit explorative behaviour from them? [emphasis added]
> — Rob Tieben, Tilde Bekker, and Ben Schouten, 2011, p. 362

Firstly, as suggested in the above quote, researchers still do not fully understand how to encourage people's explorative behaviour when they encounter screen-mediated contexts. Many design principles for provoking curiosity derived from early-developed psychological theories, such as Berlyne's collative properties and Loewenstein's information gaps, are not difficult to translate into cognitive-based approaches to trigger curiosity and increase motivational appeals of the digital content. However, they are mainly applied to ways of presenting information on a screen. Methods of encouraging people's curiosity and exploratory behaviour toward screen-mediated contexts receive little attention.

As discussed in chapter 1, we are, as the supreme opportunists, hardwired to survive and develop through interacting with the environment. Curiosity and its motivational forces turn us into active beings that seek out information and develop diverse adaptation. Through encountering and interacting with the new and unknown, individuals familiarise themselves with the external environment. Thus, their knowledge gradually grows, and they develop complex thoughts. When we concentrate on designing digital content that appeals to our curious brains, active engagement with digital worlds largely relies on our cognitive processes. Especially, in the age of desktop computers, active exploration and bodily interaction with the screen itself and its surrounding environment are only a small concern; curiosity is resolved through visual inspection of screens. Therefore, provoking curiosity through cognitive-based information processes plays a more important role to craft curiosity triggers and engage users' attention and interest in the design of digital interaction.

In fact, long before psychologists focused on cognitive processing factors to explain curiosity's mechanisms, many early theories of curiosity were largely developed from observations of animal behaviour and human interactions with novelty. For example, according to Berlyne's oft-cited classification of curiosity, curiosity is divided into two groups based on the forms of exploratory behaviour: specific and diversive. Specific curiosity is triggered by an unusual object or a thought-provoking question, and it keeps people focused towards the stimuli, whereas diversive curiosity is manifested in sensations or novelty-seeking behaviour. Also, in the view of the optimal arousal theory, exploratory behaviour is activated either to stimulate or reduce an unbalanced level of arousal.[93] From the perspective of dual process theory, curiosity is defined in terms of our exploratory behaviour patterns towards the novel stimuli. As such, the psychological understanding of curiosity is closely linked to our novelty-seeking behaviour and exploratory behaviour with the incoming novel stimuli.[94] As shown, our exploratory behaviour with regards to how we encounter curiosity stimulus are central to many early theories of curiosity.[95] As many screens have exited personal and private contexts in favour of public or shared contexts for everyday activities, encouraging people to explore, act on curiosity and develop closer relationships with technology in everyday life is more important than ever before.

Today's design practices for inducing users' emotional feelings and curiosity should not only require our conscious reflections, but also should consider the embodied relationship to the screen and its surrounding context. If we look back at the

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[93] See section 2.2.2
[94] See sections 2.2.5 and 3.1.1
[95] This will be discussed in more detail in the following chapter.

peepshow box of the 17^{th} century, the showman had to attract the public in competition with other street performances by using music, puppets, and other props to trigger people's interest in the peepshow box (and the images inside) before offering a glimpse of the scene (Balzer, 1998). What made the peepshow appealing was not just the boxed apparatus that suggested hidden content, it also benefited from situational and contextual factors.

Regarding the situational nature of using many screens in a public or shared space, situational and contextual factors are becoming increasingly important for enabling and sustaining curiosity to keep people aware of the world around them and to be more attentive to others. However, currently, capitalising on contextual and situational determinants to provoke and resolve our curiosity has not been well-researched in digital media design. As with the question raised by Tieben et al. (2011) quoted at the beginning of this section, we need to put more effort into exploring what factors influence our curiosity when encountering screens before moving into an engaging state with the content on the screens display.

2.4.2 Missing the role of curiosity for thriving on novelty and difference

> If computational devices channel people's activities and perceptions too closely, then people have to live out somebody else's story, not their own.
> — Bill Gaver, 2002, p. 4

Furthermore, designers should think about how to best promote the essential role of curiosity in user experience design. As mentioned in the introduction, today's problems rooted in screen-saturation, such as shallow thinking, screen fatigue, and over-stimulation, provide the main motivation for research. Therefore, provoking curiosity is more than a means to grab attention or change behaviour, it is about expanding users' experience and knowledge, and more profoundly, finding what is meaningful in the long term. If the purpose of using curiosity in the user experience is solely to grab attention at the initial stage of the interaction section, we have lost sight of the critical purpose of human curiosity. Designing for curiosity should enable people to ask their own questions and to develop their inner interpretations in their exploration of the world around them. As cited in above Gaver's (2002) statement, the design of the interactive experience should enable people to create their own meanings, rather than to live out somebody else's dream.

Many current curiosity-provoking approaches seem to help transform information into a curiosity stimuli but are less successful in supporting one's self-directed exploratory behaviour. Such focus on crafting information into curiosity triggers would help people engage in what Kashdan (2009) calls *passive curiosity*, in that people's curiosity is only passively aroused when they encounter novelty and uncertainty. The viewer lacks the excitement or strong desire for knowledge that is associated with passive curiosity's opposite: active curiosity. Consequently, modern design approaches diminish the intensity and power of active curiosity by only activating its counterpart. The most fascinating aspect of human curiosity that originates from within needs more support to extend beyond the passive.[96] As previously mentioned, many theoretical accounts of the inner workings of curiosity include both external and internal sensations.[97] An individual's innate desire for knowledge and self-directed curiosity-driven experience should take into consideration of design approaches for sustaining curiosity more often. In other words, we should consider the way that design practices help turn one's passive curiosity stimulated by encountering a screen-mediated context into active curiosity that lets self-directed free-spirited minds emerge and develop.

Therefore, the idea of provoking curiosity needs to help users carry out their open-ended, self-directed exploration, rather than simply direct users' actions. As shown in the literature review of this chapter, the majority of digital media practitioners tend to utilise curiosity's immediate pleasurable experience and irresistible effect to nudge one's actions on a screen, and some even consider it as a secret psychological tool to move a user to instantly take specific actions or to lead the user to desired outcomes (e.g., to learn a known knowledge point or to make a consumptive decision). Along this line of thinking, the idea of provoking curiosity is more focused on looking for ways to craft intriguing psychological hooks (i.e., information gaps). This directs users' curiosity to moving on the predefined path, but it might leave little room for open-ended interpretation and imagination. As supreme opportunists, we are born to experience boundless opportunity, not simply to fill an information gap to get rid of

[96] See chapter 1
[97] See section 2.2.5

its aversive feeling associated with the unknown. The idea of provoking curiosity is to make people to come closer to their full potential, rather than to exploit curiosity to create short-term novelty or reducing the feeling of uncertainty.

In addition, if curiosity is provoked to do a simple or constrained act, we have a tendency to get bored after curiosity's resolution. This kind of curiosity, aroused by a simple question, is only a teaser for shallow exploration. It does not open up more possibilities for interpretation and imagination. Thus, designers should avoid becoming too manipulative in exploiting the effect of a knowledge gap on the user's decision-making and actions. Allowing people to think of their own questions and supporting their innate interests is important to stay true to the essential value of human curiosity.

Malone's (1980) study of curiosity, as noted above, was derived from the computer gaming context. He reviewed the works of Berlyne and others to apply his theory of curiosity to the computer learning context. His ideas about making information appear incomplete, inconsistent, or not parsimonious are considered similar to Loewenstein's (1994) information gap theory, in that creating a knowledge gap can naturally produce feelings of deprivation and compel people to take action to find the missing information to close the gap (i.e., to feel relief from information deprivation). However, the gaming context, where he noticed curiosity as one important source for enhancing the user experience, actually uses curiosity to elicit a sense of mystery. The implications of producing mystery in our experiences are rather different from that of making an information gap (Leslies, 2004).[98] Finding a missing piece of information to fill a gap is like building a puzzle. The puzzle-like information gap may only provoke a short-term effect; as soon as the missing puzzle piece is fitted, the gap is closed and the curiosity is ended.

In other words, the exploration of a puzzle-like information gap might not be able to resonate within us for long. In contrast, mystery engages us with no imposing answers. Therefore, a curious person would extend his or her desire to explore further in the form of imagination and fascination. This point is also similar to Malone's (1981) discussion of what distinguishes toys from tools. In his study, Malone (1981) saw the defining function that distinguishes toys-systems from tools-systems is their affordance for self-oriented goals produced by users. I think it is important to engage the user to create a meaningful experience, though Malone did not reflect upon this point to model a curiosity by creating a mysterious effect or a toy-like interaction for self-directed exploration in designing the user experience.

The true value of curiosity, as argued in the preceding chapter, is that it enhances human capability to become fully-fledged in their environments. The wondering characteristic of curiosity that emerges from within is an evolutionary advantage that moves us to look beyond the present and even transcend the mere need for survival. Only with this unique human trait can human beings explore and discover the world with new viewpoints, ask more questions and experience the familiar from a fresh

[98] See Leslies (2004), for Treverton's distinction between puzzles and mysteries.

perspective. The curious mind should not simply be led to pursue a set schedule or to expect answers that have been prescribed.

As stated in the introduction, the ubiquity of digital screens has been increasingly blamed for making our thinking less critical and creative, because it promotes a state of restless curiosity. Provoking curiosity in the user experience in this thesis is also a call for designing an experience that offers space for users to locate their own interpretations, rather than being limited to the prescribed result. The research will further explore the ways of provoking such a mode of curiosity. The design for curiosity should look for more ways of supporting active sense of curiosity, encouraging re-thinking and re-evaluation of the existing experience, and developing a new perspective through digital media interaction.

2.4.3 Conclusion

To conclude, as Arnone et al. (2011) identified in their study of curiosity for digital learning technology, there is a need to develop new ways to study curiosity in the context of today's pervasive technology. Effective approaches to cultivate curiosity in screen-mediated contexts are still incomplete.

In today's screen-saturated life, an active sense of curiosity for sustaining self-directed exploration and deep thoughts is gaining more significance. As discussed in the introduction, many are concerned with the negative impact of digital technology on our ability to think deep and creatively. The focus of experience design for curiosity should expand from engaging one's passive curiosity in the digital world to helping support more active senses of curiosity for self-directed learning, exploration, imagination, and creativity. In essence, we need to design for active curiosity that will embrace people's willingness to explore and discover when they encounter a screen-mediated situation. More importantly, we have to look for ways to encourage people to thrive in novelty, rather than just deplete their attentional strength to do what have been told.

Therefore, in the following chapter, I will reconsider approaches to elicit curiosity through direct observation of people's actual exploratory process within screen-based contexts. I will look into certain questions, such as what contributes to exploratory behaviour and what results in the inhibition of curiosity. Through observation and analysis, design suggestions for user experience design will emerge that would be more able to support users' active curiosity in a screen-mediated context.

Chapter 3: Identifying Curiosity Triggers through Observation

3.1 Introduction

3.1.1 Reasons for choosing observational research methods

As discussed in the previous chapter, there are problems and limitations with applying the concept of curiosity in current digital media design. Many curiosity-provoking strategies largely depend on cognitive operations to compel people to make sense of the unknown and reduce uncertainty in digital content. As reviewed in the previous chapter, common design practices evoke a sense of curiosity include introducing curiosity arousers in stimuli (e.g., adding novelty, incongruity, ambiguity, etc.), asking thought-provoking questions, and posing surprising statements. These theoretical formulations are effective psychometric algorithms, but they seem insufficient to identify what situational factors support active curiosity, especially for increased walk-up-and-use technological scenarios in everyday life.

While a number of curiosity-provoking techniques have been used in creating digital content, not much is known about how to engage people's curiosity for a screen-based object at the initial stage of the perceptual process. The processes and dynamics relating to people's curiosity-driven exploratory behaviour has been a neglected area of digital media design research. This omission is largely because readily identifiable curiosity-driven behaviour is often limited to visual inspection. Given the visual nature of digital screen use, the dominant form of exploratory behaviour (i.e., physical engagement) in the process of curiosity resolution through a screen is usually reduced to an image of a single user viewing a screen monitor, albeit perhaps more closely than a disinterested viewer. The only observable impact of curiosity is staring and clicking. Therefore, how an individual becomes focused on a screen is not of concern. Consequently, the embodied, contextual, situational factors necessary to provoke and sustain curiosity in the computer interaction have been often overlooked.

In fact, the forms of curiosity-driven exploratory behaviour are varied, such as searching, observing, visual exploring, experimenting, investigating, asking unsolicited questions, and manipulating the source of curiosity stimuli (Kreitler, Zigler, & Kreitler, 1975; Fire, 1985). The relationship between curiosity and exploration, as Edelman (1997) concluded, is "embedded and intertwined" (para. 21). However, not all that could be observed during interaction is apparent on a traditional computer screen. There is nearly no readily identifiable physical change that signals the curiosity-driven process in relation to the media. Therefore, exploratory behaviour has not been adequately noticed and researched in design literature in the area of curiosity.

However, analysis of exploratory behaviour is an important pathway to understand curiosity (Jirout & Klahr, 2012). Based on the common assumption that much of spontaneous exploration is driven by curiosity, many curiosity theories developed in the mid-20th century that explained that the spontaneous exploration and self-directed activities of animals and humans were to uncover the meaning behind the exploratory behaviour. As mentioned in the previous chapter, early drive-based theorists defined curiosity as an appetitive need for information, which is an uncomfortable state of arousal that elicits exploratory behaviour to gather information about curiosity stimuli in the environment in order to reduce feelings of aversion. Therefore, the function of exploration in the drive-based theory of curiosity is also referred to as an arousal reduction activity.

Other classic theories of curiosity also characterise curiosity as a range of behaviour. For instance, paying attention to the object of one's curiosity is a manifestation of the need to satisfy perceptual curiosity; novelty-seeking behaviour is recognised as the result of low curiosity stimulation intensity. Diminished visual attention has been linked to a lack of curiosity (Daffner et al., 1992). Also, Berlyne's classification of curiosity, as mention in the previous chapter, is primarily defined based on many types of exploratory behaviours. Day's zone of curiosity is the state in which a person would be best energised to explore his or her interests. As such, the primary research method in the study of curiosity is largely based on the observation of exploratory behaviour, and the level of curiosity is often measured with behavioural indices (Fire, 1985).[99] For example, Maw and Maw (1964), which is based on Berlyne's work, specifies the following behavioural forms as the expression of curiosity, "…curiosity is demonstrated by an elementary school child when he:

1. reacts positively to new, strange, incongruous, or mysterious elements in his environment by moving toward them, by exploring, or by manipulating them,
2. exhibits a need or a desire to know more about himself and/or his environment,

[99] Many types of curiosity are defined in term of exploratory behaviour, see Fire, 1985.

3. scans his surroundings seeking new experiences, and
4. persists in examining and exploring stimuli in order to know more about them" (p. 31, quoted in Arnone, 1995).

Therefore, the effect of interaction design on curiosity should not be analysed without reference to actual exploratory behaviour. From a biological and evolutionary viewpoint, the role that curiosity plays in the survival of human beings affects exploratory behaviour to keep us motivated to learn by trying new experiences in a given environment. We then internalise those experiences by assimilation, accommodation, and alternation of thinking. It is almost axiomatic to suggest that curiosity is at least one of the most important motivational prerequisites for exploratory behaviour. Without aroused curiosity (i.e., the desire to know and explore more), individuals are unlikely to invest much time or energy in exploring or expanding themselves. They will likely not get involved with the unknown or even potentially dangerous activities. Thus, exploratory behaviour[100] is an inherent expressive form of curiosity. In English, the word *curiosity* can be defined both as the desire to know as well as the behavioural trait (or physiological reaction) elicited by it. It is indeed difficult to discuss curiosity apart from exploratory behaviour.

All in all, to develop design strategies for provoking curiosity, it is important to understand curiosity with respect to exploratory behaviour. As concluded in the previous chapter, there is still a lack of understanding of ways to provoke curiosity

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[100] Also known as orientational-investigatory activity (Berlyne, 1966)

from a more situational and contextual-based viewpoint. To improve user experience in the age of ubiquitous screens, it is important to consider how curiosity unfolds in the exploratory processes. Especially for many of today's digital scenarios that require innate motivation to approach and use the display, curiosity is oftentimes a necessary condition to initiate the interaction process in a public or shared spatial context. To better understand how to design for curiosity with screen-mediated media and technology, the activation process of exploratory behaviour should be considered. We can then proceed in the actual interaction context and examine its influential factors.

Although one's cognitive process is not visible, behaviours can be observed. Our exploratory behaviour is closely linked to our curious mind. As Loewenstein (1994) stated, "Curiosity involves an indissoluble mixture of cognition and motivation" (pp. 94-95). Therefore, we can see signs of curiosity's process through observation of people's behaviour, including both verbal and nonverbal behaviour. While the observation method cannot reveal every piece of information (e.g., the relationship between one's curiosity prior to, and after their exposure to a digital screen), I believe that much of what can be learned from observing people's interactions will help develop our understanding of curiosity at a deeper level. We can then isolate its influential factors in nurturing people's active curiosity. Therefore, I will identify curiosity influential factors through observational studies.

In this chapter, the primary aim of the observational studies is to identify the relationship between exploratory behaviour and a screen-mediated interaction context. Through observation of actual interactions with screen-based media, what is left unexplored in the exploratory process of a curiosity-driven experience should be revealed. Thus, the focus of this chapter is primarily observing the ways in which people, including individuals and groups, initiate their exploratory behaviour in and around a screen-mediated context. Furthermore, I will propose a model of the curiosity process from which to identify what factors contribute or inhibit people's active curiosity.

3.1.2 Choosing the research venue

To identify various forms of exploratory behaviour and its relationship to the use of a screen, I originally considered conducting more formal observations at several places I had previously observed (i.e., Big Screen Edinburgh in Festival Square and large information kiosks in Edinburgh Central Library). However, I noticed that the interaction rate and forms of exploratory behaviour with screens appeared too low. Therefore, I decided to choose the National Museum of Scotland as my observational site because I expected the range of exploratory behaviour to be broader since this place is a rich source of information and novelties for individuals seeking knowledge and stimulation. Curiosity, learning, and exploration seem to be encouraged through active discovery in the places of this kind.

The National Museum of Scotland preserves a large amount of historical artefacts and cultural treasures. From 2006-2011, it underwent a nearly five-year-long redevelopment. This museum contains several exhibition spaces that have been redesigned with a wide range of digital technology to enhance and engage visitors' experiences. These include large double-sided screens, spherical displays, and interactive devices, which are potentially unfamiliar to visitors. Thus, the museum provides an environment to study how people come to explore, seek out, become aware, and gain interest in learning with the assistance of the novel technologies. Additionally, the exhibits that use interactive tabletops and multiplayer games support simultaneous use of the digital exhibit to learn and to experience a sense of curiosity together. Thus, this place provides ample opportunities for the observation of how members of groups interact with one another when engaging with the screen-mediated exhibit.

As observed in the previous studies, those who walked through the public square or visited the library seemed to have a goal-oriented mind-set as their interactions with the public screen were mostly limited to brief glances. In a museum, many visitors typically come for relaxation, leisure learning, and inspiration. As a result, they have more time and availability. Many visitors wander around the exhibition space and have more time to spend on the subjects that interest them most. Don Norman (2004) wrote in his book *The Design of Everyday Things*: "Positive affect arouses curiosity, engages creativity, and makes the brain into an effective learning organism" (p. 26). When in a place where positive emotions are encouraged, people are more likely to feel curious and to be open to experience new things. Also, according to the curiosity studies shown in the previous chapter, novelty-seeking behaviour is likely to emerge in low-stress conditions. Gould (as cited in Philips, 2013) also suggested that people's curiosity and exploratory behaviour are socially accepted and are expected to thrive in museum. Therefore, museum visitors are likely to explore the unknown and become engaged if something grabs their attention and appeals to them.

Furthermore, many researchers and educators describe museums as informal learning settings (e.g., Fire, 1985; Knutson and Crowley, 2010, p. 189). Although there are various objects and exhibits for learning with predefined learning goals, visitors have no mandatory objective to get involved. In the context of this informal learning setting, curiosity encourages exploratory behaviour that is more self-directed. In museum studies, curiosity is regarded as an important factor in many visitors' exploration. Therefore, understanding how museum visitors' curiosity unfolds help designers turn passive curiosity into active curiosity.

According to Rounds (2004), the majority of visitors can be viewed as *drifters* who come to the museum to pique and satisfy their curiosity. From the evolutionary perspective, Rounds (2004) suggests that curiosity-driven exploratory strategies that help visitors engage in "wide-but-shallow learning" (p. 384) fit people's situational goals during their visit. In other words, curiosity is an important driving force that leads the drifters to pause and learn more information about displayed objects and exhibits. However, since drifters usually aimlessly view exhibits for less than 30 seconds (Falk, 1983; Nielson, 1946), the role of people's attention and curiosity is, therefore, more significant in self-directed exploration and learning. People's active curiosity should be the strongest motivational force in the exploratory behaviour within such informal learning context. That is to say, curiosity plays a crucial role in the allocation of attention, pathfinding, and time for visitors in this kind of places.

All in all, such a context is more accommodating for the expression of curiosity and voluntary exploratory behaviour and spontaneous activities. This provides more opportunities to observe people's interactions with screen-based exhibits, revealing how curiosity unfolds in an individual or social group's learning process.

3.1.3 Research questions

The primary purpose of this observational study is to obtain information about how people's curiosity unfolds around digital displays in order to gain a better understanding of what factors contribute to the curiosity process. The collected data is expected to provide a solid context for analysing and answering the main research question of how we can provoke and sustain people's active sense of curiosity in the digital experience. Derived from this main question, several sub-questions are used to guide the focus during the observation at the museum. The guiding questions include, but are not limited to, the following:

1. How do visitors demonstrate their curiosity when they first encounter a screen? How do people approach exhibits of interest? What are their curiosity-driven behavioural patterns in the immediate vicinity of an exhibit?

2. What is the potential of the design of a screen-based exhibit to arouse curiosity? How do these design factors cause an individual to proceed forward in the exploration process?

3. What other factors prolong one's curiosity when using a screen-mediated exhibit?

4. What factors diminish one's curiosity and exploration?

3.1.4 Observational phases and study approaches

The data collection methods were roughly divided into three phases of direct observational studies.

3.1.4.1 Phase 1 – Exploratory stage

The early observations were conducted on the afternoons of 17 March 2012 and 24 March 2012. As the first stage of research observation, the main objective was to make an open-ended observation in order to gain a wider understanding of the overall situation. Since there is a wide array of digital interactive exhibits in the National Museum of Scotland, the focus was on identifying which digital screens are favoured by visitors and worth further investigation. The recording methods were note-taking and sketches.

3.1.4.2 Phase 2 – Focused observation at the selected exhibits

At the second stage, the observations were carried out over a period of five weeks. After the investigation of phase 1, I chose four exhibits for observational studies:

Robot Ships, Earth Sphere, Making Faces, and Underwater Camouflage Design (see Table 3.1 below).

Table 3.1 A brief description of four selected exhibits

Exhibit name	Location	Exhibit Hardware	Description
Earth Sphere	Restless Earth Gallery	A large two-metre spherical display	This large exhibit uses novel spherical display and video to show the dynamic ways in which the Earth rotates.
Robot Ships	Connect gallery	An interactive tabletop game, supporting concurrent use	This exhibit is designed to show scientists' ideas about how robots can be used to clean up toxic spills in the ocean in the future.
Making Faces	Imagine Gallery	A touchscreen kiosk and a large slave monitor	This interactive exhibit allows children to make faces from a series of facial components on a touchscreen kiosk. Another large slave screen, hanging from the above, presents an identical image from the small touchscreen kiosk for people to watch and work collectively.
Camouflage Design	Adventure Planet Gallery	A touchscreen kiosk and a floor projection	This is a multiplayer game designed for young visitors to learn and experience how underwater creatures can survive using camouflage.

I conducted observations of visitors' interactions with above four exhibits because they meet the following criteria that fit research objectives: (a) they use apparent technological novel effect to grab attention and interest; (b) they enable certain physical movement and gestures to resolve curiosity; (c) they accommodate co-present visitors to work in parallel; (d) their locations are suitable for doing unobtrusive observation.

The observation at this stage was unobtrusive, as considering the fleeting nature of curiosity and the observer effect.[101] The locations I chose for conducting observations at the museum during this phase were at peripheral locations, so I would not affect the visitors' behaviour. Even so, I remained able to observe visitors' movement and behaviour in the galleries. Furthermore, to make my presence in the vicinity of the exhibit have less influence on visitors' behaviour, observations were often conducted with my child. This allowed me to appear as the parent of a young child rather than an observer watching their behaviour.

In general, the purpose of my observations was to examine the ways people interact with and around the above-listed exhibits and to identify what factors account for provoking and sustaining a visitor's curiosity through an interactive exhibit. The observations of visitors' interactions with the exhibits were documented in the forms of notes and photographs.

3.1.4.3 Phase 3 – Re-evaluation

Since the observations at earlier phases were conducted subtly to reduce the observer effect, some observation locations were too far away to hear the conversation of the subjects. As a result, the social dynamics were sometimes unclear. With the permission of the museum[102] to carry out observations on-site for a week, I conducted observations at those sites again in April 2014 (every day from 16 to 22

[101] The observer effect (also referred to as the Hawthorne effect) is a common problem in observational data collection method. People are likely to change their natural behaviour or choices when they know they are being watched or observed by others.
[102] See Appendix B for the ethics check list and email correspondences with the museum's staff about permission

April 2014). During this third phase of research, I wore the museum's badge while carrying out observations (so I would declare my identity and explain my project if approached by a visitor). Since I was permitted to conduct observations, I was able to choose observation locations that were closer to the interaction area. Thus, I could closely observe the users' verbal and nonverbal behaviour. Thus, more information about how the social context affects visitors' exploratory behaviour was collected.

Learning from previous observation experience, conducting studies in the museum without using video or other recording instruments had the disadvantage of extensive note-taking. Therefore, at this stage, I designed a field data recording sheet[103] in advance to avoid taking notes in a disorganised fashion. I had hoped that it would allow the note-taking process to occur in a smoother fashion. However, I found it was not really helpful in reducing the time for note taking because the number of visitors to the museum increased due to a holiday break. I then abandoned the use of this form.

[103] See Appendix B, section 4, for this observation form.

3.2 Observational data

3.2.1 Earth Sphere display

Figure 3.1 The Earth Sphere display in the Restless Earth Gallery. (Left: the Earth Sphere. Middle: the spatial context of the Earth Sphere in relation to another large wall-sized video – the Earth Events. Right: a close shot of some scratches on the surface of the Earth Sphere.)

3.2.1.1 Description of the exhibit

The Earth Sphere is an educational platform that shows high-quality moving images and videos about geological processes and concepts, e.g., Earth's layers, plate tectonics, rock formations, volcanic processes, and continental drifts (see Figure 3.1: Left). The animated content lasts approximately two minutes and is internally projected onto an air-inflated spherical display (without sound). Given its large viewing surface, visitors can easily see the display when entering the gallery and it is large enough to allow a number of interested visitors to watch the content simultaneously from all sides.[104]

3.2.1.2 Spatial context

[104] See more information about this exhibit hardware from http://www.pufferfishdisplays.co.uk/case-studies/national-museum-of-scotland/

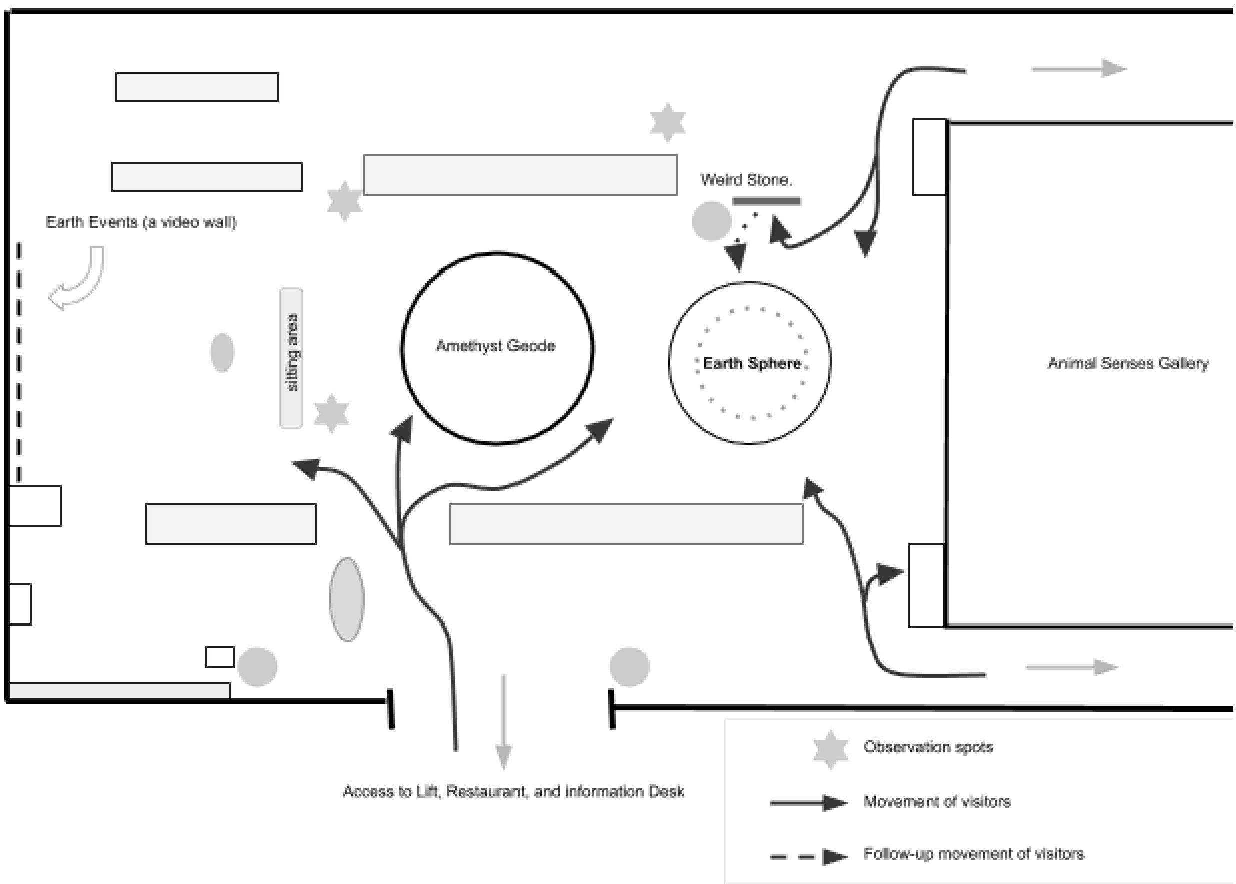

Figure 3.2 The spatial context surrounding the Earth Sphere and visitors' movement in the Restless Earth Gallery

The display is located in the Restless Earth Gallery, part of the Natural World Gallery, on level 3 of the main Royal Museum building. In this exhibition space, many extraordinary rocks and minerals of various sizes are on display as well. Around the area of the Earth Sphere display, there are two attractions that often grab visitors' attention: one is a large amethyst geode pair fixed on a central plinth, and the other is a large polished slab of orbicular granodiorite (see Figure 3.2 for the location of these exhibits). At the back of the gallery, there is another large wall-like traditional projected display – the Earth Events – showing a film about earthquakes and their aftermath (see Figure 3.1: Middle). The general ambient lighting condition is well controlled, which makes the screen-based media noticeable, but it remains comfortable for viewing in this dimly lit environment.

3.2.1.3 Interactions around the exhibit

In general, most visitors just passed through the display, or took a very brief glance at it when entering the exhibition space. Many visitors were not observed to be engaged with the Earth Sphere. Many of these disinterested visitors, however, still invested time to explore other exhibits around the gallery. Other nearby exhibits and objects, such as the traditional wall video (i.e., the Earth Events) and the large purple amethyst geode pair, apparently drew more attention of museum visitors. Many visitors wandering in the Restless Earth Gallery did watch the Earth Events. It was also common to see people show interest in the amethyst geode pair. They touched and took photos of it. In comparison, the self-illuminating giant globe with stunning motion graphics was not an eye-catching spot to hold the attention of museum visitors in this exhibition space. The Earth Sphere rarely caused visitors to stop and view its content for over five seconds. Very few social interactions or conversations occurred among group visitors who viewed the globe.

The general behaviour patterns of interested viewers are as follows:

A. attending --- glancing briefly from a distance --- ignoring the display and continuing the visit

B. attending --- approaching and standing in front of the display (touching or poking the surface of the display) --- disinterested --- resume scanning behaviour

For some interested visitors, the initial gesture was to touch or poke the surface of the display, only a few resolved their curiosity by passively watching. It is interesting to note that, standing in sight of popular viewing locations, there are some scratches on the surface of the Earth Sphere, which indicates visitors' history of contact with the sphere (see Figure 3.1: Right). Since the device is non-interactive, the person who actually touched the display lost his or her curiosity quickly and usually moved to see other nearby objects or items, rather than continuing to watch the digital content to learn more about Earth science.[105]

3.2.2 Robot Ships tabletop game

Figure 3.3 Robot Ships tabletop device and its located context. (Left: the Robot Ships tabletop device with two black pads on the table. Right: the spatial context around the Robot Ships in the Connect Gallery.)

[105] See two instances of this in the later sections 3.3.3.2 (vignette 1) and 5.3.3 (see Figure 5.3) in chapter 5

3.2.2.1 Description of the exhibit

Robot Ships, a tabletop interactive exhibit, is designed to show scientists' ideas about how the robots of the future can be used to clean up toxic spills in the ocean in the form of moving images (without sound and texts). Taking inspiration from social animals, the virtual robot ships act similarly to ants or bees. The seeker robots automatically find toxic spills caused by ocean tankers and leave a trail for cleaning ships to follow. The exhibit uses the technology of Video Augmented Environments (VAEs) to turn a table's surface into an ocean, where visitors can watch the robot ships work.

The interested visitor can simply watch or become more actively involved in the robots' work by moving oil spots. There are two black palm-sized mouse pads in an irregular shape to resemble oil spots placed on the table (see Figure 3.3: Left). Using oil-spot-liked pad to make contact with a digital robot ship will cause a change in the ships' direction, so people can interfere with the progress of the robots' work in real time. The interaction is simple. Players do not need to learn how to activate the game or follow the instructions. No layered or sequenced actions are required and no complex information is hidden for further exploration to reveal.

3.2.2.2 Spatial context

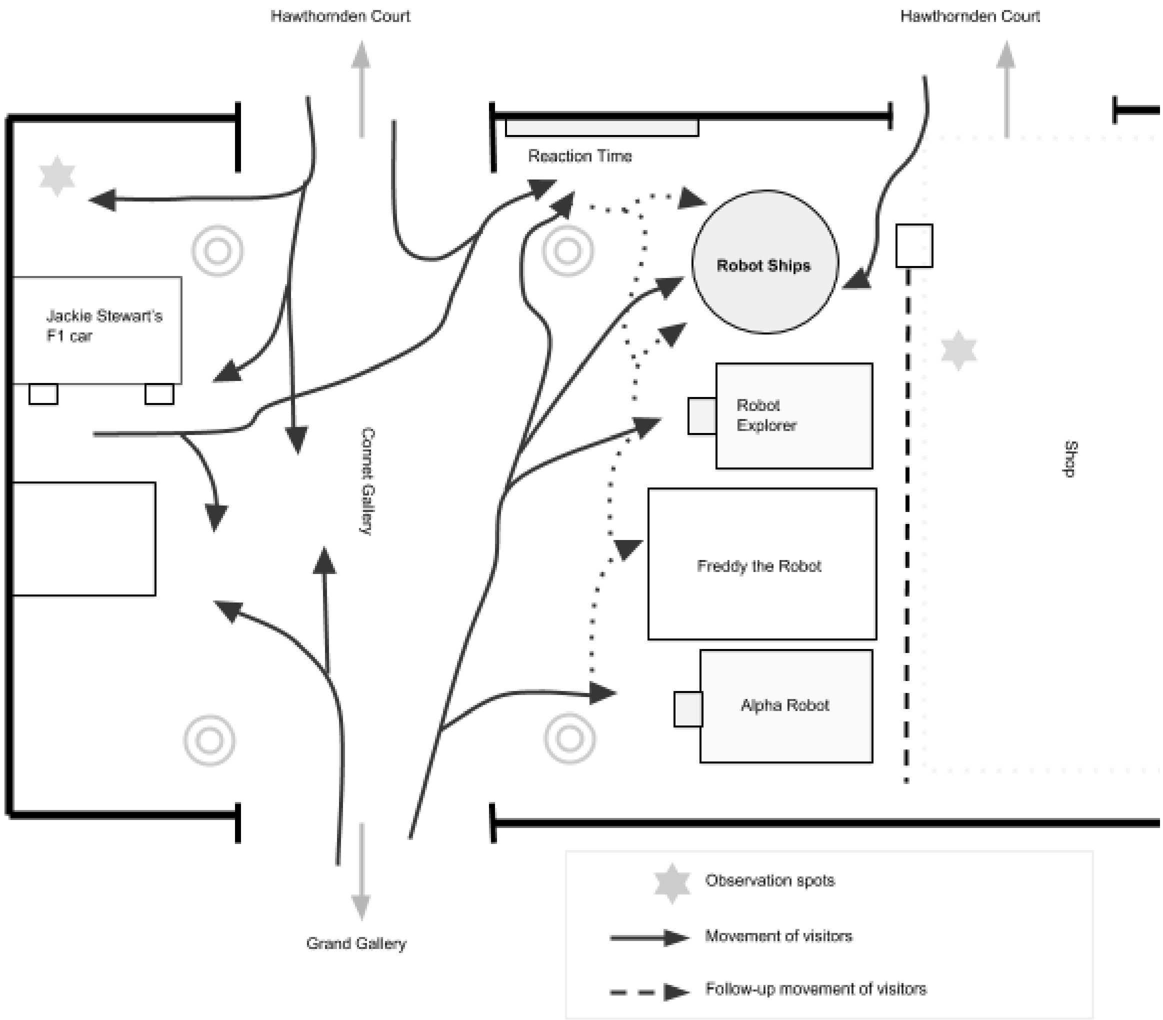

Figure 3.4 The spatial context of the Robot Ships exhibit in the Connect Gallery

Robot Ships is located in the robot-themed area in the Connect Gallery, where there are many interactive exhibits and hands-on activities for visitors to learn about science and technology. Other popular exhibits, including Jackie Stewart's F1 car, steam locomotives, and space age rockets, are also located in this gallery. The Robot Ships is installed near one of the main gates in the Connect Gallery, from which the Robot Ships is not easily seen when people are just about to enter or leave the gallery through the main gates (see Figure 3.3: Right). Visitors who enter from the

Hawthornden Court may notice this tabletop exhibit, because it is the first significant item on their path to the Connect gallery. In addition, there are other exhibits surrounding the Robot Ships, including a large colourful mechanical interactive Reaction Time and interactive machine Robot Explorer (see Figure 3.4 for a diagram of the placement of these exhibits).

3.2.2.3 Interactions around the exhibit

Throughout the observation, this tabletop device grabbed many visitors' attention and invited interaction. However, Robot Ships was located in an area that is not central to the Connect Gallery. It was not the first exhibit that comes into the visitors' view when they enter from the main gates (only a few who entered from Hawthornden Court normally were affected by the space layout). It looked like a normal table from a distance. Compared to other interactive exhibits nearby, it had a less attractive appearance. The key factors that grab visitor's attention seemed highly situational, largely caused by changes in the social dynamics around the Robot Ships.

People's curiosity to Robot Ships related to a number of situational factors. The first notable factor to grab people's attention to this tabletop game is the timing when they completed their exploration of the nearby exhibits, such as the Reaction Time and the Robot Explorer. During the observation, many people noticed, stopped, and played with Reaction Time when they walked around this area. Reaction Time often became a honeypot site[106] as soon as people started to gather. As Reaction Time was

[106] See section 2.3.4 in chapter 2 for an explanation of the honeypot effect.

designed for individuals to challenge themselves to test their reaction time in thirty seconds, many interested passers-by had to wait for their turn. While waiting, some of those visitors became interested in the Robot Ships to fill the void.[107] But some of those people quickly abandoned the tabletop game when the Reaction Time became available.

During the third phase of observation, the museum was populated with many holiday visitors; the influence of the honeypot effect on visitors' curiosity was not apparent. Many exhibits were busy and surrounded by interested viewers. In many situations, people were drawn to the tabletop game because another group left. The movement of a group away from an exhibit was an effective cue to grab the attention of other visitors in more crowded situations. People at peak times seemed to be motivated by factors quite different from those visiting during low-traffic times. Another significant factor was more socially determined. Some visitors' attention was led by the first person in a group who had already noticed the display. For those whose interest was triggered by a group member's curiosity, they would either play the game with their group member or walk closely to watch in passing.[108]

Many times, the interested people simply stepped closer to the edge of the table, showing no hesitation to take a black pad from the table to directly make contact with the moving object. The fast moving seeker robots were usually the target for

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[107] In other words, Robot Ships helped to disperse visitors away from this honeypot site.
[108] See also 3.3.3.1 Social dynamics, vignette 1, for instance.

many.[109] If one or more people were already playing the game, the interested visitor would move to the other side of the table to watch the game. In a very few instances, they made observations from a distance or from behind the current user before playing with the table themselves. However, the existing player was usually affected; he or she often ended the interaction very soon or shows less movement. During the observation, long interaction sessions never occurred when two unfamiliar groups co-presented at the table. Most people's gestures and movements were similar when using the black pad to interact. However, adults, in general, were more fixed at one side of the table, catching the ships within his or her arm's length. The movement and gestures of teenager visitors were more expressive, and they tended to move around the table in their interaction sessions. In some cases, some young children chased the seeker robots by moving around the table.

Another significant interaction pattern was the use of hands to touch the virtual image on the table. When people accidentally found that the virtual images could be interfered by any physical objects, people became more interested. Many played with Robot Ships using their bare hands or fingers without using the pad to interact with the ships. This interaction style often attracted other co-present players' interest, and many would start to do the same with their hands. Using hands and fingers to play brought out more interactive behaviour and gestures. For instance, a visitor used both hands to wrap around a seeker robotic ship and tried to make it move somewhere; another two visitors worked together to trap as many robot ships as possible on one

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[109] The cleaning ship moves much slower than the seeker robotic ships.

side of the table. It was common to see people playing with their hands and fingers to catch the moving robot ships or to manipulate the ships' movement.

On average the interaction sessions were short. They varied from less than ten seconds to more than thirty seconds, but some people walked back to try again. The typical forms of individuals' interactions with Robot Ships can be classified in the following patterns:

A. attending --- directly interacting with the moving robot ships by moving the pad --- (playing with virtual images with bare hands or fingers) --- disinterested --- moving to nearby interactives

B. attending --- watching the current player briefly (not focused on the digital content) --- (interacting with the moving robot ships by moving the pads or hands) --- disinterested --- moving to nearby interactives

Moreover, some social aspects of exploratory behaviour are observable in this case. Visitors travelling in a small group (e.g., families, couples, and friends) made up the bulk of the interactions. Visitors who seemed to be alone were not motivated to interact with the game. The persons who played alone at the tabletop game were usually split from his or her group, and the members of their group were often found nearby interacting with other exhibits. When the person abandoned the game, he or she would move to re-join his or her group. Since many visitors were in groups, most people's interactions with the Robot Ships were with their group members. Most people played with the moving images in parallel around the table, but they held few conversations. However, one usually ceased to play if his or her group members had lost interest.

During the group interaction section, verbal behaviours were rare and short. Sometimes, the content of conversations was inaudible from the observation spot. "What is it?" was the most common phrase. However, most received "I don't know" as a response from his or her group member. No conversations occurred between different visitor groups.

3.2.3 Making Faces interactive exhibit

Figure 3.5 The spatial context around the Making Faces exhibit. (Left: a large wooden sculpture displayed in a glass cabinet for children to find facial features. Middle: the Making Faces exhibit, consisting of a master touchscreen kiosk and a large slave screen which mirrors users' creations. Right: showing the spatial relation between face-related exhibits – the Making Faces and the wooden sculpture – in the Imagine Gallery.)

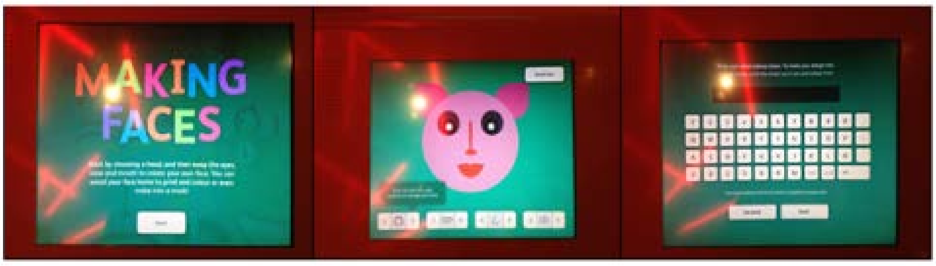

Figure 3.6 Screenshots of the application of the Making Faces kiosk. (Left: the introduction screen where the text shows “Start by choosing a head, and then swap the eyes, nose and mouth to create your own face. You can email your face home to print and colour or even make into a mask!” Middle: the main screen for selecting facial features. Right: the emailing screen for inputting email address to send the face creation out.)

3.2.3.1 Description of the exhibit

Making Faces is a kind of software interactive exhibit designed for children aged 5-8 to learn about the concept of a face. The installation uses a fixed 19-inch touchscreen kiosk as a primary interaction area (i.e., the master screen), and another secondary large 50-inch screen hanging from the ceiling as a slave screen to mirror the creation made on the master screen (see Figure 3.5: Middle and Right).

The user interface of the Making Faces application is made graphically with vivid colours and includes three input screens (see Figure 3.6). The first screen shows the introductory text with a start button to enter the main screen. The main screen is where the user can create funny faces. The application provides many facial components, such as a pig-like head, cartoonish eyes, a pink nose, and a monster’s sharp teeth, so the user can choose and mix them up to make various faces. At the top right-hand corner of the main screen, there is a button to enter another screen for emailing the face just created. This email function allows the user to type one email address at one time with on-screen keyboard to send out a printable mask template generated from the user-created face on the main screen.

3.2.3.2 Spatial context

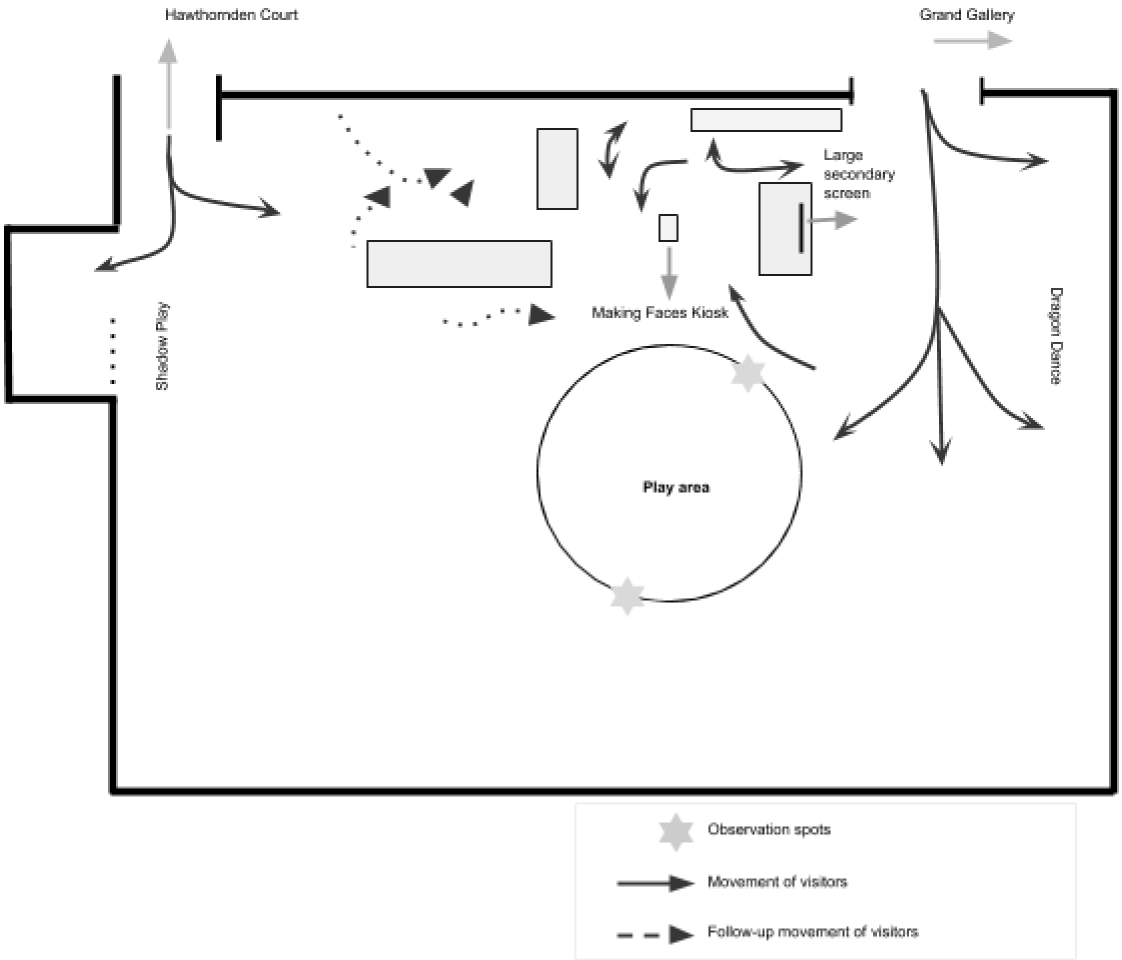

Figure 3.7 The spatial context of the Making Faces exhibit in the Imagine Gallery

The spatial context in which this exhibit is located is the Imagine gallery. According to this exhibit's design brief, Making Faces is designed especially for families with young children under 8 years of age to learn and experience something together in a playful and experimental way. The gallery space is infused with warm light (orange and green colour), which makes this space feel more stimulating and appealing to young children. Many exhibits seem well-designed for provoking young visitors' curiosity in terms of the stimulus properties (e.g., oversized teapots, strange animal models and special celebratory clothes).

The space is roughly divided into several discrete areas for different activities, e.g., storytelling corner, semi-enclosed projected shadow play theatre, and an interactive dance floor (see Figure 3.7). The Making Faces device is located near one of the gallery entrances. In the nearby area, there is another large wooden sculpture with an unusual shape sitting in a glass display cabinet placed right beneath the large repeater screen (see Figure 3.5: Left). A label on the cabinet reads, "What makes a face? Can you find eyes, ears, noses, mouths?" The labelling technique also helps trigger specific curiosity and motivate learning. This wooden sculpture and Making Faces are located in the same area (see Figure 3.5: Right), and they both are used to help children learn about faces.

3.2.3.3 Interactions around the exhibit

During the observation, nearly all people who used Making Faces were children at preschool age with their families. Many of them showed interest in using Making Faces and appeared to have fun with it. Some visitors noticed it when they were wandering around in the Imagine Gallery. Others became aware of it because of the presence of the current user.

Most young visitors who walked into the gallery from the north side gate tended to firstly approach the areas located deep inside the gallery, while adults they usually let their children lead the way or moved to the corner to park their buggies. Some adults directly and walked to and stayed in the Play area with their babies. Only the rear side of the suspended large screen and the aforementioned wooden sculpture can be seen when people enter from the main gate. For the visitors entering from the other gate, the activity zones, like storytelling corner and shadow play area, were often visited when they first entered the gallery. The visitors' movement was affected by the spatial layout as those exhibits are located facing or alongside their walking direction. The area of the face-related exhibits is not a focal point to many at the moment they came into the gallery. They might only notice the Making Faces installation in passing.

But this visitor behaviour pattern changed when people were already using the kiosk upon entrance. Often, the little curious children quickly went to the front area of the kiosk screen with their parents in tow, trying to see what that screen could do. At the same time, children who were already in the gallery also looked into the Making Faces exhibit interaction area. In a few cases, there were more than two children from different families simultaneously attracted to the kiosk when they found someone started using it.

The interested child usually walked to the front of the kiosk screen if it was not occupied, immediately touching and sliding on the screen to see what would happen. If someone or a group was already using the kiosk, the interested child often tended to stand close to wait for his or her turn, watching the kiosk screen and looking at the current user, rather than looking up at the big overhead screen from a distance. In some cases, some children's engagement style was intermittent. They were distracted by other visitors or objects nearby. They used Making Faces several times, but there were only one or two interaction sections they were more engaged. In general, children's exploratory behaviour with the kiosk was rather simple, and many of them spent time in making faces and emailed their own creation (often with the help of adults).

The accompanying adults often explored with the young children, taking a helper or a teaching role at the beginning. Afterwards, most children could play by themselves. The few parents of older children tended to just watch by standing nearby or wandering nearby to wait until their child needed them. For those not standing close to their child, they tended to look up at the overhead screen to see what their child had created, keeping themselves involved in their children's play by using their face creation as a talking point. In many cases, young players laughed and talked with their family members or co-present children while using the main screen. Experimenting with various kinds of odd-looking faces manufactured fun and more curiosity for young visitors.

The general behaviour patterns of young users' interactions were as follows:

A. attending --- touching, poking, swiping, or pressing the button on the kiosk screen --- sometimes looking up at the overhead screen to see the same creation on the large screen, and then looking down at the kiosk screen to swap facial features to make another face --- distracted, disinterested --- moving to nearby interactives --- coming back to play again

B. attending --- playing with their family members together, talking about how the game works and what they created --- distracted --- disinterested --- moving to nearby interactives

C. attending --- following their parents' instruction, talking about how the game works and what they created --- playing on their own --- disinterested --- moving to nearby objects and interactives

In comparison, the large, strange wooden sculpture underneath the large overhead screen virtually drew no attention from all visitors, even though its visibility (i.e., the glass case allows a 360-degree view of this sculpture), exhibition location (where it had more chance of receiving glances), appearance (unusual or extraordinary), and labelling method (i.e., the label is worded as an open-end and invitational question) was more advantageous than the Making Faces setup.

3.2.4 Underwater Camouflage Design game

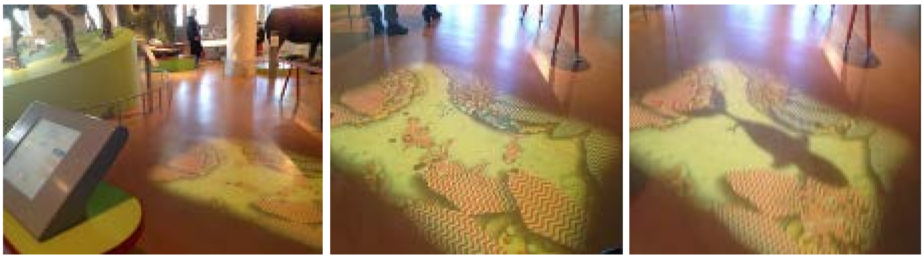

Figure 3.8 The context of Camouflage Design game. (Left: the control kiosk and a floor-projected virtual pond. Middle: showing the fish swimming in the pond. Right: showing a situation in the game when the predator shark comes.)

Figure 3.9 Screenshots of Camouflage Design game on the kiosk. (Left: the introduction screen to enter the game. Middle: design the fish by selecting its patterns and colours. Right: name the fish by giving it initials.)

3.2.4.1 Description of the exhibit

Camouflage, the process of blending into the surrounding environment, is an important means for some animals to hide themselves from predators. In the Adventure Planet gallery, a game-based learning installation called Underwater Camouflage Design is designed for young visitors to learn and experience how underwater creatures survive by using this tactic. The game consists of two parts: one is the main interactive area where there is a touchscreen kiosk for visitors to design a camouflaged fish (see Figure 3.8: Left), and the second part is an observing zone (i.e., a two-metre wide virtual pond projected on the floor in front of the game's kiosk, from which visitors' fish appear [see Figure 3.8: Middle]). To achieve the game's learning goal, the design of the camouflaged fish has to effectively blend into the surrounding environment to avoid being eaten by the predator – a big shark (see Figure 3.8: Right).

The design of the camouflaged fish is created through several easy steps on the kiosk. The first start screen challenges the visitor to try out the camouflage design game by asking, "*Create your own camouflaged fish and test your design. Can your fish stay safe from the shark?*" Before choosing a camouflage design, the screen shows more information about the concept of animal camouflage to educate the players. Then, players can design their own fish by selecting its size, colours, and patterns before releasing it into the virtual pond. When finished the design, the player can sign the fish. After a few seconds, the game asks players to look at the pond on the floor and to see whether their design keeps the fish well hidden (see Figure 3.9).

In the projection area, ripple effects is shown before a new fish appears. As the game supports multiplayer, players can see newly released camouflaged fish (marked with the player's initials) and other previously designed fish swimming together in the virtual pond. Shortly afterwards, a *duh-nuh* sound is played, signalling that the shark is coming towards the fish. When the shark swims through the pond, most fish will move fast to the stones adjacent to them to dodge the shark, and the poorly camouflaged fish (i.e., the design of fish appearance is less deceptive to match the look of the stone) will then be eaten by the shark. The eaten fish will become an image of a black fish bone and then disappear from the virtual pond, and the other surviving fish will retake the pond after the shark is gone.

3.2.4.2 Spatial context

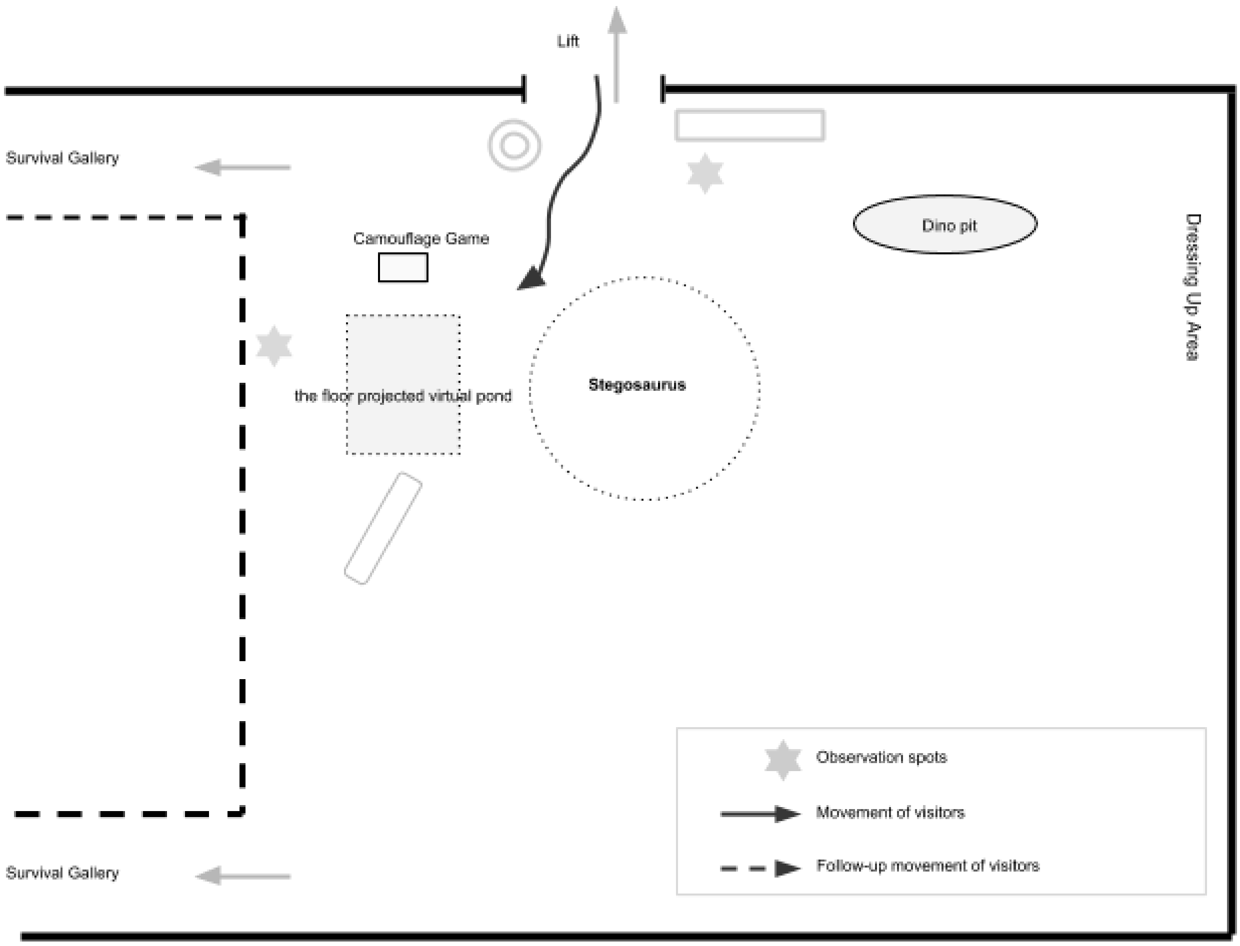

Figure 3.10 The spatial context of the Camouflage Design game in the Adventure Planet Gallery

This game-based installation is placed in the Adventure Planet, which is a gallery designed for families and young visitors to discover the nature world. In this space, many hands-on exhibits hide things from viewers' eyes and provide many opportunities for people to learn about the world of nature through curiosity and physical exploration. For example, a dino pit showing parts of submerged fossils and bones triggers young visitors' interest to unearth more within the pit. Cubby holes keep specimens hidden for curious young visitors to touch and guess what the specimen is.

In this gallery, there are three digital kiosks deployed to educate people about the natural world: two are puzzle-based games about museum collections and the other is the observed kiosk – Underwater Camouflage Design game (see Figure 3.10). The three kiosks for game-based learning are similar in physical appearance; Camouflage Design is installed with the floor projection system, and the puzzle-based game kiosks have seats provided.

3.2.4.3 Interactions around the exhibit

During the period of observations, compared with the other kiosk-based games in the Adventure Planet Gallery, Underwater Camouflage Design game stimulated and engaged the curiosity of many visitors.

Different from the exhibits observed previously, people's initial attention to the presence of the game largely benefited from the gallery's layout. Most visitors noticed either the kiosk or the virtual pond on the floor when they walked into the Adventure Planet Gallery. For visitors who entered from the main gate, the Camouflage Design touchscreen kiosk was easily seen, which easily attracted their attention to the game. In many instances, people noticed the kiosk even when nobody was present around the interactive areas, and many of them approached to see what was on the touchscreen and quickly started the game. In some cases, people who walked into the gallery from the other gate did not notice the Camouflage Design at the beginning; however, the brightly projected virtual pond with many swimming fish and ambient sounds presented naturally on the floor grabbed the attention of many visitors when they passed by this area. For those whose curiosity had been triggered, they often stopped at the edge of the projected pond and looked down at the moving images for a time, and many of them also quickly realised the kiosk was associated with the virtual pond and moved to the front view of the screen to learn more about the kiosk. In short, the factors that contributed to arousing curiosity for this game installation were largely affected by spatial effects and visual attractiveness.

For those whose curiosity was stimulated, the design of this game had successfully engaged their fleeting curiosity (e.g., many children told their accompanying adult about the survival of the camouflaged fish they designed, or asked further questions). Even adults with babies in the buggy played the game and watched their fish. For many children, the virtual pond was their playground: they not only enjoyed watching if their designed fish survived in the pond, but also made many playful gestures and movements around the pond. Although this educational game was not designed specifically for social play, some children who were co-present at this virtual site played together, and this made their learning experience more fun and exciting.

Since the behaviour and activities were rich around the installation, the general patterns of an exploratory process are classified as follows:

A. attending --- designing a camouflaged fish from the kiosk --- moving to the floor projection --- watching, playing, talking --- (returning to create more fish) --- playing, linger longer --- disinterested --- moving around in the different area of the gallery, searching for other curiosities

B. attending --- watching the floor projection --- moving to the kiosk and designing a camouflaged fish --- watching, playing, talking --- disinterested --- searching for other curiosities

Social interactions among the visitors were rich during the observation. In the areas of the touchscreen kiosk, many parents often took an active involvement with their children's design of a camouflaged fish by explaining how to play the game and offered help in children's using the kiosk. In the floor projection zone, adults and children usually watched their designed fish together. Children often moved quickly to the projection zone after finishing their design at the kiosk and talked to their parents, asking them to see their own designed fish in the virtual pond. Oftentimes, parents were responsive and took a leading role in explaining the concept of camouflage. Some adults worked with their children or pretended to feel frightened while the shark is coming. If a child lost a fish from the shark attack, the accompanying adult usually would encourage the child to have another try to make a new fish from the kiosk to experience the game again.

Many conversations between members of a family group developed around the game. In many cases, the accompanying adults kept making conversation relating to the game and camouflaged patterns. Children with more responsive or communicative parents often spent a relatively longer viewing time and had fun in the virtual pond. But sometimes a child's interest in the game was interrupted by their parents or other visitor groups.

3.3 Discussion of the results and its implications for curiosity design

3.3.1 Initial questions and thoughts

The museum visitor researcher Deborah Perry (2012) once described, "Curiosity in museums is both a prerequisite for and [...] an outcome of visitors' meaningful experience" (p. 97). The observations of the above four digital devices for leisure learning and their surrounding exhibition spaces, indeed, provide rich opportunities for researching people's curiosity-driven exploratory behaviour. The actual visitors' interactions with and around the observed exhibits raise questions concerning current understandings of curiosity triggers and design practices for curiosity.

The first striking fact is the low interaction rate with the Earth Sphere. This self-illuminating globe, which dynamically shows the Earth's continuous movement and geology from a 360-degree view, is a relatively new technological way to engage people's attention. Presumably, the readily apparent technological novelty should catch the eyes of many visitors. But this technological novelty seems unable to engage visitors' curiosity effectively. In fact, as the museum's interactive displays manager Lyndsey Clark said in the press release, the museum expects the Earth Sphere to be “the centrepiece of the museum’s new Restless Earth Gallery” (as quoted in de Procé, 2011). The design strategy of raising people’s attention and interest seemingly relies on our common sense assumptions that something with attractive features and notable appearance should be more effective at catching attention and sparking curiosity. The giant crystal-ball-like screen object itself, in theory, should have a strong novelty-effect that entices people to learn more. However, this was not the case for the actual visitors’ interactions with Earth Sphere. My observations found that most of the museum visitors just passed by or quickly glanced at the screen installation. Why were people less interested? Why did this apparent novel technology barely draw attention, while the traditional flat video wall (i.e. the Earth Events) in the same exhibition space received much more attention?

With regards to the problem of display blindness,[110] the observation results also raise the question of what situational factors can effectively trigger curiosity. Similar to the Earth Sphere, the Robot Ship tabletop game adopts novel VAEs technology to deliver the learning concept. By using VAEs, the ordinary tabletop surface can be transformed into a virtual ocean. Indeed, it has successfully draws the attention of many visitors to interact with the moving digital object, although most of them did not spend much time with it. However, its location is not obvious to many visitors. As shown in section 3.2.2, it is not in the direction of the high traffic route in the Connect Gallery. It appears just like an ordinary table from a distance. It even lacks

[110] See the introduction.

sounds or any signage to grab people’s attention from a distance. It could be easily ignored since there are many other interesting interactive exhibits and novel objects in the Connect Gallery that compete for visitors’ attention. What are the factors that can overcome display blindness and draw visitors’ curiosity within this busy exhibition space?

Another unexpected finding comes from observing people’s interactions with and around Making Faces. The installation encourages children to understand the basic concept of faces on a digital kiosk, which is a common technological way of presenting information in this museum. Therefore, it is presumably less able to effectively grab many people’s attention and engage curiosity as there are many other attractions nearby. However, based on observation, many visitors, including children and accompanying adults, were quite interested in using Making Faces. Although the game is rather simple and short, many children did spend a relatively long time creating faces of various kinds, and they tended to use it repeatedly. Compared to the nearby large wooden sculpture that has irregular and distinctive shapes and uses curiosity provoking questions on the label to trigger visitors’ interest in identifying facial features, the ordinary kiosk ought to be less attractive and, therefore, less effective at provoking curiosity. But it is clear that the Making Faces occupied much more visitors’ attention than the sculpture did. How did the design of Making Faces attract curiosity?

In the case of the Underwater Camouflage game, visitors’ interest and engagement is significantly higher compared to the other three observed exhibits. It draws people to gather around a virtual pond, where they watch fish and talk about their design. From players' conversations, it is apparent that a large number of young players did learn about the concept of camouflage to some degree. Many played more than one time to design fish with different camouflage patterns. More interestingly, children made many imaginative gestures, movements and social interactions which were not prescribed by designers. This game-based learning exhibit seems to catch people's curiosity successfully and even further developed into creative and imaginative expressions. However, the game does not deliberately use curiosity tactics, such as asking provoking questions or adding surprises, though the use of floor project technology adds a sense of technological novelty. Why does this interactive exhibit engage curiosity and elicit imagination? What makes it so successful?

The evidence from observations of visitors' interactions with these digital exhibits poses a set of questions to curiosity studies. Much of visitors' exploratory behaviour cannot be fully explained by applying early curiosity theories described in the previous chapter. The quote from Flatley (2009) cited in the introduction also reminds us that factors that stimulate curiosity are not merely conditioned by the properties of a stimulus. In the case of the Earth Sphere, the technological novelty is not as mesmerising as might be expected.[111] The seemingly less attention-demanding installations, like Making Faces and Robot Ships, did catch people's active curiosity

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[111] The National Museum Scotland uses the following text to describe the Earth Sphere: "At the centre of the gallery, a mesmerising two-metre sphere […] projects images and videos from the inside out, offering a 360-degree view of the dynamic way in which the earth evolves and changes" (National Museum of Scotland, n.d.). The use of the describing word *mesmerising* implies museum's anticipation of strong attraction elicited from the Earth Sphere in visitors' perception of the display.

and interest. Also, the simple game Underwater Camouflage that is designed to provide a context for learning a simple knowledge point engages many players' interest and elicits their imagination, which was unintended by its exhibit designers.

To identify what factors may provide explanations to these initial questions, it is helpful to start by constructing a common behavioural pattern from visitors' exploration processes, and then determine what factors interfere with the unfolding of the curiosity process. Therefore, in the following section, I will first summarise the behavioural patterns found in curiosity-driven processes and the literature on curiosity, and then point out factors that influence the curiosity process.

3.3.2 Behavioural patterns in curiosity-driven processes

Most observed visitors seemed to come to visit the museum for leisure, for social gatherings, for excitement or to satisfy their curiosity through the various exhibits. The visitors' exploratory behaviour was evident, driven by their desire to learn and explore. Based on the literature review and the observations of how those curiosity-driven visitors responded to screen-mediated exhibits, the interaction process can be roughly divided into the following stages: searching, attending, approaching, exploring, engaging, and adapting. Some of the significant behavioural patterns that arose throughout this process are organised below in Table 3.2.

Table 3.2 Behavioural patterns in the curiosity process

Process	Behavioural patterns
Searching	• Scanning the environment for novelties indicated by the head looking around or using the museum map • Slowing down their walking pace • Moving in a haphazard manner (i.e., the way-finding pattern is unconnected) • Showing no systematic preference on the objects within the gallery
Attending	• Searching stops, eyes appear to light up, and becoming attentive to a specific object begins • Giving a glance at the exhibit while walking past • Photo-taking • Partially orientating the body towards the exhibit (i.e., facing the display area) • Orientating themselves towards the exhibit while simultaneously observing the current user and others • A curious person may conduct an activity to resolve curiosity in a more covert manner, e.g., viewing the interested exhibit from a distance, observing the current user of the exhibit • Approaching toward the object of one's curiosity • Walking right up to the viewing area to immediately tap on the screen to see what would happen without observing it beforehand, and then considering looking more closely or adjusting strategies in perception of the stimuli. • Asking questions: What is it? How does it work?
Engaging	• Eyes examining or taking a close look for a longer period. Continuing to interact with the exhibit • Engaged with repetitive manners • Interacting with others (e.g., co-presented visitors, strangers, members of one's own group) • Conversations, e.g., sharing what one has found or made • Playful and imaginative activities
Adapting	• Showing the loss of attention, e.g., looking away, drifting attention, getting distracted, and feigning interest in conversation • Giving up the action, and moving on to another area of the museum • Resume searching and scanning behaviour

The above table outlines a general process that curiosity-driven explorations follow. But not every curiosity-driven exploration to a screen-based exhibit will include every stage. Some people in the museums did not have a searching stage since their interest appeared to be led by their accompanying group member. Some people might seem to engage with the content, but I was not able to observe any playful or creative experience. However, by generalising the exploratory behavioural patterns, I can then identify what factors influence curiosity, either positively or negatively, in each step of this process.

3.3.3 Key factors and design elements that interfere with the curiosity process

Following the above, I identify three factors that can sustain or inhibit curiosity, including social dynamics, playful expression, and the system's affordance for embodied interaction. Each of these factors will be briefly discussed below, and will be then further pursued in more depth in a separate chapter (chapter 4, 5, 6).

3.3.3.1 Social dynamics

The social dynamics of the co-present people around an exhibit is the most salient factor that can either enhance or discourage curiosity dramatically throughout interactions with stimuli. This is evidenced by the following observed facets with and around the above four interactive exhibits.

1)

 Figure 3.11 A mock-up image that illustrates a young visitor spotting the Robot Ships installation when he walked with his family towards the	One young visitor, accompanied by two parents and one nursery child on their way leaving the Connect Gallery towards the Hawthornden Court, noticed a group of visitors – two adults and two young children – gathered around at the Robot Ships installation (see Figure 3.11). He quickly moved closer to the Robot Ships tabletop, and stood beside to one of the young players. His parents and

Hawthornden Court in the Connect Gallery.	younger sister were about to leave the gallery, but they stopped their movement. The younger sister was also soon attracted to seeing what people were playing. The young girl walked towards her brother and the exhibit, but she was not tall enough to see what was on the tabletop. Their parents did not show interest at the beginning and just turned their head to watch their children, waiting at the place where they had stopped until they noticed the younger child wanted to climb up to see the top of the table. In the meantime, the young visitor had already started playing. He took up a black pad to move around on the table immediately after the four existing visitors left. The parents approached to hold the girl up to see the interactive video. The moving images of robot boats engaged the girl, and the parents soon became interested in this video exhibit. They joined interacting with the robot ships by moving the back pads and tried to explain it to the girl. But they misinterpreted the game's concept; they thought this installation was a game about catching the ships.

2)

 Figure 3.12 Two girls from the	A family of one mother and two young children noticed and interacted with the Camouflage Design game together at the virtual pond. The two little girls were happily playing around the projection and seemed to make a friend with a

same family (right and left) were about to approach a newcomer (centre) in the Camouflage Design game's virtual pond.	newcomer, a baby taken by another adult to the pond, by showing her their fish in the water (see Figure 3.12). Their mother, who had been making the fish with them a few minutes ago, said to them, "Should we get downstairs to have a coffee?" One of the girls answered immediately, "No!" But the mother remained walking towards the entrance gate, and said "Emily, don't shout at me." In the meantime, three girls started acting like fish; they all appeared interested in watching the moving images on the floor. "Girls!" the mother called them again impatiently. "My shark is coming, my shark is coming," one girl announced loudly. But, their mother did not want to wait and pretended to walk out of the gallery. When the mother walked nearly outside of their sight, the two girls stopped playing and ran to their mother, only the baby girl was left in the projection area. After that, the baby found herself alone and ceased to explore the pond and then was taken by her accompanying adult to see other nearby exhibits in the gallery.

3)

Figure 3.13 A mock-up image that depicts a boy and his grandfather (centre) interacting with the Making Faces installation, while the boy's grandmother (right) sitting in the play area is watching their creations on the large overhead screen.

A boy and his grandfather were using the Making Faces exhibit, and then the boy called out aloud to his grandmother, "Look, what I made, grandma." His grandmother, who was sitting in the play area about a few feet away from the kiosk, turned her head and looked towards the large screen and smiled back (see Figure 3.13). Although the grandmother did not give feedback immediately, she kept watching the large screen.

In the meantime, the boy and his grandfather remained engaged with the kiosk. And a few seconds later, she talked to the boy from his seat: "This is an interesting one. Can you make a face like *Boo-ba*? ..." (I was not sure what the word the grandma said because I did not hear it clearly, though I was sitting very close to her. The background noise was too loud. But the word sounded like the name of their family dog, which was confirmed by how their conversation continued). The boy seemed encouraged and inspired and continued using the exhibit, chattering with his grandfather who seemed to enjoy it as well.

4)

Figure 3.14 A boy (centre) was playing on the pond of the Camouflage Design game with his mother (right) and sister (left).

A young boy who was with his mother and sister in the Underwater Camouflage design game's virtual pond looked happily when he saw the virtual fish swimming on the floor for the first time. Then, he quickly became aware of the pond's relationship to the kiosk. He and his mother moved forward to the kiosk and made a fish go into the pond. Afterwards, they were both eager to move back to see what would happen in the pond.

"Look! My fish, my fish!" the boy pointing at the fish said excitedly to his mother (see Figure 3.14). He went on touching, sitting, and making some movements within the floor-projected pond. Shortly, the boy saw all the fish swim quickly away from the centre of the pond to hide in the stones when the shark was about to come. He looked very interested and kept walking or swimming back and forth in the pond.

Shortly, he saw the shark again. He seemed to understand the game's sequence more as the game progressed. He then started moving like a fish, trying to hide in the virtual stones when the shark was coming. Then, he changed his gestures try to catch the fish and even named the fish (there were some fish in the pond two of which were designed by the boy and many others were left by the previous players. The boy found two fish unnamed, i.e., without labels to show the player's initials). He told the fish by his made-up names to hide, and reported loudly to his mother, who was standing further from the virtual pond with his sister, which fish were going to be killed by the shark.

But when another new family – three adults, two young children –

	approached, he became withdrawn and showed less movement. He peeked at the two young visitors, and appeared attentive to what their grandfather was talking about for a second and continued to stay in the pond. He remained sitting and watching the virtual images. However, he was silent and did not make any imaginative gestures before he turned to his mother.

From the evidence above, co-present people, such as accompanying adults, group members, simultaneous players, and new encounters, can play a crucial role in a person's interactions with and around the interactive exhibit, although their effects on other people's curiosity are unclear (sometimes good, sometimes bad). From the vignettes above, we see people's interest in using the exhibit was both intensified and quelled by accompanying group members or the gathering crowd, or, as shown in vignette 3, the disinterested members of one's own group usually had a negative effect on the current interested user.

Also, as mentioned in the observation of Robot Ships, some people ceased to explore and walked away when new people joined them at the table. Although the Robot Ships table is big enough for three to five people to stand around it simultaneously, in actual situations, it is unusual to see two unrelated individuals or groups interact with the moving images at the same time for long. A similar situation was found in other three case studies, though not as significantly. People's avoidance reflects social rules (it is best to give way to others) underwritten in our exploratory behaviour in public or shared space. From a curiosity perspective, social pressure agitates sense of anxiety that inherently comes along with curiosity.[112]

Why do the social dynamics of co-present people have a strong effect on our curiosity? Our curiosity, including children and adults, appears to have a deep-rooted interest in, or concerns about, the people around us. However, current design practices rarely consider creating or sustaining curiosity with regards to the social dimension of user experience. Only a few use the effects of the present user (i.e., the honeypot effect) to trigger a passer-by's curiosity in order to overcome display blindness. However, as mentioned in chapter 2, many of these studies only pointed out this phenomenon in their observational studies,[113] and further discussion and analysis of the honeypot effect in relation to curiosity were scarce.

Few researchers suggest exploiting the honeypot effect to increase nearby viewers' attention by deploying personnel to make demonstrations on-site. However, this is not always feasible. In complex surroundings, people may be also drawn to other honeypot sites nearby. For instance, in the Imagine Gallery, many exhibits have the potential become a honeypot site as soon as people are gathered around it. In one case, when a boy started rolling the bar to make a large Chinese dragon move in the Imagine Gallery, a family group noticed and joined to help the Chinese dragon dance

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[112] See also the concept of neophobia in chapter 1 and dual process theory in chapter 2
[113] Most public display studies only describe the fact that people's curiosity towards the public display increases when the presence of others around or engaged with it is perceived, see chapter 2.

with that boy; at the same, their movement also distracted the child who was using Making Face.[114] The phenomenon of people attracting people does not exclusively occur in screen-based interactions. This is a natural behaviour that can be found in many everyday contexts, such as a crowds gathering around street performances. Indeed, our curiosity can be captured by honeypot sites significantly. While taking advantage of the honeypot effect is an effective way to draw curiosity of passers-by in a walk-up-and-use scenario, it is more important to think about why the honeypot effect works so effectively. Simply utilising the honeypot effect without realising its relation to curiosity is somewhat manipulative of people's attention and limits its strength.

Often times, the 'people attracting people' concept seems intuitive, but it is also difficult to explain. Loewenstein's information gap theory of curiosity might provide a clue to explain the honeypot effect. According to the information gap theory, curiosity is aroused when we perceive a gap between what we know and the knowledge we desire, and the factors that determine the intensity of curiosity are associated with the appraisal of the value of resolving that curiosity.[115] The tremendously successful headline "Do You Make These Mistakes in English?" written by Maxwell Sackheim to promote an English course is an example of using a bit of information to increase the desire to resolve curiosity. The word *these* implies the reader that they might miss out on specific information that is important to others

[114] The Chinese Dragon exhibit is suspended from the ceiling, so sometimes the interactive affordance of this exhibit goes unnoticed by the young visitors.
[115] See chapter 2

(Kramer, 2012). Translating this into a real world scenario, the crowd around a honeypot site makes the specific missing information more significant to passers-by.

As museum researcher Rounds (2004) suggested, for the first time curiosity-driven museum visitor all of the unknown objects and exhibits on display should have an equal potential interest value, but what produces the most interest value cannot be known prior to interaction. The current user, acting as a positive hint, implies that the exhibit is pleasurable, attractive, and interesting. Crowds serve as a basis for making judgment about the potential interest value for the visitor. Since many people are engrossed in a certain activity, the potential viewer sees the activity as valuable. Therefore, phenomena like the honeypot effect could grab people's attention as it functions as an indicator of social common interest.

The honeypot effect essentially tells us that our curiosity has a strong social aspect. However, curiosity's social nature has been left underexplored. Most researchers in the field of digital design research on curiosity or related emotions rarely notice the potential role that curiosity plays in user interactions.[116] We, as interaction designers and researchers, should put more effort into learning about curiosity's social nature since many already raise concerns about the disinterested social bonds brought by ubiquitous screens in everyday settings.[117] There is a need to gain a more comprehensive understanding of the relationship between social dimensions and curiosity. As to its significant impacts observed in people's curiosity and exploratory

[116] See chapter 2
[117] See the introduction

behaviour, I will continue this topic in the next chapter (i.e., chapter 4) and consider its implications for experience design.

3.3.3.2 Affordance for tactile or bodily interaction

Providing physical means to engage with the exhibit seems to be an important feature that enhances interactions and active engagement with the exhibit in the curiosity process. The following vignettes highlight this point:

1)

 Figure 3.15 A boy and his mother encountered the Earth Sphere. The boy seemed surprised, raising his hands up and moving quickly towards to the display.	A boy noticed the Earth Sphere upon entering the Restless Earth Gallery. He said “Cool!” and turned his head to look at the accompanying adult who was walking behind him (Figure 3.15). The boy quickly walked to the front the Earth Sphere, stopping by the iron fence surrounding it. He leaned on the fence, so he could reach with his right arm to poke the surface of the Earth Sphere’s screen. He poked for approximately three seconds, and upon discovering it was not interactive, he pulled his arm away. He then looked backwards at his accompanying adult before quickly walking away towards other objects.

2)

<table>
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<td>

Figure 3.16 A visitor group watching the Earth Sphere.</td>
<td>A group of visitors, one adult and two preschool children, came into the gallery together. They passed by the Earth Sphere without watching it. The two girls wandered around the gallery, while the adult walked slower, following behind them.

Later on, the adult became interested in the Earth Sphere when she passed by it again. But she only looked at the screen for approximately two seconds and looked down to read the words on the sign. When the two girls noticed and moved over to the Earth Sphere (see Figure 3.16) the adult immediately took on a teaching role. She asked them “Do you know what it is?” “It’s the Earth,” answered the younger girl. The older girl began moving around the Earth Sphere. The adult looked at the display and said something about how the Earth is layered “...There are some things under the ocean, do you know that? ...” Two girls’ eyes did not fully engage with the display, but they touched the part of the screen that the adult was referring to. The older girl touched and swiped the screen. When she found no further interactive response, she then played with the fence. In the meantime, the little one also tried to reach out to touch the screen, but she fell onto it.</td>
</tr>
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3)

 Figure 3.17 A girl trying to touch the surface of the Earth Sphere.	One group of visitors, one adult man and a girl, stopped to watch the display when they entered the Restless Earth Gallery. The man, standing to face the Earth Sphere pointed to the screen and said something to the girl (I couldn't hear from the observational location). The girl moved forward, closer to the display, and she began to wave her hands. It appeared she was trying to detect the source of projection. Then her hand moved closer to the surface of the sphere, trying to touch the surface of the Earth Sphere (see Figure 3.17). When the man came towards her, the girl disengaged with the Earth Sphere and turned around. She noticed the nearby exhibit object −Weird Stone − a slab of orbicular granodiorite.[118] "Look, you can touch it" she said, and then touched the stone. This leads me to believe that the presence of the man possibly discouraged the girl from touching the Earth Sphere. The girl seemed delighted with touching the surface of the stone. The man stayed to watch the Earth Sphere alone for a little while until another young boy came into the exhibition. The man disengaged when the young boy came up to him, and both of them seemed to be attracted to the girl's findings. The boy did not pay any attention to the Earth Sphere. All three of them then moved around in the Restless Earth Gallery without paying further attention to the Earth Sphere.

[118] See Figure 3.2 for the location of Weird Stone

4)

 Figure 3.18 A baby trying to touch the virtual image on the pond of the Camouflage Design game.	A mother and her baby stopped at the virtual pond in the Underwater Camouflage Design game's area. Upon noticing the kiosk, the mother tried the kiosk and made a fish. She then pushed the buggy over to the pond and took her baby out so she could see from a better vantage point. The mother held her with one arm, standing at the edge of the pond and pointing to the swimming fish, happily saying "Did you see the fish?" to the baby. "That's mommy's fish." The baby looked down at the pond projected on the floor, appeared curious about what was before her eyes, and squeezed her mom's body to show that she wanted to see it more closely. The mother put her down on the pond, saying "Look! Look! Did you see mommy's fish? Oh, there is another fish like mommy's…" The mother kept speaking to the baby but stood back at the edge of the pond. The baby started to use her hands and her fingers to touch the floor in deliberate movements (see Figure 3.18). It was as if she was trying to assess what she was seeing. Soon, she also noticed her body and hands were covered with the beaming image. She moved her hands and shook her foot, as if she was puzzled by the projected image overlaid on her skin. But it was not too long before her attention moved

	from her body back to the pond and the moving images. She kept crawling and attempting to touch the fish that her mother pointed to her, but seemed puzzled when fish suddenly were swimming away when the shark came.

5)

 Figure 3.19 A mock-up image that shows a boy noticing the Making Faces.	A young child who just passed by the Making Faces installation slid his hand along on the kiosk screen. He did not originally seem curious about the screen, because he did not fully position himself in front of the kiosk before touching (see Figure 3.19). But after touching, both the kiosk and the large overhead screen changed to feature a cartoonish face. It may have been the brightly coloured, funny-looking face shown on the main screen that interested him, or he seemed curious about how the overhead screen related to this kiosk. He positioned himself at the kiosk, touching the screen with his index finger randomly and looking up at the overhead screen. He seemed to want to make sure that the two screens were related. But soon he became more focused on the kiosk screen, trying out many faces. Then, he called for his mother, who was looking after another young child, to come help him when he entered the email screen.

6)

Figure 3.20 A person used his hands to directly interact with the digital images (i.e., robot ships) on the Robot Ships tabletop game.

Two young men who were waiting for their friends noticed the Robot Ships. One directly took a pad to touch the moving robot ships on the tabletop, while the other just watched. Very soon, a little boy also came to the table and took the other unused pad to interact with the ships. The young man, who first interacted with the Robot Ships, continued in a similar interaction style. The little boy started to use both hands to catch the ships. Both men noticed this, dropped the pad, and watched the boy playing.

Not long afterwards, the friend of these two men finished playing Reaction Time and came to the table, asking the two, “What is it?” The man replied, “I don’t know”, and the three men left the table, moving to the other side of the gallery. However, about one or two minutes later, the man who did not interact with the tabletop originally returned to play the Robot Ships again as his friends wandered in the Connect Gallery.

When he returned, there was no one playing Robot Ships. His first gesture was to touch the moving ships with one of his hands. He touched them several times, sometimes with both hands, and looked interested in the virtual images trapped in his hand (see Figure 3.20). Then he used one black pad, throwing it to catch ships that were too far to reach normally. He continued with these

	playful interactive styles for a while until he was re-joined by his friends.

The exploratory behaviours shown in the examples above suggest that tactile or physical interaction could be a critical design element to sustain curiosity, despite its fleeting nature.

As mentioned earlier, many visitors' curiosity with the Earth Sphere ended abruptly when they found that the surface of the Earth Sphere did not support any interactivity for further exploration. Most people who touched the display usually ended the exploration by turning to other exhibits nearby rather than staying to watch the digital content. When an individual wants to know more about screen-mediated exhibits, the act of touching and swiping on the screen surface seems to be a natural means of exploration. Without physical response from the exhibit, the question about what is on screen has to be answered largely by relying on visual inspection. In the case of Earth Sphere, the large Earth-like display makes the visitor easily aware of its existence and what concept it intends to deliver. In this sense, if one has no particular interest in learning about how the Earth evolves and changes, his or her initial curiosity grabbed by the giant self-illuminating globe would not be sustained without no interactivity to reveal further information. Compared to vignette 4, a child's incidental, serendipitous finding at his fingertip promoted further exploration.

In the case of Robot Ships, the interactive style allows a higher degree of initial physical involvement with the digital objects. This prolongs the visitors' engagement with the exhibit. However, as mentioned previously,[119] the purpose of the exhibit is unclear to its user. As Robot Ships' narrative is vague on first sight, the player has to fill-in the information gap by watching the animation or interacting with the virtual image to understand what the animated video is about. Most people initiate interactions without observing first, like the man in the vignette 5. Most interested visitors seemed to assume that the game was interactive and immediately took one pad to touch the moving robot ships on the tabletop. Their behaviour suggests that viewers prefer to learn by touching rather than observing. Visitors appeared to become more interested in the moving image when he or she found new ways of interacting with the game, e.g., using their bare hands to catch the virtual moving ships or using two pads to surround or trap a robot ship. The Robot Ships' affordance for direct physical manipulation of the virtual content in real time captures curiosity and engenders new interaction styles.

In the introduction, I mentioned that the weakening of real world interaction and social relationships brought by ubiquitous screens is one of the challenging issues that concerns many people. A screened world seems to be destroying our natural ability to learn from context and endangers embodied social relations with co-present people. The observational findings reveal that our bodily actions in the screen-mediated exploratory process play a crucial role in capturing and sustaining our

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[119] See section 3.2.2.3

fleeting curiosity. Embracing people's active sense of curiosity, designers should consider the tangible, bodily, and tactile aspects of user experience in the curiosity process.

Although the exhibit's affordance for tactile or bodily interaction is not always necessary for engaging experiences or for helping knowledge acquisition,[120] it should help capture those fleeting moments of curiosity. Moreover, reflecting upon people's interactions with bare hands on Robot Ships, new forms of interactive patterns emerged from the user's physical interaction with the virtual moving images, which should also serve as new stimuli to sustain their curiosity. In current design techniques for stimulating curiosity, designers often use cognitive-based psychological triggers to create curiosity.[121] However, the embodied means is left underexplored in studies of curiosity. Therefore, further research into this relationship between bodily action and curiosity is necessary. In chapter 6, I will expand upon this topic and explore how physical means and bodily interactions relates to our curious nature.

3.3.3.3 Playful affordance

Another significant factor that contributes to sustained curiosity is the affordances for playful activities and exploration. The following visitor's exploratory behaviours exemplify the need for play during the curiosity exploratory process:

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[120] For example, the traditional video wall in the Restless Earth exhibit has no interactivity, but many visitors did watch the whole short film.
[121] See chapter 2

1)

 Figure 3.21 Two girls from different groups were playing together using Making Faces.	Two girls appeared to be making friends with each other in the gallery. One of the girls entered the gallery with her family earlier than the other girl. She had interacted with Making Faces with her accompanying adults for a short time before the other girl entered. While she wandered the gallery, the other girl who looked slightly younger came in with her father and baby sister. The two girls met in the gallery and began playing together in the play area. Then, the older girl took the younger one to the Making Faces installation. The two girls both stood in front of the kiosk. At first, the older one touched and tapped on the screen, while the other girl watched (see Figure 3.21). With just a few clicks by the older one, the younger girl laughed after seeing the eyes quickly swap, and she also touched the screen. They soon both touched the screen, taking turns to change the facial features, and making different funny faces. They laughed at their creations, keeping themselves happily engaged. The younger girl’s father who was standing with the baby crawling on the floor near the storytelling corner asked her what she have found. The younger girl said loudly, “I can make a lot of faces. Do you want to see?” The girl did not wait for her father’s participation. She resumed her play and chattered with the older girl at the kiosk. During the process of making their own faces, they appeared to have fun and enjoy the moment.

2)

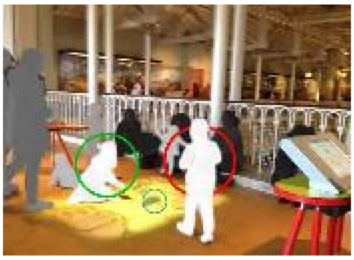

Figure 3.22 A boy (highlighted in a red circle) made a dead fish (highlighted in a blue circle) appear in the pond. This attracts attention of other co-present players (highlighted in a green circle).

Five young visitors from three different families were gathered around the Underwater Camouflage game's virtual pond, waiting to see whether their designed fish would survive the shark attack.

When the shark was about to appear, the children became excited and appeared eager to see what would happen. However, all fish were camouflaged well and successfully hid from the shark. One child seemed disappointed and quickly moved back to the kiosk, releasing two new fish into the pond. But this time rather than repeat the successful formula tested earlier, the new fish were less camouflaged. When the shark came again, the boy pointed out what fish would be eaten to other children around the pond. "Yeah!" shouted the boy when his fish were eaten by the shark, and the other co-present players were surprised to see the spooky fish bones left in the water (see Figure 3.22).

Upon learning this, one little girl asked her father to deliberately design an odd-looking fish, which would not blend into the surroundings, so she could see the black fish skeleton again. The girl and her father went to the kiosk, and the boy who made the poorly-camouflaged fish earlier also joined them to help their design. They released a large fish with pink-and-white colour in a half-and-half pattern. When the shark swam through the pond

<table>
<tr><td></td><td>again, those children were thrilled and celebrated when the dead fish showed up again.</td></tr>
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3)

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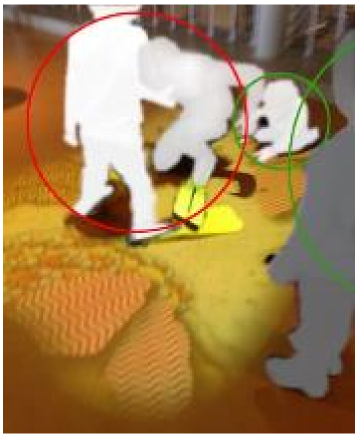
<tr><td>
Figure 3.23 Young players (highlighted in a red circle) pretend to be scuba divers – wearing snorkels, flippers, and goggles. In the meantime, two young boys from another family group (highlighted in green circles) are playing around them.</td><td>A child who had designed two fish played at the Underwater Camouflage Design game's virtual pond for a short time. He left the game because his brother was calling him to come to play in the dinosaur pit area with him.

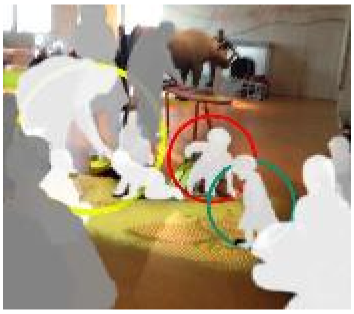
When the boy was heading to the other side of the gallery, another group of young boys had just finished their fish camouflage design at the kiosk and were moving to the pond to see if their fish would survive. The two young boys were at the virtual pond watching the fish, and their parents also seemed engaged watching and making conversations to draw their children's attention to different fish pattern "... that one can't find the place to hide." The parents exclaimed, "scary shark is coming, shark is coming." Two children were less engaged than their parents and starting tip-toe through the pond.

Later on, the first mentioned boy came back to the pond wearing the flippers, a snorkel, and goggles (see Figure 3.23).[122] The boy acted like an underwater explorer, pretending to walk in the water and yelling, "I caught a fish alive" to his brother who was moving</td></tr>
</table>

[122] The scuba diver costume is available at the other corner of the Adventure Planet gallery, see section 3.2.4.2

	towards the virtual pond. (The fish the boy pointed at had a poorly camouflaged pattern that was unable to blend into the stone. The two previously mentioned young boys noticed this scene and seemed interested. At the same time, the shark appeared, swimming through the pond. One young boy suddenly said loudly, “My fish didn’t get caught” to his parents who were standing on the other side of the pond. This indicates that the boy was taking part in the play created by those he just met with the scuba dive costume.

4)

 Figure 3.24 Children and adults around the pond of the Underwater Camouflage Design game. A boy (marked in a red circle) pretends to catch the shark, and a girl (marked in a green circle) is playing with the fish. Their accompanying adults are sitting around and watching their play. Another family group – two adults, two little boys, and one girl – are at the left side of the image (marked in a yellow circle).	There were five young children who appeared to know that there was no interactive capability in the Underwater Camouflage game’s virtual pond. They still showed interest in interacting with the virtual fish, however. (At the time I started observing them, there were already many children and adults around the pond, see Figure 3.24). One nursery boy was trying to catch the shark. He pretended to plunge into waters when the shark was swimming through the pond. The other girl of a similar age from another family also stamped on the ground to scare the shark away when the shark-like shadow appeared. In the meantime, another two little boys and a girl from the same family were also acting like a fish

	swimming at the other side of the virtual pond, swiveling or slithering along on their stomachs on the floor. As the shark was coming, these three children noticed the previously mentioned two children's actions, though they did not make any conversation and did not interact with each other during their co-presented playing session. A moment later, the first two mentioned children and their family members left the pond. The pond was occupied by the three children family. Two boys were rolling themselves back and forth while waiting for the shark, and the girl moved around and was more attentive to her mother. When the shark appeared again in the pond, the boys imitated the previously mentioned two children's gestures to interact with the shark.

From the above vignettes, playful ways of exploration prolong engagement and make the learning process more enjoyable.

In the case of Making Faces, the designs are explicitly made for fun and delightful visual attraction that seem to provoke the playful dimension of the user experience and engage one's expectations for fun and novelty seeking. As observed in vignette 1, delightful and playful reactions were noticeable from the player's interactions with Making Faces, although their physical gestures and movement were not as diverse as those of people who were imaginatively involved with the Underwater Camouflage Design game. In the case of Underwater Camouflage Design, the game turns interested visitors into imaginative players, but they still learn the knowledge point properly.

The interactive exhibit Underwater Camouflage successfully offers a context for young people to learn and experience how camouflage can help an underwater creature to stay safe from predators. Many fun and playful activities grew out of the players. The enjoyment is not simply derived from reaching the game's prescriptive goal. Several cases show self-directed goals that emerged in the process.

In the case of Robot Ships, which used fewer gaming elements and funny stimuli, the need for play in the exploratory process is still observable. As Robot Ships is used to teach a scientific idea and is not targeted exclusively to the young children, it is originally designed for a fairly simple interaction.[123] However, as observed, people's interactions with Robot Ships became somewhat playful when the unintended interactive means (i.e., using bare hands and body parts to interfere the movement of ships) were discovered.[124] In other words, people intend to try out the unexpected things in a playful and improvised way, rather than in a regulated, efficient, literal, and consequential manner.

As argued in the previous chapters, designing an experience for curiosity has the ultimate aim of fostering an active sense of curiosity, not simply for enjoying the thrills of the newness. Provoking curiosity aims to enhance a sense of wonder, to

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[123] See section 3.2.2
[124] See vignette 6 in section 3.3.3.2

help people explore further, to thrive in difference, to find a different view on what has been learned. The above vignettes of children's play in the Underwater Camouflage Design game's virtual pond also suggest that an interactive design for play can allow users to create more novelty and new experiences from the same source of stimuli. Therefore, I believe that play can contribute to our active curiosity for diverse and creative thinking by reshaping, manipulating, and transforming reality. Adding a note of playfulness in the process of curiosity-driven exploration should help develop an open-ended attitude. I will continue to research the relationship between curiosity and play in order to further develop approaches that encourage fresh discoveries and creative thoughts that are considered at risk to today's screen-saturated life.

3.4 Conclusion

> To channel curiosity into more powerful intellectual pursuits requires precisely that there be this transition from the passive, receptive, episodic form of curiosity to the sustained and active form.
> — Jerome Bruner, 1966, p. 117

According to the early psychological theories of curiosity (e.g., drive-based theory and dual process theory), our exploratory behaviour is often driven by curiosity to learn novel or resolve the tension from complex, ambiguous, or surprising stimuli. However, references to curiosity in the digital media design literature are limited to the use of psychological models to scientifically create curiosity.[125] In this sense, adding curiosity to the user experience is formalised through psychological techniques to craft passive attraction to sensory experiences or to rely on cognitive-based processes to engage cognitive curiosity. These curiosity-provoking design practices effectively increase motivational appeals of the digital content but are less concerned with other situational factors when users encounter a screen-mediated context. Consequently, as concluded in the previous chapter, exploratory behaviour that is essentially related to the development of curiosity is underexplored.

Reflecting upon observational studies, there are other factors that play a role in provoking and maintaining people's curiosity-driven exploration. In the case of the Earth Sphere, the novel spherical display might catch visitors' attention, but not enough to elicit deep curiosity. In contrast, the exhibits like Making Faces and Robot Ships with less attractive appearances and few benefits from their spatial layouts, did catch many people's curiosity and invite interactions. People's exploratory behaviour reflects that the screen could not attract curiosity simply based on the aforementioned principles (i.e., novelty, conflict, surprise, complexity, etc.). Direct observation is a useful method to help us rethink how curiosity changes in the screen-mediated interaction process and what interferes with it.

Based on these observational studies, curiosity can be dramatically sparked and maintained by a number of factors, from social dynamics to design features of an

[125] See chapter 2

exhibit (i.e., supporting bodily exploration and playfulness). Firstly, social factors are arguably the most influential. Social dynamics have significant impacts on individuals' curiosity throughout curiosity-driven processes, from searching and attending to the engaging stage. It is also one of the main reasons people end their exploration due to the member of their group becoming disinterested or the social anxiety brought on by unknown co-present players. Secondly, the observations show that people's interactions with the screen-mediated exhibits were largely affected by embodied experiences. New forms of embodied interaction delight and encourage further exploration. Finally, many visitors' playful gestures and imaginative activities reflect that there is a need to resolve curiosity with a sense of playfulness.

The observational findings highlight the importance of the relationships between curiosity and sociability, embodiment, and playfulness. In the previous chapter, I have argued that designs for curiosity in today's screen-saturated everyday contexts should avoid using strategies that exhaust people's attentional strength and should help transfer passively stimulated curiosity into active curiosity. To sustain people's fleeing curiosity aroused passively by external screen-mediated devices, it is important to find ways to aid the transition of one's passive curiosity into an active mode. To make meaningful experiences, as the quote Bruner (1966) above argues, we should facilitate an effortless shift from passive curiosity to an active sense of curiosity. Reflecting upon the observation studies, curiosity's relationship to sociability, embodiment and playfulness need to be further explored.

Therefore, these three dimensions of user experience will be brought into focus throughout the next three chapters (i.e., chapters 4, 5, and 6). Through the review of literature and analysis of design examples, the subsequent chapters will build theoretical connections between curiosity and these three conceptual elements and suggest more practical means to embrace active curiosity and unleash its potential in everyday contexts in ways that are less attention-demanding but more engaging with the people and places around users.

Chapter 4: Sociability and Curiosity

4.1 Introduction

During the observations of the museum visitors' interactions with the interactive exhibits, the impact of social dynamics was observed in the stages of searching, attending, engaging, to adapting. Social dynamics appeared to be the most significant factor that could spark, or extinguish, curiosity and interest throughout all stages of the exploratory process.

Firstly, for people in the searching stage, the honeypot effect has been identified as a highly influential factor that triggers visitors' curiosity to attractive exhibits.[126] The honeypot effect is contagious, which reflects our curiosity's social nature. As discussed in the previous chapter, a honeypot site can be viewed as an indicator of social common interest at the moment (i.e., a site that is emitting the interest value enjoyed by others) that can effectively pique one's curiosity about other people's interest and experience. In a complex space that offers many possible subjects of interest, such as a museum, which exhibits and objects have the most potential interest value to a first-time visitor, especially for people who seek novelty and fun experiences, possibly should be judged based on other people's curiosity. A honeypot site highlights how space is used socially for a person, therefore it can effectively trigger curiosity's social nature. In other words, although the design of the space plays a fundamental role in navigation and exploration, the effect of social

[126] See section 3.2.3.3

dynamics on people’s attention and curiosity is often more determining and immediate. Other situations, including adults who follow their children’s interest[127] and people’s wayfinding led by their visiting partners,[128] are examples of socially oriented interest.

For those whose curiosity was stimulated, their exploratory forms suggest that their curiosity was affected socially in the attending stage of the exploratory process. For instance, as observed in the visitors’ using Robot Ships, several people tended to watch current players’ actions before taking up the black pad from the table to interact with the exhibit themselves. Although some showed no hesitation to use the exhibit with other unknown museum visitors in parallel, they kept a physical distance from them at the table. A few asked, “What is it?” to their group members when seeing the virtual content on the table. This shows some people initially use their group members as a source of knowledge to fill information gaps rather than to find a solution on their own. Compared to when Robot Ships was vacant, curious visitors usually show no hesitation to approach and directly interact with the digital content unlike; some people even did not observe the table for a second before starting direct interaction. The presence of others, to some extent, determines people’s strategies to resolve their curiosity.

For proper engagement with the content, the impacts of social dynamics on the individual’s curiosity-driven processes remain significant. Some social situations

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[127] See 3.3.3.1 Social dynamics, vignette 1, for instance.
[128] See 3.3.3.3 Playful affordance, vignette 1, for instance.

affect curiosity positively as shown in an instance discussed in chapter 3. One boy's interest in Making Faces exhibit became more intensified as his grandparents became involved in his learning process.[129] The adult's approval enabled the young player's deeper engagement. Also, as seen in the case of Underwater Camouflage Design game, a boy who learned that the poorly camouflaged fish would create a funny visual effect (i.e., the brightly coloured fish would become a black cartoonish fish bone if attacked by the shark) turned his knowledge into a new curiosity in the game to trigger other co-present players' interest.[130] People tended to share new discoveries and creations with their group members. Young children, in many cases, would share, help, and play with co-present viewers. In addition, when with responsive group members, people's curiosity-driven process usually goes longer and deeper.

However, social dynamics can also serve to diminish curiosity. As just mentioned, some visitors who were less hesitant and directly started interacting with Robot Ships alongside other players. However, the addition of new groups often made the current users (or groups) end their interaction sections shortly. Simultaneous interactions were rare during the observations of visitors' interactions with Robot Ships.[131] As well, the young boy's imaginative verbal and nonverbal behaviour in exploring the

[129] See vignette 3 in section 3.3.3.1 Social dynamics
[130] See vignette 2 in section 3.3.3.3 Playful affordance
[131] See section 3.2.2.3

Underwater Camouflage Design game was diminished as a new group came to play at the virtual pond.[132]

As we have seen, social dynamics has significant influence on curiosity and exploratory behaviour, though the effect could be either positive or negative on one's curiosity and exploration. However, as discussed in chapter 2, many theories of curiosity and design practices do not to take social factors into account. The relationship between sociability and curiosity should be an increasingly important area for researchers of digital media design. In public display research, the emergent body of research has identified the social dynamics as one of the influential factors affecting passers-by's curiosity and interest (e.g., Müller et al., 2012). In a paper titled *Enticing people to interact with large public displays in public spaces*, the researchers suggest that the public is resistant to interaction with large public displays because of possible social embarrassment (Brignull and Rogers, 2003). Social factors should be an important research subject when considering how people would behave to satisfy their curiosity, especially in the context of public or shared spaces.

As reviewed in chapter 2, much of digital media design literature on curiosity emphasises its motivational effect on users' behaviour and emotional rewarding, and several curiosity arousers are proposed to add a sense of curiosity to designed content (i.e., applying the concepts of novelty, complexity, uncertainty, etc.). Unfortunately,

[132] See vignette 4 in section 3.3.3.1

curiosity's value on social interaction has been left underexplored. Reflecting upon observational studies, the role of curiosity regarding sociability should be a promising area of research for unleashing curiosity to improve the social interaction experience. Therefore, the relationship between individuals' curiosity and sociability should be explored further. I believe that an understanding of this relationship should contribute to the design of the interaction experience, especially for encouraging co-creation and participation among community members or even among strangers. The social nature of human curiosity should be an important resource for enhancing experiences and sustaining active curiosity in digital media design.

Therefore, this chapter will build a theoretical foundation between sociability and curiosity. Firstly, I will begin with a review of the literature from various disciplines to theorise the social nature of human curiosity. Afterwards, I will provide some digital media design examples to contextualise the discussion, including a mobile game that applies curiosity for collaboration, a charity initiative that uses digital augmented objects to build and share memories, and a crowdsourcing news-gathering platform that allows individuals' everyday wonders to be answered by others collectively. Then, I will return to several observational findings from the museum presented in the preceding chapter for a more detailed discussion on what design elements and concepts would meet curiosity's social needs through the course of interaction. All in all, this chapter emphasises the social value of human beings' curiosity in the design of digital media experiences.

4.2 Social nature of human curiosity

> What interests us most, right from the start, is social interaction.
> — Lyall Watson, 1989, p. 134

Reviewing the lifespan of other animals, we humans spend a relatively long period of time in childhood. Curiosity brings us to face a variety of unknown things that could be dangerous, particularly in our early years. Human babies and young children need to be protected at all times, not letting curiosity produce too much impulsive behaviour or too many dangerous activities. Therefore, care and support from social groups is crucial to reduce the danger of curiosity and provide safety for little ones venturing into unknown territory. The extension of childhood gives youngsters more time to learn and absorb information from the world around them in a playful, imaginative and fearless way before entering the adult life. More importantly, the younger generation can develop an attachment with their elders that not only helps them grow but also strengthens the consolidation of communities for establishing and maintaining social and relational ties.

In the theory of evolution, there is a concept called *neoteny*, which also echoes this point. Neoteny[133] is a term in evolutionary theory that refers to when species retain juvenile features into adulthood (e.g., the adult axolotl which retains larval external

[133] Neoteny is also called *pedogenesis*. It stems from Ancient Greek νέος (néos, "young") and τείνειν (teínein, "to extend"), see Neoteny (n.d.).

gills best illustrates this evolutionary biological trait).[134] In human beings, according to Johnson (n.d.), our neotenous characteristics include both physical features (e.g., a relatively big head, sparse body hair, and a flat face) and psychological traits (e.g., curiosity, playfulness, emotional attachment, and social behaviour).[135] The protracted period of childhood that nurtures curiosity and demands support naturally deepens our relational skills and involvement with people around. Several researchers also suggest that extending the juvenile period and delaying maturation may have allowed humans to infer the intentions of other individuals and develop other social skills (Brüne, 2000, p. 302). Therefore, curiosity may be a productive way to delay the timing of rigid thinking and invest in fostering social and cooperative living.

From an archaeological perspective, our ancestors *Homo sapiens*, compared to the Neanderthals, had more childlike visages. This neotenous feature would emotionally elicit more help from caregivers that would help our species to evolve to have much better capacity to read others' emotions and intentions (Keating, Randall, Kendrick, & Gutshall, 2003). This also facilitates social bonding between members of a group, so all members look after the younger generations (e.g., promoting development of co-parenting, shared-parenting, and parent-child bonds). It has been said that since bipedalism and the enlarged skull size increase childbirth trauma for mothers, the strong social nature of *Home sapiens* helps nurture and care for new-borns by sharing

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[134] In evolutionary terms, researchers have assumed neoteny is one of the ways to shortcut the evolution process, see Brüne (2000) for more details.
[135] See Brüne (2000) for more detailed on neoteny-related physical characteristics and behavioural features.

childcare with fellow group members, which also benefits the social development of individuals and the survival of the human species (Medina, 2010, pp. 12-15). In addition, as mentioned in chapter 1, *Homo sapiens*, compared with other early humans, have stronger neophilic natures that help them be less fearful of foreigners and expand their social connections.[136] Therefore, many physical features and behaviour traits help *Home sapiens* form larger social communities.[137] Our curious nature appears to have been genetically and socially preserved from the birth of humanity.

Curiosity expands our experience and knowledge not only through interactions with the environment, but also through social involvement (e.g., exploiting the knowledge and expertise of other individuals). The unfolding of children's curiosity needs support from adults, and sometimes children need to rely on adults' reading of others' minds to understand what others think and feel (Leslie, 2014). For adults, sociability is also an important means of satisfying curiosity. In my observations of museum visitors, some adults asked, "What is it?" to their group members before using the exhibits.[138] This shows that social groups remain important resources to resolve an individual's curiosity. Human beings' curious brain is also a social brain, because it is interested in other people's feelings and thoughts. Scientists who study

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[136] See section 1.2.1 in chapter 1
[137] According to Krantz (1998), curiosity as well as other drives (e.g., mother-love, compassion, cooperation, inventiveness and competitiveness) have been regarded as human beings' social instincts that are important to the survival of human beings. In the story of the Neanderthal's extinction, as mentioned in chapter 1, it has been argued that the social nature of *Homo sapiens* is crucial to its competition with the Neanderthal during the period of their co-existence (Gallagher, 2011, p. 21; Medina, 2010, p. 14).
[138] See vignette 6 in section 3.3.3.2 for an example

brain development also note that “the brain seems to love to learn from other people” (Gopnik, Meltzoff, & Kuhl, 2001, p. 196). Watson’s remark on human natural interest cited in the beginning of this section also echoes this. Humans, with their neophilic traits, love to learn and know from others.

The social nature of human beings’ curiosity is thus an important means to understand the world. Recent research in psychology has started to emphasise the social value of being curious, arguing that curiosity leads us not only to seek out physical experience, but also to explore social information and cultural knowledge (Kashdan, 2009). Some refer to our interest in how others’ think and behave as *social curiosity* or *interpersonal curiosity* (e.g., Hartung and Renner, 2013; Renner, 2006[139]). Others use the term *empathetic curiosity* (e.g., Leslie, 2014).[140] It could be said that a large part of our knowledge about the world develops through social interaction and collaboration.

From the observation of children’s behaviour, we learn that our curiosity is largely shaped by social factors. Many parents would often have these experiences. Although children are easily attracted by new toys or objects,[141] they are much more likely to keep their eyes on a stranger. When children see novel things, they will not only physically explore it, but also show it to their parents or caregivers. Children

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[139] Renner (2006) defined social curiosity as an “interest in how other people think, feel, and behave” (p. 306) and further classified social curiosity into two types: general and covert social curiosity.
[140] Leslie (2014) uses the term *empathetic curiosity* referring to having “interests in the thoughts and feelings of others” (p. 229).
[141] In Ellis and Scholtz’s study of children’s toy preferences, novelty is decisive for children’s choice of play toys (as cited in Malone, 1981, p.337).

also tend to look at adults to see if their caregivers noticed what they have found. When parents are pleased and respond to the child's discovery, their excitement is exaggerated. Parents of young children also know well that their children not only have eager to explore the world, and more often, they test how people respond to their behaviour. For instance, a young child loves throwing things, sometimes it is not for seeing the effects of gravity, and they simply want to see how their parents will react. Children's learning and exploration of the world are largely involved with others.

An observation I made about my child's playgroup also confirms that our curiosity is significantly affected by other people. My 1-year-old daughter and I attended a playgroup every week at a church hall. Based on the activity theme, the helpers usually placed the toys in several small areas, such as books in an area for storytelling, musical instruments in an area for making sounds, or dolls in a role playing area. Each play area was semi-open and located on both sides of the main walkway. I observed that most of the time, babies, who were too young to be self-mobile, were usually taken by their parents to stay in an area that nobody occupied. Some exceptions were made when parents met their acquaintances. However, younger children who could walk on their own often firstly approach the area that was occupied by one or more other children, even when they did not know each other. Most children were not drawn to the toys that were located nearest to them. In other words, other children and what toys were held in their hands were more likely to draw a new comer's initial interest. Most children did not play together, but they always showed interest in their co-users from time to time. Our curiosity about other people in our environment helps us build spontaneous social bonding and strengthens interaction.

In adults, the curiosity-driven exploration also leads individuals to have not only intellectual but also social growth. In *Curious: The desire to know and why your future depends on it*, the author Leslie (2014) used Leonardo da Vinci as an inspiring example of someone whose curiosity contributed his sociability. On Leonardo's to-do list, we can see his wide-ranging desire for intellectual and cultural exploration motivating his explorative behaviour to seek out conversation with others to learn what works and why (Leslie, 2014, pp. 42-44). Being curious helps one become more open, expressive (i.e., using verbal behaviour asking why, how and when etc.) and attentive to other people's opinions and thoughts. More importantly, being curious may also reduce negative preconceptions and attitudes, and help people be more receptive to new information (Kashdan, Afram, Brown, Birnbeck, & Drvoshanov, 2011; Mussel, 2010; Reio, 1997[142]). While people with greater curiosity are more likely to be more open to social interactions, the nature of curiosity is fragile. Imagine, a parent who does not respond to his or her child's pointing gesture, the child will naturally cease to show his or her curiosity. The nurturing, exhibition and satisfaction of an individual's curiosity are important factors in fostering social bonding and care.

[142] In his research on adults' job performance, Reio (1997) suggested curiosity is relevant to social-related learning process.

A clue to curiosity's social value is also evidenced in the etymology of the word. The etymological root of the word *curiosity* – from Latin *curiosus*, which means "careful, diligent; inquiring eagerly, meddlesome," – is akin to the now obsolete English word *cura* "care" (Curious, n.d.).[143] Carefulness, attention, and proficiency (i.e., attained by careful application) were part of the meaning of curiosity. In other words, the concept of curiosity had originally been characterised by the attitude of care and by the feeling of concern about others. However, the concept of care has become distinct from everyday common meanings of curiosity, which suggests changes in social and cultural attitudes relating to inquisitiveness or exploratory behaviours.[144] Curiosity's social nature is easily ignored, as similar words with negative connotations, such as interference, eavesdropper, and gossip, have poisoned the meaning is curiosity. In English, the weird sense of the word *curious* is revealed when describing someone as curious (Baumgarten, 2001). On many occasions, we avert our gaze and sometimes pretend to be incurious, because we do not want our vulnerable curious stare to be noticed. The expression of one's curiosity may cause other people to feel anxious. Because we are all social creatures, we are not only curious about others' feelings and behaviour, but we also care about what others think of us as well. Therefore, curiosity evokes not only the desire to know more, it needs care and support from the social world.

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[143] The word *curiosity* used to mean proficiency, exquisite skills, greater mastery, deep learning, attained by careful application (Curious, n.d.). This also reflects our belief that mastery requires curiosity and careful attention to the details. See also section 1.2.3 in chapter 1 for more details.
[144] The revival of the concept of curiosity as *care* is also reflected in Michel Foucault's (1980) statement on curiosity (see Foucault, 1980). I also quoted his words on curiosity as care in the conclusion of this chapter.

Curiosity, the tendency to engage with novelty, suggests that one sees a different value against the constant, the old, the tradition, and the ordered. Thus, it is inherently uncompromising and insubordinate. It could upset the rhythm of other people. Therefore, its irresistibility, impulsiveness, and physical pleasures, and rebellious behavioural tendencies all give room for cultural discourse that debases the value of curiosity in human societies. Dating back thousands of years, what ancient people thought about the curious nature can be found in the mythological characters created by human societies all over the world. In several well-known ancient stories, the result of uncontrolled curiosity is terrible disaster, especially for those who have voracious eagerness to pursue the new or for those who cannot resist temptations of the unknown. Pandora's Box[145] and the story of Adam and Eve[146] are such examples. Curiosity in those old stories is represented as a character flaw rather than being considered as a natural need for new information. People began to disapprove of the careful attitude and connection to sociability rooted in the conceptualisation of curiosity.

In Western cultures, cultural explanations of human curiosity have changed over time. The influential theologian of late Antiquity, St. Augustine had a strong critical attitude about human beings' curiosity. In his autobiography *The Confessions*, St. Augustine believed that the three temptations, i.e., passion, curiosity, and pride,

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[145] In Greek mythology, Pandora, who was the first woman on Earth created by Zeus, was given beauty as well as a curious mind. She was told not to open the box that was a gift from the gods; however she could not resist the temptation and opened a box, releasing all the evils of mankind to the world.
[146] In *Genesis*, the curious minds of Adam and Eve let themselves become enticed into eating the fruit of The Tree of Knowledge, creating the original sin in mankind.

hamper the road to the truth (Harrison, 2001). He used the Latin words *concupiscentia oculorumor* (i.e., the lust of the eyes) to represent his understanding of curiosity. He asserted that curiosity made people become tempted by beauty and made them vulnerable to fall into sin. In his view, the tendency of the eyes to look towards the new plays an influential role in enticing one into the look into forbidden knowledge. St. Augustine's thoughts exerted great influence in the Middle Ages (Harrison, 2001, p. 270; Walsh, 1988, p. 81).

For instance, St. Bernard of Clairvaux (1090-1153), who was active in France in the 12th century, echoed St. Augustine's condemnation of curiosity, stating that "Curiosity, therefore, rightly claims first place among the degrees of pride, and is rightly seen as the beginning of all sins" (as quoted in Park, 2001, p. 322). Blaise Pascal (1623-1662), the French Catholic philosopher of the 17th century, asserted that "Curiosity is only vanity. Most often we only wish to know in order to talk about it" (as quoted in Walsh, 1998). In the early 20th century, Austrian psychologist Sigmund Freud (1856-1939) represented curiosity as "Schaulust," which was similar to St. Augustine's ocular lust (Lowenstein, 1994, p. 77; Ofer & Durban, 1999). Martin Heidegger (1889-1976), the German philosopher of the 20th century, in his influential book in *Being and Time* (1927) also explained that the distraction away from the understanding of the truth results from one's curiosity only for the sake of viewing.[147] In short, St. Augustine's view of curiosity has influenced the later

[147] Influenced by St. Augustine, Heidegger uses the word of curiosity in a more narrow sense to describe our temporary moments of engagement with novelty and distraction as an aspect of Dasesin's inauthentic being. In *Being and Time*, Heidegger (1927) says "When curiosity has become free, it

Western cultural (or philosophical) treatment of human curiosity. This explains why early Western literature tended to suppress the natural desire to experience the new and strange (see Benedict, 2002, for a review), and also explains why many socially undesirable behaviours, like drug abuse and downright weird experiences, are blamed on our curious nature today.

In the English language, the usages of the words *neophilia* and *neophobia* also reflect different cultural attitudes about the notion of curiosity. According to the Oxford English Dictionary, the word *neophilia* originated in the late 19th century. It describes 'a love of novelty.' Neophobia is its opposite, the "fear or dislike of what is new" (Neophobia, n.d.). In different areas of study, the meanings of neophilia are never identical. In biology, it is defined as a biological instinct to search for the novel, and it is often associated with the study of species' exploratory drive and adaptation in the environment. It is used as such by the aforementioned author of *The Naked Ape* Desmond Morris. In psychological literature, neophiliacs are those who show a strong affinity for the new, similar to novelty seekers and thrill seekers. Neophobia[148] are those who have an abnormal fear of change. Psychologists identify the subject of people's love or fear in the word itself, such as technophilia, xenophiles, exophilia[149], food neophobia, agoraphobia etc. These words are used as a

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takes care to see not in order to understand what it sees, that is, to come to a being toward it, but only in order to see. It seeks novelty only to leap from it again to another novelty ... Curiosity has nothing to do with the contemplation that wonders at being" (p. 172). Heidegger's definition of curiosity is narrowed to the everyday phenomena of novelty seeking and distraction, thus he linked it to an inauthentic mode, which is opposite to today's usage (see Heidegger, 1927, pp. 220-224).

[148] Neophobia in psychology is also called *cainotophobia* or *cainophobia* (Colman & Andrew, 2009).

[149] Exophilia refers to having attraction to bizarre or otherworldly things.

neutral scientific description; there is no strong judgmental attitude toward our nature for the new. However, in the literature, neophiliacs are represented as anti-traditional cultures. In his book *The Neophiliacs: The Revolution in English Life in the Fifties and Sixties*, Christopher Booker (1964), for instance, argued that the neophiliacs lowered the social sense of morality during the period of prosperity in the 50 and 60's, because neophiliacs usually showed distaste and abhorrent attitudes towards tradition.[150] On the contrary, in *Prometheus Rising*, writer Robert Anton Wilson (1983) regards neophilia as the innovative force that sped up social change in the age of Enlightenment and the Industrial Revolution. Wilson (1983) notes that those who were suspicious of new technologies or complex inventions (i.e., neophobia) tended to use words like *witch*, *satanist*, or *heretic*, to jeer at neophilia (Neophile, 2015). The cultural explanations for people's love for the new and different seem to waiver between positive and negative.

Back to the evolutionary point of view, although humans are all born with instinctual curiosity, the difference in individuals' willingness to take risks to resolve their curiosity is important to the survival of a species. For some, the search for the new is pleasant. For others, keeping stability is more favourable. Such variation in the composition of a cultural group helps its members face change with dynamic forces to take a various degree of approach-avoidance attitudes. Gallagher (2011) suggests that there are three dominant subcategories of curious human beings: neophiliacs (i.e., those who are extreme novelty and thrill seekers), neophobes (i.e., those who

[150] See Gallagher, 2012, p. 235

are strongly resistant to change), and moderate neophiliacs (i.e., those who are at neither one extreme nor the other). Therefore, a society's attitude towards stability, progress, change and competition could be viewed as the balanced force amongst those groups. A society that precipitates stability would see rapid change as negative for the maintenance of the established order, thus the overly curious minds would not be encouraged. Neophobes' resistance to change would reduce risk and make reformers more cautious. A society that anticipates progress and prosperity would take a more positive cultural view of curiosity, advocating creative thinking and attitude. Therefore, people with a high level of curiosity would be more advantageous in such a cultural milieu.

In fact, the emancipation of curiosity in Western societies underwent a shift in the way curiosity was expressed and evaluated.[151] In the past, exploration of the unknown had many limitations. The pursuits of the unknown in a more conservative society may have been more influenced by utilitarianism; therefore, funding, publication and application may not be invested into a pure curiosity.[152] Unacceptable questions or scientific pursuit would be at a cultural disadvantage. As such, it is difficult to pursue curiosity without support from a neophiliac culture.

[151] Ball presents the history of how confusing attitudes to curiosity in the transitional period from the 16th to the 18th centuries. In Ball's analysis, the emancipation of curiosity is as the result of a shift in moral evaluation of curiosity (see Jacob, 2014).
[152] In *Curiosity: How Science Became Interested in Everything*, the author Philip Ball notes it was only when people could use electric lights in the 18th century that pure curiosity began to form as a radical force to drive scientific innovation (Forbes, 2012).

As mentioned above, from the etymology of the word *curiosity*, we can see the meaning of care has been lost. It may reflect the inhibition of curious minds in early Western society. Imagine, one asked a question and the other(s) replied: “I don’t know, and I don’t care about the answer.” One’s curiosity would be reduced or become isolated. For the pursuit of the new and the unknown to develop, the cultural community must care and support curiosity’s development to some degree and make discovery and knowledge important. Now, cultural attitudes toward people with curious minds have radically changed throughout the years. The social nature of curiosity is increasingly getting more attention in recent positive psychological studies as it is believed to have benefits in enabling interpersonal closeness and improving emotional well-being (e.g., Kashdan & Roberts, 2004; Kashdan, Steger, & Breen, 2007; Kashdan, 2009; Leslie, 2014, p. 44). As today’s life is saturated with screens of all kinds, curiosity’s social nature is becoming more important to foster social relations and knowledge production and exchange.

The contemporary photographer Shizuka Yokomizo’s work *Stranger* serves as an example of using social curiosity to initiate people’s participation in her work.[153] In her photography, Yokomizo looks for humans encountering complete strangers. She selected the addresses and then sent her subjects anonymous letters (see below) to invite a momentary encounter.

> Dear Stranger, I am an artist working on a photographic project which involves people I do not know…I would like to

[153] See Yokomizo’s Strangers project from http://www.tate.org.uk/context-comment/articles/what-are-you-looking

take a photograph of you standing in your front room from the street in the evening. A camera will be set outside the window on the street. If you do not mind being photographed, please stand in the room and look into the camera through the window for 10 minutes on __-__-__ (date and time)…I will take your picture and then leave…we will remain strangers to each other…If you do not want to get involved, please simply draw your curtains to show your refusal…I really hope to see you from the window. (Cecconi, 2012, para. 1)

This artwork requires curiosity from both parties, the photographer and the participant. For the photographer, her curiosity to explore the art of human connection is the driving force behind her work. For the participant, his or her curiosity about the photographer, a complete stranger, is the main motivator for people to reveal their privacy and to inhibit distrust toward strangers to form a connection. By taking part in co-creating this photographic practice, their curiosity about unusual events (i.e., being strangers) could be satisfied. By making such encounters among strangers happen, social distance and interpersonal relationships may change.

The evolutionary psychologist Dunbar (2004) suggests that the acquisition of social information and knowledge is an important method for people to control over the state of their social networks. New studies even show that people with neophilic traits show more **c**are for social order (e.g., Kagan et al, 2007; Beswick, n.d.) with a combination of character traits like persistence and cooperativeness (Leslie, 2014).[154]

[154] Leslie (2014) states that “People who are deeply curious are more likely to be good at collaboration. They seek out new acquaintances and allies in the process of building their stock of cultural knowledge” (p. 18).

Recently, social learning theorists also suggest that watching other people behave is an effective way to learn in a vicarious learning mode (e.g., Cecil, Gray, Thomburgh, & ISPA, 1985). Many people today take a neutral point of view towards curiosity and the curious behaviour we exhibit, quite unlike the medieval view of strong moral criticism. However, we must understand the value of individual differences in approach-avoidance attitudes that are also important to the survival and thriving of individuals and groups. As stated by Gallagher (2012), "Whether it's liberals versus conservatives, risk takers versus the safety conscious, or technophiles versus technophobes, our conflicts can be uncomfortable, but ideally, the payoff of our different attitudes about novelty is a stronger, more resilient group as a whole" (p. 79).

Overall, human beings' curiosity has a strong social nature. Individual's curiosity is established from a long period of childhood; it is nurtured or inhibited by the elder generation. It belongs to the wider cultural community and society. Curiosity is not utilitarian, sparking it does not require incentives (i.e., external rewards). Even so, its performance increases with appropriate social support. Understanding the social side of curiosity helps to explain the user's exploratory behaviour, including approaching and avoidance behaviour, in the contexts of public or shared spaces; and more importantly, it helps design for fostering social interaction and interactive activities.

4.3 Implications of curiosity's social nature for experience design

> The reason why people love seeing what other people are doing or thinking on the likes of Facebook or Twitter is that we love doing it offline – we're social animals.

— Clive Thompson, 2014

From the above discussion, curiosity is not just an emotion to drive information seeking behaviour, but also is a conduit that helps us empathise with other people and build social connections and acquire knowledge. Today, since digital media is emerging as a new tool for creating and supporting various types of social interactions and communications, the social effects of curiosity would be of vital importance to the design of interactive technologies for enabling social interaction and fostering participatory cultures.

In recent studies, social curiosity has been identified as one of the main motivators for people to use social media (e.g., Urista, Dong, & Day, 2008) or take part in the process of co-creation and collaboration (Füller, 2010). As in the above statement by Thompson (2014), engaging and delightful experiences in using social media, such as Facebook updates and Twitter posts, are derived from satisfying of our natural need to acquire social information and knowledge in a different way.

Therefore, in the following section, I will take three digital media design examples to explore how the social effects of curiosity deepen its impact on user experience and how it evolves within digital contexts. The discussion of curiosity's social nature in three cases is presented as follows: firstly, three projects will be introduced, and each example includes how curiosity's social nature is used in practical circumstances;

then, the relationship between curiosity and sociability in each example will be analysed.

4.3.1 Discussions of sociability and curiosity through other examples

4.3.1.1 Curious Cube

Released in November 2012, *Curiosity – What's Inside the Cube?* is a multiplayer social gaming experiment designed by Peter Douglas Molyneux's studio 22Cans. As its name suggests, the experiment creates a mysterious cube covered by thousands of layers of little cubes called *cubelets*. The person who removes the last piece of the last layer would discover a hidden secret, which is, promised by Molyneux, "life-changing in any measurable way" (Lehrer, 2013, para. 2). The means of removing the cubelets in fact is rather simple: tapping on a mobile screen. The cubelets can be chipped off little by little, layer by layer. Thousands of users can simultaneously tap away the cubelets of the Cube. Removing the cubelets earns players virtual coins to buy tools (e.g., a chisel), which can be used to speed up the action of demolition. To keep players curious, the game provides some basic rewards to reduce the feeling of mindless screen tapping, including revealing unique easter eggs (e.g., pictures of faces, travel photos),[155] giving an unexpected coin stash, and providing drawing functions to leave marks on layers that other players would see. As the effort required to tap away such massive amount of cubelets is significant, the game

[155] See information about the design of each layer of the cube at http://www.giantbomb.com/curiosity-whats-inside-the-cube/3030-39467/

presents a chance for many people work in collaboration to achieve one goal, even though only one person will win.

After six months of the experiment, 225 billion cubelets have been tapped away by over a million game downloaders. Indeed, this game created a massive multiplayer experience by thousands of concurrent users, just as Molyneux intended. Obviously, this game is based on human beings' curiosity. The desire to know what is inside the cube motivates players to work together to peel back layers. Many players seemed to only tap endlessly without knowing what to expect, though some have expressed their positive experience with the Cube. In my view, the mechanism that keeps players engaged to dig into this cube does not simply depend on an unveiled box alone (i.e., the secret), because there are no clues provided to hold their curiosity. Curiosity cannot be sustained in a void. The period of active curiosity about a completely unknown box would be very short. An unknown secret in a box might keep people playing for a short time to kill time (or to consume novelty), but it is insufficient to engage so many people over months to complete the task.[156] I think the opportunity that this game provides for people to discover a hidden secret together might be a more intriguing factor in sustaining players' curiosity.

In this game, several design approaches helped enhance curiosity's social effects. Firstly, the social side of the game is made clearer to players. One of the most interesting things in playing this game is to see someone else, such as Facebook

[156] After initial launching, there was a significant decrease in participation input as the novelty effect of this game wore off, see http://matt-siegle.com/curiosity-whats-inside-the-cube/

friends and strangers, alongside the player dismantling the same cube. The game shows beams of white light shooting out from cubelets that are chipped away by other players in real time. The Cube becomes more fascinating when it zooms into the cubelets that were chipped away by other Facebook friends or strangers' taps. Secondly, according to players' discussions on the social media, many players liked to update their progress and share their thoughts about the cube's secret.[157] Social media and gamers' forum on the Internet can help players relate to others who share their ideas and experiences.

These design approaches sustain curiosity and support the social potential of the mobile gaming space, which might result in creating momentary social bonds and enhancing the embodied feeling of connectivity and cooperation. In this case, social and collective curiosity played a role in the task. Without a sense of collective curiosity, the centre of the cube would not have been discovered as quickly. The strange box indeed triggered individuals' desire to participate Molyneux's social experiment. Since the application was widely downloaded, the mass interest facilitated social engagement for conversation and collaboration to explore the unknown together.

4.3.1.2 Oxfam Shelflife

[157] See some examples of players' discussion about this game at Touch Arcade's website (http://forums.toucharcade.com/showthread.php?t=164684) or Giant Bomb forum discussions (http://www.giantbomb.com/curiosity-whats-inside-the-cube/3030-39467/forums/)

Oxfam Shelflife is an innovative research project developed by the Tales of Things and Electronic Memory (TOTeM) team, which is a collaboration between five universities: the University College London, the University of Edinburgh (Edinburgh College of Art), Brunel University, the University of Dundee, and the University of Salford. The idea of this project, according to the Head of retail brand Oxfam's Sarah Farquhar, is to promote sustainability by eliciting long-lasting interest in the community history through donated items (ECA collaborates on innovative Oxfam app, n.d.). The project enables donors to share stories of their experiences and memories associated with the donated items for others (e.g., shoppers and the future owner) to discover. The interested donors can tag a Quick Response Code (QR code)[158] onto their donation, and through the use of its mobile application, the donor can write down their stories or family histories on the TOTeM platform. When someone visits the participating Oxfam shop,[159] they can discover the story behind the tagged items by scanning the QR code.[160]

In this project, the team deploys the object's hyperlinking system (i.e., QR codes), which is an important means to enable connections between the object in the real world and the associated stories and memories stored in the digital platform (i.e., the

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[158] QR code is an object hyperlinking system, which connects the flow of the distributed content. The object hyperlinking system, which sometimes is referred to as physical world hyperlinking, is a type of visual reference tags (or markers, visual links) designed to link physical objects to relevant information on the Internet via using mobile phones with built-in camera and reader software (or a special app). The mobile phone user can, therefore, read the intended information about the object by simply taking a picture of the tag. Currently, the presence of mobile barcodes has popping up on everything these days, including Aztec Code, High Capacity Color Barcode, ShortCode, QR codes. Of these, QR codes have been widely used in print advertisements or the mobile gaming practices.

[159] There are ten participating Oxfam shops across Manchester.

[160] See how Oxfam Shelflife works at http://shelflife.oxfam.org.uk/how_it_works/

Tales of Things database). This provides a different form of engagement with personal experiences and memory sharing processes. A tag of QR code functions both as an interface for technological connection and identity and an emotional trigger for curiosity because many times QR codes are often scanned just out of curiosity (eMarketer, 2012).[161] Although curiosity in particular is not a specific interest in TOTeM's research, displaying a QR code onto a donated item is a key curiosity trigger that hints the object itself is augmented with further provenance information and stories to tell. The black-and-white tag, different from other ordinary donations, suggests that there is a chance to learn more, to peek into the former owner's past experience and to take part in the charity shop's new initiative. Curiosity takes the interested shopper beyond the ordinary context. Without curiosity, people would not pick up a smartphone, scan the code and read and share the story. As more people who learn about the sentimental value associated with the donation, they would care more about the donation itself.

According to TOTeM's evaluation study, the reason participants shared their stories of certain donations because they considered the object's stories to be potentially of interest to other people. Moreover, participants also pointed out that the project satisfied their curiosity about the lives of others (Barthel et al., 2013). The activity of sharing and accessing personal experiences and memories is indeed interesting and engaging. As one participant commented, "it's just somebody's perhaps interested in

[161] According to customer market research company Chadwick Martin Bailey, 46% of smartphone users who scan QR codes are just out of curiosity. 41% do it with a hope of getting information, followed by 18% who want to take advantage of a discount or coupon or free gift (eMarketer, 2012).

what I'm doing, which is this similar... type of thing [as following someone on Twitter]! Someone is interested about... somebody else's... memories'" (as quoted in Barthel et al., 2013). This participant's interest in other individuals' lives are important factors in selecting which objects to share and use augmented memory technologies. Although Oxfam Shelflife is not specifically designed to play into people's desire to learn about other people, curiosity's social nature, in this case, is an important underlying motive to make people get involved in this new form of co-creation and participatory process.

4.3.1.3 Curious City

Curious City is a newsgathering experiment hosted by the Chicago Public Media aimed at providing local citizens with a media platform to share their everyday curiosity and wonderment about the city of Chicago and the people who live there. Firstly, the media WBEZ reporter asks the question, "What do you wonder about Chicago, the region or its people that you want WBEZ to investigate?" to collect the average citizen's thoughts about Chicago. The public can post their questions on the project's website,[162] through a phone message, or by being directly interviewed on the street. Then, the public can give their opinions and vote for which questions they would most like answered. The media would work with reporters, other participants, and experts to investigate the winning question. Also, the person who asked the question would be invited to get involved, and progress will be updated to several online media outlets in real time, including Tumblr, Facebook, and Twitter. The

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[162] See the project at http://curiouscity.wbez.org/

interested public could follow the investigation as it unfolds and help shape stories by giving their own cultural knowledge, comments, and thoughts. Thus, both the media and the public contribute to the discovery of answers throughout the democratised reporting and editorial process.

Since its launch in 2012, Curious City has received nearly 3,000 questions so far, some big or small, easy or challenging, serious or light-hearted, and even some tedious, interesting, or provocative. Some examples include, “Who changes the light bulbs on the antennas atop the skyscrapers in Chicago and how frequently are they changed?” “How do they clean the Bean in Millennium Park?” “Joliet was once named Juliet, while nearby Romeoville was once named Romeo. What’s the story?” Currently, over 200 of the proposed questions have been answered and have produced some fascinating stories and reports (in mixed forms, ranging from written articles, podcasts to videos), which could also continuously serve as a topic for public discussion on the web-based story page.[163]

Curious City’s journalistic practice makes the content for citizens, not consumers, which makes the stories more engaging and relevant to the public’s interest. Both editors and participants are story makers, playing a role in the process of creating and shaping stories. The creation of local stories largely depends on the participation of the public. Through the collaboration between media reporters and interested citizens, this project embodied the ingenuity of journalistic practice and the use of

[163] See the answered stories at http://www.wbez.org/series/curious-city

multiple digital tools and platforms. This serves as a good example for making community-based participatory journals and creating stories based on what citizens want to know and what citizens care about. As the success of the project is becoming clear, this innovative news gathering practice has also been replicated by other stations.[164]

The concept of curiosity plays a critical role in this project. Not only does it instigate the topics for investigation and keeps people engaged, but it also functions as a catalyst for fostering the cultures of co-creation and participation, which, as stated above, is important to its success. Several design elements used in this project are associated with the effects of curiosity. Firstly, the media uses curiosity-provoking tactics to collect questions that people wonder about and are interested in. Secondly, people's wonder about places and people is key at the start of the editorial process, by which it also highlights a curiosity gap in others' existing knowledge base. Thirdly, all questions are selected by a collaborative decision-making process, which attracts the attention of the public to the winning question. In such a curiosity-driven context, the desire to close curiosity gaps drive the reporting process at both the individual and group level. Not only the attention of the person who raises the question would be held, but also people who care about the answer and the outcome (e.g., reporters, other participants, voters, etc.) would be more likely to actively collaborate and get involved in the process.

[164] See WYSO Curious at http://wyso.org/topic/wyso-curious and iSeeChange at http://thealmanac.org/ for instance

The question “What would the city look like if the Great Chicago Fire hadn't happened?”[165] for instance, is an interesting and thought-provoking trigger to motivate one to explore and imagine the city of the past and present. To find out the answer, curious people have to gain knowledge of Chicago’s history and investigate what the city looked like before the fire of 1871 before re-envisioning this what-if scenario. Without participants’ cooperation, support and imagination, the answer would not have been as engaging and meaningful (very likely, we can never answer this question with certainty). The process of collaboration and co-creation matters.

In fact, Chicagoan Kevin Borgia, the person who asked this question, said that he asked about what-might-not-have-happened scenarios because of his interest in Chicago’s history and because he heard people talk about the fire in everyday life (Loerzel, n.d.). The social group’s common interest elicited Borgia’s curiosity, and the Curious City website gave voice to his wonder, and in turn elicits curiosity from other people. With those participants motivated to get involved to explore and imagine an alternate history together, Borgia’s question develops into a good story. Curious City serves as a crowdsourcing project, allowing the public to give an assignment to the public media as well as providing an opportunities for the public to join the editorial process. The social aspect of curiosity plays an important role in shaping co-created stories.

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[165] http://curiouscity.wbez.org/questions/1502

On any given day, we often think of many questions, such as Borgia's 'what if' question; however, the vast majority of these questions are momentary and fleeting. By sharing these often overlooked wonders, we elicit attention and concern of others, which creates fertile ground for urban journalism. As previously discussed, exploration of the unknown may lead a person to deepen or change their relationship with others. This curiosity-driven project revolutionises the concept of journalism and motivates curious individuals to make more social connection and converse with others to create and shape the answer collectively, which I consider to be the point of this experiment.

4.3.1.4 Summary

The above three digital media projects show that enhancing social connections benefits the cultivation of curiosity, and provides a foundation for understanding how to design for the social nature of curiosity in practice.

The first case – the Curiosity Cube – is a practical example of using curiosity and its social nature to engage a large number of players to resolve curiosity collectively and collaboratively. Participants' motivation to join the second project – Oxfam Shelflife – reveals that people's interest to know others' stories is one of the key motivators to develop community memories through QR code augmented objects. And the last case – Curious City – turns individual's everyday wonders into social interest to engage crowds to participate and co-create the production of news and stories.

Unlike the museum exhibits I observed, these three digital media projects are designed with a respect for provoking curiosity and fostering social interaction and collaboration to some degree. Some of the immediate negative social impacts on users' curiosity brought about by co-present viewers are less significant than those observed in the museum visitors' interactions with the interactive exhibits. I believe that the disembodied use of digital platform for engaging or sharing curiosities produces less direct social tension and gives some liberation from the social pressure; therefore, the immediate social anxiety has less impact on curiosity and exploration. Through digital technology and social media, an individual's social nature and curiosity can simultaneously or dis-simultaneously share with other people in many different ways and even further enable collaboration and co-creation amongst both friends and strangers.

4.3.2 Revisiting the observational data

As I mentioned at the beginning of this chapter, many museum visitors' interactions with the exhibits were affected by social factors. Some were positive and some were negative. Not all of the social dynamics were controlled by the designer (e.g., accompanying adults' approval or disapproval attitude). The above-mentioned design media projects provide examples of how curiosity's social nature affects user experience on a screen. Unlike these applications, most of the exhibits that I chose to observe are not specifically designed for collective use or simultaneous interactions. With the exception of the Making Faces exhibit, three of the four observed exhibits have no functionality to support sharing on the screen interface during the learning process, nor do they encourage social or group interaction. However, as mentioned in the beginning, oftentimes people who were in the same group or were unrelated had light interactions around the Underwater Camouflage Design game. What design elements or concepts could be used to explain why sociability and curiosity was enhanced in these cases?

Reflecting upon the social nature of curiosity, I revisited my observational findings of the visitors' interactions with the two exhibits – the Making Faces exhibit and the Underwater Camouflage Design game. Based on visitors' interactions with and around these exhibits, I conclude that the following design elements play an important role in facilitating the social needs of curious museum explorers in the course of their interaction with the exhibit: elements of co-curiosity, and an interaction process that allows users to adopt covert or overt strategies to satisfy their curiosity. These two points are described below.

4.3.2.1 Co-curiosity

Inspired by the previously mentioned projects that create opportunities for collective curiosity, I argue that creating an object of co-curiosity in the interaction process is conductive to the development of social interaction. By co-curiosity, I mean that people have a sense of curiosity and shared interest together.

From the vignette mentioned in the previous chapter, a group of unrelated children became more interactive when the black fish-bone appeared in the Underwater

Camouflage game.[166] In this case, the boy who wanted to spark co-present children's interest deliberately designed a poorly camouflaged fish which would be unable to hide from the shark. The fish would become a black spooky fish bone whenever the shark came. This small, unexpected visual effect surprised the co-present children. The boy's act clearly showed that he had understood the purpose of the game, but he further turned this game on its head to grab co-present children's interest. The appearance of the black fish bone became the other players' new goal. To achieve this new goal, the interested child had to be careful to design a fish that could not blend into the stone of the virtual pond. The little girl, in this case, was motivated and engaged with the game again, although this was opposite to the game's intended purpose. Obviously, learning was occurring and progressing.

The black fish bone, therefore, serves as a co-curiosity to trigger and connect the interest of the co-present people. Since most of the first-time players would design a well-camouflaged fish to reach the goal of the game, many did not know what would happen if the fish did not survive the shark attack. The unexpected discovery of seeing the symbol of defeat (i.e., the back fish bone) deepened children's interest in exploring the game further. This co-curiosity also creates social engagement opportunities for the boy – who represents the learned (or more experienced), and other children – who represent the unknown (or less experienced). The boy, while he did indeed draw the attention of others, became involved in an unrelated family's playing experience. Similar to the role of the unsolved mysteries and questions in the

[166] See vignette 2 in section 3.3.3.3 for details.

previously mentioned Curious Cube and Curious City, this co-curiosity enables co-present players to perceive an information gap at the same time, which in turn motivates them to work together to close the gap collectively. As observed in this case, the boy created accidental friendships with other co-present young players.

As well, the shared viewing area is important to facilitate social engagement among visitors. With a shared space, the emergence of co-curiosity makes it easier to resolve curiosity together and foster collaboration. However, it is worth noting that designing a system that affords a large viewing space does not guarantee social engagement. As mentioned in chapter 3, in the observation of visitors' interactions with the Earth Sphere, most individuals' viewing did not spark conversation within a group and no simultaneous viewing from different groups was observed.[167] In the case of the Robot Ships, social interaction rarely occurred when two unfamiliar groups were present at the table.[168] Even in the observation of group engagement with Making Faces, group visitors' attention was oftentimes paid to the small kiosk screen rather than to the large overhead screen. A large viewing surface does not naturally trigger or facilitate curiosity's social nature on its own.

With an object that excites co-curiosity in the moment on a shared viewing area, spontaneous social interactions between co-present people around the public screen may be ignited. When co-curiosity is satisfied, a surge of joy is shared among people, even strangers. Without this moment of joint curiosity, most players' interactions

[167] See section 3.2.1.3
[168] See section 3.2.2.3

with the game were only in parallel, focusing on their own fish or interacting only with the members of their own group. Sociability is more likely to be sparked by co-curiosity. Recall the photo from Wikipedia that I mentioned in the introduction, the camera held in the hands of an adult photographer drew children in and became an object of co-curiosity.

Therefore, while acknowledging that a shared viewing area could accommodate social interaction, I argue that co-curiosity is more fundamental in triggering people's sociability and in fuelling collaboration in order to resolve knowledge gaps together. In essence, co-curiosity can serve as a catalyst for fostering social interaction.

4.3.2.2 Covert and overt curiosity-satisfying strategies

Designing for curiosity's social nature in ways that satisfy curiosity in the exploratory process in both cover or overt ways is my second design suggestion. During the observation of museum visitors' interaction with Making Faces, how people used the large overhead screen to satisfy their curiosity reveals the need for adopting covert or overt strategies in their exploratory process.

The deployment of a large repeater screen, mounted above the eye-level, with a control screen has become a relatively new design strategy that many museums and public settings use to enhance an exhibition space for group visitors. In museum studies, some exhibits that are designed for a single user usually found that people usually huddled around the exhibit or formed a line waiting behind it. Thus, these kinds of exhibits take up more physical space and block out potential users (Borun et al., 1998). The usage of a large overhead repeater screen offers a solution to increase the visibility of the exhibit's content for more visitors at the same time and also aids in avoiding clusters. As the design of Making Faces has to meet children's accessibility to use it comfortably, a large high-up repeater screen allows accompanying adults and caregivers to observe their children's creations more easily while their children are playing with the exhibit. According to the museum's design briefs, this large overhead repeater screen is intended to be a place for shared focus of attention to support family group interaction and develop collaborative work skills with whom can view this large screen.

However, as observed, the child users and accompanying adults all tended to look down at the smaller kiosk screen when engaged. The large overhead screen did not really play a significant role in the group users' interaction process. However, I noticed another important function it serves for potential interested users. As the overhead screen displays faces created by current users on the kiosk, people whose attention was grabbed through the honeypot effect (especially adults) often turned their heads to look briefly at the large screen. For example, a man who was standing waiting for his son playing with the blocks noticed a group of people using Making Faces. He looked up at the large over-head screen to resolve his curiosity first and then later tried it with his son (see Figure 4.1 below). This shows that the large over-head screen provided a preview of the exhibit's content for the curious onlooker or bystander.

Figure 4.1 A man (highlighted in a circle) turned to look up at the over-head screen when he noticed people were gathering around the kiosk.

Concerning the difficulty of inviting interactions and overcoming display avoidance with public screens,[169] many studies on public screens isolated people's resistance against public interactions as a common problem (Holleis, Rukzio, Otto, & Schmidt, 2007; Brignull & Rogers, 2003; Kukka, 2013). Social anxiety is the greatest hurdle in resolving curiosity within a public or shared context. However, in the main curiosity-provoking principles, curiosity's relation to anxiety is overlooked. As mentioned in the previous chapters, anxiety and fear is our brain's fundamental mechanism to avoid the potential danger.[170] The relationship between curiosity and anxiety has been considered in the optimal stimulation theory and the dual process theory as a means to reduce uncertainty about novel stimulation to a more manageable level.[171] However, since current design practices for developing curiosity in digital interactions are more focused on cognitive-based approaches to elicit curiosity, the need to eliminate anxiety arising from encountering the new (i.e.,

[169] See the introduction
[170] See section 1.2.2
[171] See sections 2.2.2 and 2.2.3

we have the need for safety to stay in our comfort zone), especially in public contexts, is left unattended.

Using a large repeater screen can provoke the curiosity of passers-by, and it may also help reduce uneasiness with novelty because people know what to expect from the exhibit. It is like using a movie trailer or crafting anticipatory curiosity in the story to make people aware of what to expect.[172] For those whose curiosity has been piqued, they can observe it from the overhead repeater screen, which does not require the body to explore before deciding whether to make a commitment. Without this repeater screen, a curious onlooker can only rely on the current user's posture or facial expressions to judge the purpose of the exhibit and their potential interest value. Therefore, this large screen serves as an important means for people to resolve their curiosity in a less physically-overt way. It helps people make the transition from a curious onlooker to an active user.

The dual process theory, as mentioned in chapter 2,[173] which explains individuals' exploratory and avoidance reactions to novelty, also highlights the need to ensure one's safety and reduce anxiety. However, this theoretical perspective of curiosity and people's avoidance or withdrawal behaviour entailed when encountering the new has been under-recognised in current design practices for curiosity.[174] This is because discovering new worlds through a computer monitor provides a safe viewpoint for

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[172] See also section 2.3.2 in chapter 2
[173] See section 2.2.3
[174] See chapter 2 for a review of current design practices for provoking and sustaining curiosity

the curious explorer to hide. Today, since many screen-mediated activities take place in public and shared spaces, the need for reducing accompanied negative emotional states to satisfy curiosity is becoming more important to encourage people to explore and approach the new.

The large overhead screen in Making Faces, I observed, also plays another important role: a public performance space for users of the interactive exhibit. As mentioned in chapter 3, the child who seemed actively engaged (i.e., having used Making Faces for an extended period of time) also repeatedly looked up at the large screen during his exploration on the kiosk screen. For example, as show in the figure below, a young player was making a face from the kiosk screen and turned to look up at the large screen when her face was down (see Figure 4.2 below).[175]

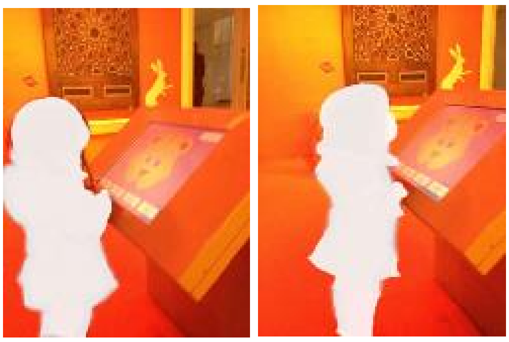

Figure 4.2 A child playing Making Faces (Left) and stopped to look up at her creation on the large over-head screen (Right).

If a child's curiosity is sparked by seeing the images of a face on the big screen and he or she becomes motivated to use the kiosk, then the interaction with the kiosk and

[175] See also section 3.2.3.3

the completion of making his or her own faces displayed on the kiosk screen should sufficiently satisfy his or her curiosity. The Making Faces exhibit is designed to make faces through touch and provides an immediate result of one's creation on the kiosk screen. By using and watching the kiosk screen, a curious child should have his or her curiosity satisfied. Despite this, it is common to see a child looking up at the large screen after a few seconds of using the kiosk, and then they looked back down to swap facial features only to look up again to see the same creation on the large screen. This behavioural pattern could repeat several times in one's interaction process. I think children initially want to confirm how their changes on the kiosk can affect the remote large screen. The repeated looks at the large screen seem to indicate that viewing (re)generates a sense of interest for performance and sharing.

The use of this large overhead screen seems to satisfy the need for sociability. As mentioned previously, children's learning and exploration often involves sharing their discovery with others. When we explore and discover, we often find ourselves wanting to show, display, report, celebrate, and make others keep up with what has delighted us. Recall the cabinet of curiosities in the 17th century, it was assembled not only to delight the eyes of an individual, it also played a social role in making public displays of knowledge.[176] The act of looking up at the large overhead screen is not caused by the need to engage with a shared screen with others. It seems to be driven by the pleasure of seeing one's own creation being displayed in a larger format that can be seen from far away, that which can continue to provoke a sense of

[176] See the introduction for the cabinet of curiosity.

curiosity in the player. The aforementioned young girl (see Figure 4.2), happily said, “Piggy! Look, mommy!” shortly after seeing the same face repeated on the over-head screen, but she did not show this same excitement when making this pig-like face on the kiosk screen.

In other words, the use of a large screen increases the visibility of user’s face creation and also provides a space for adding the feelings of performance and appreciation, which would be different from the experience brought about by a single-user kiosk. While the small-sized kiosk screen for single users develops intimate personal experiences, the effect of large-sized screens in a public context may be more sociable. I maintain that the design should also leave room for eliciting performable attitudes as well as for satisfying curiosity in a more overt way. This should lead to prolonged curiosity and encourage further exploration.

Reflecting upon the previously discussed honeypot effect, it is not always feasible to exploit it to attract other passers-by.[177] The honeypot effect tells us about how common interest catches curiosity’s social nature. Design practices should adopt ways to enhance common social interest in people when they encounter novel digital contexts. Increasing the visibility of a honeypot site within an interaction space could be a practical way of exploiting the honeypot effect in the long run. Alternatively, adding design strategies that display users’ accumulated creations and performances in a more overt manner may attract the social interest of potential users. The

[177] See also section 2.3.4 in chapter 2

aforementioned project Curious City is also an example that makes individuals' curiosity visible to the crowd. In essence, allowing people to resolve and satisfy their curiosity in a more public manner is also an effective way to sustain curiosity and sociability.

From above, covert and overt strategies that interactive systems could afford are both important for satisfying curiosity's social needs and for sustaining it. To reduce social embarrassment (or awkwardness) and feelings of insecurity (or uneasiness) in the interactive experience, it is advisable that digital media projects should allow viewers to adopt covert curiosity exploratory manners in public or shared contexts. Conversely, giving spaces for users to explore curiosity in a more overt manner would be conductive to satisfy the social need for sharing the moment of discoveries. In short, both covert and overt curiosity-satisfying strategies are crucial to support and extend curiosity's social nature and exploration.

4.4 Conclusion

> Curiosity is a vice that has been stigmatized in turn by Christianity, by philosophy, and even by a certain conception of science. Curiosity is seen as futility. However, I like the word; it suggests something quite different to me. It evokes "care"; it evokes the care one takes for what exists and might exist…
> — Michel Foucault, 1980, p. 328[178]

[178] This quote by Michel Foucault is originally from his anonymous interview conducted by Christian Delacampagne in April 6-7, 1980, appeared under the title *The Masked Philosopher* in French newspaper Le Monde. I first came across his statement on curiosity in McCall's (2011) essay and noticed it again in Cabinet Magazine (retrieved from http://www.cabinetmagazine.org/information/foucault.php), and then found it has been widely quoted in various studies and articles on the Internet. See the full text of this interviews in Foucault, M. (1980). The masked philosopher. In L. Kritzman (Ed.), *Michael Foucault: Politics, Philosophy, Culture, Interviews and Other Writings 1979 – 1984* (pp. 323-330). London: Routledge.

From the above discussion, curiosity is important to the formation of social groups and the expressions of social interactions. We have long lived our lives in social groups, individuals' curiosity is our basic means to understanding and learning about the world and its inhabitants. Social support plays a critical role in developing and sustaining one's curiosity and exploration. In the extension of childhood, as stated earlier, curiosity gives us more time to foster social bonds between the learner and the experienced and makes us being more mindful of what others need and feel. Thus, we can gain knowledge through collaboration and sharing among social groups and over generations. Curiosity's neotenous nature makes us stay curious longer and demands social support, which provides both younger and older generations chances to rethink and reflect on what has been learned through the course of our lives. Therefore, curiosity is nurtured in the social world. Our attention to other people's thoughts and behaviour influences to how we explore the world and build cultural knowledge.

Understanding curiosity's relationship with sociability is important to today's digital media design for fostering cultures of co-creation, collaboration, and participation. Digital media is emerging as a new space not only for individual curiosity, but also for collective interest. The design approaches described in the above-mentioned three cases aid in maximising the social effect on curiosity, which leads to fostering relationships with others and improving interaction experiences. Today's digital platforms that offer space for exchanges of social common interest and curiosity, such as Curious City, help spread the impact of actions. This should attract crowds, help newcomers become more involved and make participants become stronger supporters of action. Digital media and technology helps connect individuals' pure curiosity to the crowd's interest. This was once challenging for people in pursuit of pure curiosity in the early Western cultures.[179]

As reflected in the museum observational studies, provoking co-curiosity is a way to contribute to and achieve social ends. With co-curiosity, we are motivated to close information gaps through collaboration and participation. Consequently, we become more attentive to others' feelings and thoughts. With the use of digital technology, there are more opportunities to create, embodied or disembodied, social engagement and know how others feel and think (e.g., by observing comments and feedbacks in the social networking media), which may elicit our ability to care and enable more sustained engagement in the process of exploration and discovery. While recognising that museum exhibits that support shared viewing areas for co-present people usually enhance social interactions, crafting an element of co-curiosity within the interaction context is an even more effective to make people gravitate towards the new and share their experience of discovery.

Moreover, reflecting upon dual process theory and our social nature, I suggest that the experience design should provide both overt and covert ways for users to resolve

[179] See the previous section 4.2

their curiosity. For reducing social anxiety, providing users a safe point-of-view or less overt means to approach the unknown should help smooth the transition from spectator to active participant. However, allowing users to explore and discover in a more overt way may engage curiosity's social nature for sharing and performing. In the case of Making Faces, the large repeater screen makes sharing experiences easy among members of a family, even across wide distances. The design method that supports the need for social interest in covert or overt approaches makes the exploration of curiosity more socially sustained.

In short, as in the above quoted statement on curiosity by Foucault (1980), curiosity evokes care and concern, although it may agitate people because it inherently questions norms. The etymology of the word *curiosity* as care also seems to capture our intuitive sense of curiosity's social nature and offers some insight into interaction design. The original meaning of curiosity was associated with care and concern that enabled human beings to build connections and develop communities and maintain common values. In design literature, the discussion relating to curiosity largely focuses around cognitively-based curiosity but has not noticed its relation to the social development of individuals and groups. To support humans' social nature, curiosity is not just made to please individuals and to manufacture wonder, but it also allows one to find its meaningful answers and resonance in relation to shared knowledge wisdom.

Chapter 5: Embodiment and Curiosity

5.1 Introduction

In the discussion about the observational data, I have identified several important factors that facilitate or inhibit curiosity-driven exploratory behaviour. One factor that makes the notion of embodiment become salient is that people tend to satisfy their curiosity in a bodily and tactile way, especially in the initial stage of an interaction process.

During the periods of observation at the National Museum of Scotland, many visitors appeared to use their bodily gestures and movement to resolve curiosity in the interaction process. In the case of the Earth Sphere, visitors' gestures, like poking and touching the surface of the display, were not uncommon. In the area with the Robot Ships, both children and adults alike initiated their interactions in a similar way. They took a black pad from the table and used it to touch the virtual moving objects once they were in sight. Users tended to actively observe outcomes by physical means before passively observing others. Also, people's interest appeared to become more intense, when they accidentally found that bare hands or fingers could interfere with the virtual robots' movement, causing them to use more experimental and playful gestures in an attempt to interact with the moving robot ships on the tabletop.

The tendency to use physical means as a way to satisfy curiosity was more apparent in the Underwater Camouflage Design game. The majority of the children I observed made physical contact with the virtual pond, even though they were made aware beforehand that the pond is controlled by the touchscreen kiosk and that is only used for observing the game. During the children's exploration of the pond, babies and young children used their fingers and hands to touch the virtual images, while older children would stamp on the fish and the shark. Although there was no interactivity afforded by the pond, many children appeared to be delighted in making contact with the virtual images on the pond.

Since the body is the primary means of resolving our curiosity since early infancy,[180] the role of the body should not be overlooked when designing an interactive experience for provoking and engaging humans' active curiosity. As mentioned in the introduction, today's ubiquitous screen culture has alienated us from the embodied world.[181] Thus, encouraging curiosity through bodily practices should make users more attentive to the world around them, and help them reconnect the screen-mediated experience with embodied knowledge and other bodily experiences. Therefore, this chapter will build up the theoretical connection between curiosity and the role of the body, and it will identify design approaches that support the embodied nature of curiosity in a screen-mediated context through an analysis of design examples and observational studies of museum visitors' interaction with interactive exhibits.

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[180] Based on my experience of observing children, a child resolves curiosity by seeing and physical actions before acquiring verbal or cognitive skills. For example, children use their hands to manipulate objects long before they can ask questions about their surroundings.
[181] See also the smartphone addicts *di tou zu* in the introduction.

The first part of this chapter will discuss the concept of embodiment and its link to curiosity to present a theoretical connection and develop the concept of embodied curiosity. Afterwards, the second part will provide examples of digital media design that deploys or integrates bodily practices to enhance curiosity to further illustrate the practical circumstances and contextualise the discussion. And finally, the focus will be brought back to the observational findings at the National Museum of Scotland to re-evaluate what design approaches help provoke and support embodied curiosity to unfold in the interaction process.

5.2 Developing a concept of embodied curiosity

> We have to understand the world can only be grasped by action, not by contemplation. The hand is more important than the eye ... The hand is the cutting-edge of the mind.
> — Jacob Bronowski, 1973[182]

Curiosity, as one of motivators influencing an individual's decision to seek information, to learn, and to explore the world, is increasingly receiving more attention in digital media design research. However, many of curiosity-provoking strategies are designed to primarily engage the user's perceptual curiosity on a screen, and often disregard the relationship between the user's body and the screen. In the age of desktop computers, the role of the body and its surrounding context in

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[182] This statement is also quoted in RSA's report *The power of curiosity: How linking inquisitiveness to innovation could help address our energy challenges*, where the writer introduces the notion of tactile curiosity and presents a relevant theoretical background to link curiosity to the notion of embodiment (RSA Social Brain Centre, 2012).

screen interactions, as Jean Baudrillard once wrote in *The Ecstasy of Communication* (1987), is “as a large, futile body” (as quoted in Nunes, 1995).

As such, embodiment – that our ways of thinking and reasoning are largely shaped by our bodily experiences – has been ignored in the design literature on curiosity. In the traditional desktop age, many screen-mediated interfaces usually prohibit the use of the body as a means to resolve or cultivate curiosity. Thus, cognitive-based curiosity theories, such as Berlyne’s conceptual conflict and Loewenstein’s information gap theory, as reviewed in chapter 2, received wider attention by digital media designers to spark curiosity and enhance the experience of the computer-based learning and online applications.

Today, with increasing capabilities of screen-based technology for utilising human sensory and physicality (e.g., touch screens, haptic displays, tangible interfaces, interactive tabletop devices, etc.), the role of the body has gained increasing importance in digital media design literature and application. The link between the body and the digital world has been progressively more stressed by many digital media researchers in recent years. For example, Mark Hansen’s 2006 book *Bodies in Code: Interfaces with Digital Media* emphasise that our understanding of the disembodied digital world on a screen is rooted in our bodily interactions with people and the world around us. However, the linkages between our curiosity with a screen and our physical bodies have rarely been explored in digital interaction design research.

Cognitive-based theories represent curiosity as a knowledge emotion, a mental phenomenon to drive the process of knowledge acquisition, which can be consciously provoked, engaged, and resolved through questioning, reasoning and adjustment. Although few theorists, e.g., Loewenstein (1994) and Dewey (1997, as cited in Zuss, 2012, p. 68), claim that curiosity has a hybrid nature (standing at the intersection of cognition emotion and motivation), the theoretical link in-between remains underexplored. In fact, cognitive-based theories have a root in the Western dualist philosophical traditions, which profess that the mind is largely conscious and the role of the body is rendered inconsequential due to cognitive development.[183] However, the emerging view regarding human cognition has begun to incorporate the notion of embodiment into the process of abstract thinking and understanding.

Embodiment, as mentioned above, means is the way we schematise our bodies to interact with the world in everyday life. It provides a set of fundamental patterns for organising and structuring our experience and thoughts. Proponents of embodied cognitive perspective, such as the cognitive linguist George Lakoff, philosopher Mark Johnson and others, suggest that our embodied experience developed from everyday contexts provides the fundamental schematised structures to create order and meaning needed to understand various abstract concepts (Lakoff & Johnson, 1999, p. 36; Johnson, 1987, p. 102). These modes of embodiment (e.g.,

[183] This view echoes that of the early digital culture theorists who tended to overlook physical reality when talking about the virtual world.

proprioceptive and sensorimotor habituations) have been termed various names, such as phenomenological embodiment, experiential gestalts, and image schemata.

In *The Body in the Mind: The Bodily Basis of Meaning, Imagination, and Reason*, Johnson (1987) uses terms like schemata, embodied schemata, image-schemata, or gestalt structures to refer to patterns of recurring experiences in everyday life, which include “bodily movement, manipulation of objects, and perceptual interaction” (p. xix). Embodied cognition theorists use these terms to explain how we subconsciously locate structures of image schemata and extend them metaphorically to make abstract reasoning, rational connections, logical inference, and language expressions. For instance, our root senses of modal verbs, such as *can*, *may* and *must*, according to Johnson (1987), are intimately related to our physical interactions with the environment. We form patterns of typical forceful experiences, including compulsion, blockage, counterforce, diversion, removal of restraint, enablement and attraction, to guide our linguistic expressions of intentional action in a logical sense. As Johnson (1987) explained:

> When we inquire into the senses of must, may, and can, we are exploring the image schemata present in situations of the sort we encounter daily: feeling ourselves able to act in certain ways (*can*), permitted to perform actions of our choosing (*may*), and compelled by forces beyond our control (*must*). (p. 49)

Lakoff and Johnson (1980) also use orientational metaphors to explain why we are able to make sense of abstract and metaphorical expressions like “happy is up” and “sad is down.” According to their explanation, the opposition of up and down has a clear physical basis, which is that a "drooping posture typically goes along with sadness and depression, erect posture with a positive emotional state" (Lakoff and Johnson, 1980, p. 15). Therefore, we can apply our embodied knowledge of the physical orientation up-down to structure emotional expressions accordingly. Furthermore, a major metaphor in a culture like "happy is up" places other less delineated metaphors like "good is up" and "health is up" coherently within the overall system.[184] Through such examples, we can see how abstract concepts and thoughts have a basis in our bodily experiences, and we can understand how they affect our cultural values. Other schemata identified by Lakoff and Johnson (1980), such as on-off, active-passive, centre-periphery, and balance, are also very important to our understanding of many experiences and abstract thoughts. In short, as Johnson (2008) concluded,

> Meaning is grounded in bodily experience; it arises from our feeling of qualities, sensory patterns, movements, changes, and emotional contours. Meaning is not limited only to those bodily engagements, but it always starts with and leads back to them. Meaning depends on our experiencing and assessing the qualities of situations. (p. 70)

[184] The metaphors 'happy is up', 'good is up', and 'health is up' are different ways to experience the same concept *up*. Our schemata associated with verticality, erectness and uprightness is informed through many dimensions and hence gives rise to many different metaphors. For instance, 'more is up,' 'conscious is up,' 'active is up,' 'rational is up', 'high status is up', 'control is up', 'virtue is up' and 'future is up' are all instances of *up* metaphors. More importantly, the priority of these *up* metaphors is not only generally coherent with the clarity of the physical basis, but also with respect to one's cultural and personal values. So, in many cases, 'more is up' is prioritised over other *up* metaphors, but in some contexts, the opposition concept *down* may be valued more. As summated by Lakoff and Johnson (1980), "In general, the major orientations up-down, in-out, central-peripheral, active-passive, etc., seem to cut across all cultures, but which concepts are oriented which way and which orientations are most important vary from culture to culture" (p. 24).

From the above analysis, the body, embodied knowledge, and embodied metaphors play a crucial role in our perception and interpretation of the world around us; however this important factor in our thinking process around us is almost entirely subconscious. The role of the body is not simply to be a house for the reasoning mind, but rather it plays an important role in forming basic patterns for structuring the basis of human reasoning and understanding. The embodied mind theory radically challenges the long standing presumption of Cartesian dualism, whereby the human body is a separate entity from the conscious self. The embodied view has received endorsements from researchers of different disciplines. For instance, the neurologist Richard Cytowic (2003), who is well-known for his findings on the neurological phenomenon of synaesthesia, follows Lakoff and Johnson's position, arguing that "[...] concepts are not defined by fixed properties but in terms of how we interact with objects" (pp. 206-207). In a similar vein, a theorist of VR technology, Randall Walser, also refers to Johnson's view and states that "the basis of rationality is not in the world, as had been supposed, but in the human body" (as quoted in Chesher, 1994). Even William James, who proposed the concept of metaphysical wonder (as a kind of curiosity) as mentioned previously, also asserted that "as we think we feel our bodily selves as the seat of the thinking" (as quoted in Johnson, 2008, p. 95), which suggests that we are actually aware to some degree of the role of the body in our flow of thought.

The contemporary account of embodied cognition has a root in the psychologist Jean Piaget's theory of children's cognitive development developed in the 1950s (Preston, 2003, pp. 30-33). In his theory, Piaget uses the term *schemas*[185] to describe ways of structuring knowledge and experiences derived from sensorimotor actions from birth. Using schemas, a child who understands the world through sensorimotor experience can develop into an adult who is capable of thinking in abstract, representational, hypothetical, and disembodied ways. When Piaget spoke of the importance of schemas in a child's early cognitive development, curiosity was thought to be a crucially important motivator of the exploratory behaviour that drives the child to develop basic sensorimotor schemas (e.g., developing grasping and eye-hand coordination). As exemplified in Piaget's work, babies' ways of exploring objects of interest (i.e., a curiosity stimulus) are varied, including looking, sucking, dropping, banging, and repeatedly touching, by which he or she gains a basic sensorimotor schema from making sense of what the object is and what it is used for.

Based on Piaget's concept of cognitive disequilibrium, curiosity is evoked when a new concept or a different knowledge point cannot fit into a person's existing schemata (as cited in Jirout & Klahr, 2012). As a result, people are motivated to expand their knowledge-base. Our minds and bodies work together to coordinate actions to explore novel or unknown stimuli.[186] By assimilating or accommodating a new knowledge point into the existing schemata, we satisfy curiosity and increase

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[185] Piaget defines schemata as "the generalizable characteristics of [an] action, that is, those which allow the repetition of the same action or its application to a new content" (as quoted in Preston, 2003, p. 30). It is also referred to as a script, a sequence of events, and the overarching frameworks through which organise and understand everyday encounters.
[186] Berlyne (1978) also considered curiosity as the motivator that causes children to ask questions and find answers.

our understanding of the world.[187] As we grow, our curiosity becomes more selective, because events that are likely to evoke cognitive disequilibrium would be fewer and fewer as our understanding of the world expands. Thus, curiosity is crucial to develop schemata and to expand knowledge.[188] Other researchers, such as Giambra, Camp, and Grodsky (1992), also suggest that curiosity-driven experiences facilitate adults' cognitive pattern development. It could be said that curiosity is a prerequisite to construct the foundation for people's cognitive development and rational thinking from early childhood throughout their lifespan.

In their studies of curiosity, most researchers recognise it as a critical motivator that affects immediate exploratory and information-seeking behaviour (e.g., Voss & Keller, 1983; Loewenstein, 1994). However, the implications of curiosity-driven experience and exploratory activities recurring in the everyday life were overlooked. In existing literature, a much greater emphasis has been placed on Berlyne's curiosity collative variables and Loewenstein's information gap theory; thus, cognitive-based design practices for provoking curiosity received more attention than the bodily-based approaches. Many design practices, such as novelty, uncertainty, conflict, surprise, and complexity, are used to craft an information gap to consciously stimulate a person's perceptual curiosity. However, as implicated in embodied cognitive views and Piaget's view of curiosity, our curiosity is not simply based on

[187] Miller and Jablin (1991) describe it as the development of new cognitive maps.
[188] Recent studies also reaffirm this point that inhibiting curiosity in childhood would have an adverse impact on a person's cognitive development (see section 1.2.3 in chapter 1).

the objective characteristics of an object. It is affected by how we interact with the stimulus in everyday life and our familiarity with it.

In short, embodied mind theories provide an important foundation to understand that our perceptual interaction with a screen-mediated interface is not entirely in the mind. There is a significant relationship between the body and curiosity. The operation of abstract reasoning in the mind has a radical root in the structure of image-schemata, through which we find meaning in the world. That is to say, as concluded by Lakoff and Johnson (1999), “the mind is inherently embodied” (p. 36). Our embodied mind developed through everyday interactions with our environment aids in the understanding of abstract and metaphorical thought. Therefore, curiosity’s embodied nature motivates us to explore the new and the unknown from childhood. It is crucial to learning and the development of cognitive abilities.

The concept of the embodied mind and children’s developmental theory reveals the link between the body and curiosity in relation to our understanding and comprehension of the world around us. The introductory quote of Jacob Bronowski (1973) at the beginning of this section reflects this. We are curious embodied beings. We learn and engage with the world around us with our hands and with our five senses. Curiosity has this embodied nature to motivate exploration of the world and to drive the developmental process. Our understanding of abstract concepts, symbols, and metaphorical expressions could not be adequately grasped without rich experience from the recurring patterns of interactions with the world we inhabit.

5.3 Engaging curiosity through bodily practices

5.3.1 Introduction

As proved above, resolving and satisfying curiosity through bodily means plays a fundamental role in developing sensorimotor schemata, embodied metaphors, and cognitive abilities. This relationship of bodily experience to curiosity has important implications in designing user experience and using approaches to sustain people's active sense of curiosity in the exploratory process. Designing for curiosity in screen-mediated everyday contexts by encouraging bodily practices should not only make our sense-making process and wonderment more naturally engaged, but more importantly, it should contribute to the development of embodied cognition in the long-term.

In his book *Body and World*, Samuel Todes (2001) proposed reading into the natural features of the human body, such as the front-back asymmetry, upright posture and bipedality (i.e., stereo vision), to understand the role the body plays in the meaning-making process. In his introductory essay *Introduction II: How Todes Rescues Phenomenology from the Threat of Idealism*, the author Piotr Hoffman (2001) cited Todes' words: "Our body is built with a front-back asymmetry such that effective activity is directed toward what lies ahead" (p. 118). He further used the example of our forward-backward-directed movement and relates it to our experience with viewing devices. Hoffman (2001) suggested that:

> Our backward-oriented actions are naturally clumsy and rarely effective; and unless we decide to turn around, our exploration

> of the perceptual field behind us requires artificial, man-made devices (a rearview mirror, a TV camera, etc.). Action and active perception are always forward-oriented: our body sets out to “face” or “confront” the object, to “approach it,” to “come close to it,” and so on - briefly, to make the object “present” to us in the sense of making it accessible to our use and exploration. (p. xliv)

Our understanding of encounters with screens, especially in a walk-up-and-use context, has been habitually shaped by the natural structure of the body and embodied metaphors derived from the bodily experience in everyday life. Certain concepts that arose from our embodied experience, such as front-back, right-left, in-out, up-down, deep-shallow and central-peripheral, are implicated in our ways of conceptualising perceived objects and ideas. Hence, we may see what is in front of (or before) us as something encounterable or approachable. Thus, frontal-oriented media can be understood metaphorically as another active spectator. In this sense, we may project our face-to-face relations (i.e., non-mediated situations) to the media we encounter. In an analysis of frontal ontology of faces and screens, for instance, author Ingrid Richardson (2010) sees personalisation of the TV and computer – the idea that technologies are like human beings with a face or a body – as “another clear example of this perceived consonance at work” (para. 13). The anthropomorphic relationship between the human body and technology evidences that our forward-oriented body help form our screen viewing experience.

In short, we see that certain features of physical bodies have been metaphorically projected onto our ways of using, naming, understanding and classifying the meaning of our experiences with the media and technology. To design for provoking curiosity through or with the use of a screen-based media, the role of the body and bodily experiences developed from everyday bodily interactions with the world around is fundamental to our perception and understanding of the digital interaction experience.

5.3.2 Discussing embodied curiosity through other case studies

Currently, many digital media applications have already applied bodily practices or translated embodied knowledge to intentionally or unintentionally trigger users' curiosity and enhance engagement. For instance, the mobile game Curiosity, as mentioned in the previous chapter,[189] engages the players' curiosity through direct manipulation of a virtual box on the screen. By tapping away digital pixels with fingers to reveal hidden secrets, the act of touching makes the player assume an active relationship with the digital box and engage their desire to know what is inside the box. Other technologies, such as location-based applications and social media, all increasingly use bodily actions and embodied knowledge in the digital content. These digital media technologies enhance users' perceptual experiences and their immersion into the disembodied digital world by making it more relatable in our embodied mind.

As discussed in chapter 2, this research on curiosity for experience design is focused on people's interactions with the world and the surrounding cultural context. In this section, I will look for new forms of digital interaction that enhance curiosity and

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[189] See section 4.3.1.1 Curious Cube

exploration through bodily actions with the screen. Thus, three digital media installations will be selected to see how bodily practices have been implemented in curiosity-driven exploratory processes, and their interaction design will also serve as practical contexts for further reflection on observational studies of visitors' interactions with the interactive exhibits at the National Museum of Scotland. Then, I will propose design suggestions that better engage embodied curiosity to foster active sense of exploration and interaction with the world around users.

5.3.2.1 Foundation Edinburgh

Foundation Edinburgh: the Story of a City is a nearly twenty-minute film exhibit designed to show the growth of Edinburgh from the volcanic eruptions to today's events, as well as many parts of the city's heritage, including religion, art, and literature.[190] Unlike most films shown in the museum that are projected on the wall, this film is displayed on a huge screen installed on the floor in a blacked-out theatre at the Museum of Edinburgh. As the screen is set in the floor, it is also railed to prevent people from stepping on it. People are expected to stand to look down to watch the film. Many parts of the film's content are also represented from a bird's-eye perspective, zooming in to see a series of animated images and illustrations, which make the viewer feel as if they are flying above the city when watching the story of Edinburgh.

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[190] The film exhibit was created by Registers of Scotland in partnership with the City of Edinburgh Council. It went on display in in the Museum of Edinburgh in 2012. See photos of the Foundation Edinburgh from http://www.edinburghmuseums.org.uk/Venues/Museum-of-Edinburgh/Exhibitions/Past-Exhibitions

During my visit on 25 January 2014, six people (three groups, including four adults and two young children) were present at the installation. Most of them leaned over the railing to watch over the whole course of the film, and two young children changed their position several times during the film screening, from standing to sitting on the ground to grasping the railing with both hands. In general, most people appeared engaged in the narratives as the story was unfolding as few conversations occurred. When the scene slightly zoomed in and out of an old map of Edinburgh, I also experienced a strong and active moving sensation when the images were moving in and out on the screen. The film evidently facilitates embodied experience in the visitor's viewing experience.

In this case, the content provides immersive visual impacts, and people's bodily posture resemble the way we look a hole or travel down a tunnel towards different time and space. As seen in this event, viewers' perceptual experiences and bodily gestures are incorporated in the act of watching the film. However, as the floor-embedded screen was a physical construct of its own, the space for bodily expression was confined. The spontaneous playful or imaginative activities were not invited due to the physical limitations of the display device.

5.3.2.2 Touching the Neolithic

Touch the Neolithic is an interactive dome film commissioned by the National Museum of Scotland through a joint collaboration between Historic Scotland, the University of Exeter, and the University of Edinburgh. It went on display as part of a wider exhibition – Touching the Past – in December 2013.[191] The film was presented on an immersive 3.5 metre, 180-degree dome-like screen tells the story of a stone-built prehistorical site, Skara Brae in the Orkney archipelago of Scotland. This dome-like display uses laser scanning, photogrammetry, and digital reconstruction to realistically represent the settlement of Skara Brae. It also contains several abstract images of ancient objects, such as a whale bone pin and a cooking pot fragment. To play the film, the users have to place 3D printed museum replicas, which have RFID chips embedded, on the table. The interactive film experience is expected to engage people's interest in museum artefacts and bring new meaning to Orkney's neolithic world heritage.

According to a video clip of museum visitors' interactions with the film installation (Knox, 2013), people seemed curious about the 3D objects on the table but also appeared hesitant to approach and interact with the film. However, since this dome-styled installation has a large display area, its technological novelty still engaged some people to watch it from a distance. Although it is not clear whether the viewer's actual curiosity was enhanced by touching 3D objects in this short video clip, the interaction style of this film, which requires viewers to position themselves

[191] Touching the Neolithic museum exhibit was created by Pixogram. Jonathan Knox, the designer of Touching the Neolithic, was also kind enough to share his view on curiosity in relation to his design practice, see Appendix C: Email correspondences with Jonathan Knox. For the visitor interaction with the film installation, see a video clip and images of the film exhibit from http://pixogram.co.uk/?portfolio=nms-exhibition

at the centre of the viewing area, helps allocate viewers' attention to the presentation and enhance their perceptual experience.

This new form of interaction adds physical actions and a tangible object to initiate the viewing experience, which creates a novel mode of embodiment. The act of placing the 3D replicas meets the need of embodied curiosity and aids in reconnecting the screen viewing experience to the physical world. However, this new interactive form demands that interested visitors use their bodies to excise and resolve curiosity in an overt manner. Unfortunately, this could sometimes make curiosity's expression become more withdrawn.[192]

5.3.2.3 Piano Stairs

Piano Stairs is one of a series of experiments launched by Volkswagen in their 2012 campaign called *The Fun Theory*, which was used to test whether adding more fun in an activity would change the behaviour of people in everyday situations. The Piano Stairs was installed in a subway station in Odenplan, Stockholm, to turn the subway stairs into a giant piano, which would play musical notes in real time when people walk on them. Through Piano Stairs, the campaign expected more people to take the stairs instead of the escalator by making it fun. According to the campaigner's self-reported survey results, 66% more commuters chose to take the stairs adjacent to the escalator.

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[192] See also the design suggestions for overt and covert curiosity-satisfying strategies in section 4.3.2.2 in the previous chapter.

Thankfully the experiment was captured on video (see Rolighetsteorin, 2009). By watching the experiment, we can see many people's reactions to this giant piano were positive. Some people experimented with the sound tentatively, such as raising one foot and then setting it down in a different position to test the sound effect. Others seemed to have fun in their piano play. Adding sound to common stairs leads to spontaneous exploration and fun in music creation. Although this installation did not have a traditional flat screen as the main interface, it offered a new interaction style that made use of users' entire bodies. People could use their bodily actions and movement to experience and control the sound making process. The novel interaction style did invite many commuters to get involved when their curiosity was sparked. Even though musical stairs to play sounds are unusual, playing music with a piano keyboard is a common experience. Therefore, most people can easily understand how the new device works when their curiosity is provoked by the sound of the piano.

5.3.2.4 Summary

The above three installations are all examples of rooting the user's exploratory experience in the bodily interaction with media devices. The first experiment, Foundation Edinburgh, enhances users' interaction by reframing physical and perceptual experiences together to create a sense of involvement in Edinburgh's past life. Although the viewing experience is not interactive, the embodied sensation helps engage curiosity. In the case of Touching the Neolithic, learning about the archaeology through a screen with a sense of touch (via 3D replicas) helps connect the perceptual experience of watching simulated virtual images to the physical world.

The final installation, Piano Stairs, which uses familiar experiences to reshape the ordinary walking experience, turned a simple action (walking on the steps) into a fun and creative activity. These projects provide good examples of engaging embodied curiosity and making people involve themselves in the process of exploration, and they will be used in the next section to contextualise the discussion about observations of museum visitors' interactions with screen-mediated exhibits with regards to the notion of embodied curiosity.

5.3.3 Revisiting the observational data in terms of embodied curiosity

5.3.3.1 Affordances for bodily exploration

Reflecting on curiosity's embodied nature, the first design approach that I will consider is the affordance of the screen-media device and its context for bodily exploration.

In the cases of Robot Ships, as mentioned in chapter 3, many players, including young children and adults, made a variety of tentative gestures to interact with the virtual image at the initial stage of exploration. Some people became more engaged when they discovered that the digital content can be affected by any physical objects. For instance, a boy invented a new style of interacting with Robot Ships by using two black pads to capture a ship (see Figure 5.1: Left). In these cases, young players' also showed many interesting ways to play the game and to engage in their fantasies. For instance, another young boy pretended to be the shark after he saw the shark disappear from the floor-projected pond (see Figure 5.1: Right). These activities[193] developed organically rather than from instruction.

Figure 5.1 Visitors' showed spontaneous interaction styles with the interactives. (Left: a young visitor took two black pads to interact with the digital content on the Robot Ships' tabletop. Right: a boy pretended to be a shark to eat fish at the Camouflage Design virtual pond.)

As mentioned in chapter 3,[194] the information presented on the kiosk screen told players that this virtual pond was only used for watching the result of their camouflage design (i.e., to see whether their designed camouflaged fish can blend into the surroundings to stay safe when the shark appears in the pond). However, people expressed unexpected, interesting and playful actions in their exploration of the pond. This shows that people's imaginative interpretation of the game's context helps them retain a high level of curiosity and interest in the process of learning and exploration.

[193] Other examples of visitors' playful interactions with the Camouflage Design game can be found in section 3.3.3 in chapter 3.
[194] See section 3.2.4 in chapter 3

I thought that these playful interactions were induced and sustained by the ability to be physically immersed in the virtual pond. Since this projected pond was overlaid onto a physical surface, it removed physical constraints and made the place become more surreal, illusory, and somehow delightful. For interested players, this pond could become an imaginary setting for imagination and creative expressions. As the design of the virtual pond allowed more bodily involvement while people watched their fish, the digital image sometimes overlays onto players' skin, which also trigger more exploratory gestures to touch the virtual fish. This physical-virtual hybrid seemed to effectively provoke and sustain the curiosity of many museum visitors. In this case, a floor-projected context that allowed a higher level of physical involvement with the digital content encouraged people to act out their imaginations and retain a sense of play.

Compared with the design of the aforementioned Foundation Edinburgh, they were both viewed from above and had no interactivity. However, the Underwater Camouflage Design game's virtual pond allowed the viewing experience to occur with affordances for bodily involvement with the digital context. In the case of Foundation Edinburgh, the physical design of the device itself may have suppressed or reduced the expression of a viewer's active curiosity through bodily gestures and movement.[195] The large virtual pond projected on the floor made the player experience the rewards from curiosity (i.e., learning a knowledge point about

[195] This is not to say that the film of Foundation Edinburgh is less attractive to the viewer's curiosity than the Camouflage Design game's virtual pond. The design of physicality of the film installation supports its intention to fully engage one in the content in a blacked-out theatre.

camouflage tactic) in a more embodied and immersive sense, though it was not an interactive context. Therefore, this unusual virtual-real hybrid context permitted different ways of physical involvement that elicited young visitors' playful imagination and wonderment. They discovered more possibilities to engage with the content, which helps with knowledge acquisition.

Oftentimes, our curiosity about how technology works is as fleeting as our attention paid to what is on screen. We merely passively look through a screen to satisfy curiosity. This research suggests that screen-mediated contexts that have affordances for bodily exploration benefit the expression of embodied curiosity. Providing space for users to explore the novel context with a high level of bodily involvement can focus their attention and express their spontaneous thoughts in action. This helps self-directed spirit to emerge and transforms the passively aroused curiosity into more active mode.

The design of Camouflage Design game serves as a good example for supporting curiosity's embodied nature to help people form their own meaning and experience while still learning a specific point (i.e., how can fish use colour to hide from the predator). If the task of learning underwater species' survival technique simply works through a traditional computer-based interface, the user can only play the game on the computer to satisfy their cognitive need, which may mirror a similar experience of playing other computer-based games. As the large-sized virtual pond on the floor can allow more bodily expression, any ideas or spontaneous thoughts could be more easily expressed in action. Thus, screen-mediated contexts that reduce physical constraints (or augment the possibility of manipulating reality) could unleash users' interpretations and imaginations in the process of exploration and satisfying curiosity.

5.3.3.2 Making progress in prediction

In the case of the Robot Ships, users' direct interaction with the exhibit content was high. Most people seemed to assume the projected image on the table had interactive properties and tended to take a black pad from the table to contact the virtual moving images directly, showing no hesitation and not spending time observing others prior to action. Also, it was common to see people use their hands or fingers to interact with the projected moving objects when they noticed those moving robot ships can simply be moved with fingers or hands. This exhibit succeeded in inviting museum visitors' interactions when people became attentive to it. However, as mentioned in chapter 3, most people spent a short time with the exhibit and many seemed to ignore the knowledge point. During my observation, there were few discussions related to this exhibit's theme, and people did not spend enough time in watching how robots work together to clean up oil spills in the ocean.

Why did this interaction design with high physical involvement fail to sustain curiosity and engage its viewer for a long time? Since it successfully invited initial interaction, we might expect the exhibit to be interesting in the long term. In the case of the Camouflage Design game, the use of a floor-projected virtual pond also caused its players to physically involve themselves with the digital content. However, it also elicited many players' creative and playful dimensions of curiosity. What can account for this? Compared to the Robot Ships, the Camouflage Design's virtual pond was practically non-interactive. People could not interact with any of the virtual images in the pond, such as the swimming fish or the shark. Their bodies could only have a closer involvement with the virtual pond. One possible explanation for fleeting curiosity in users' interactions with the Robot Ships is rooted in the unclear connection between bodily actions and discoveries.

In the aforementioned Piano Stairs, most subway commuters who encountered it should have had no prior knowledge of what this new installation was for. However, its appearance resembled a giant piano and passers-by could hear the piano sound effects when they stepped onto each of the keyboard-like steps. The idea behind this installation design is easy to grasp, making the experience of walking stairs similar to playing piano. The interactive design triggered people's curiosity through novelty and provided open-ended bodily practices for the curious passers-by to resolve their curiosity independently, and at the same time, they can make new discoveries, make sense of what they encounter and discover performable sound effects. The connection between bodily practices and discoveries is understandable and predictable, which is conductive to make new chains of exploration and discovery.[196] As shown in the video, people's attentive gestures ended the ambiguity of their physical relationship with the Piano Stair so that interested people predicted the outcome and became actively involved in the creation of the sound. In the case of the Robot Ships, its

[196] See also sections 2.3.2 and 2.3.5 for curiosity-provoking methods by generating circles of increased curiosity and resolved curiosity

users did not show delight or deep engagement in their discovery. Although the Robot Ships system provided interactivity that its users could physically interact with, manipulate, and change in an open-ended manner, the intention of the exhibit design was not clearly revealed as people satisfied their curiosity through tentative gestures and experimental movement.

Therefore, while design for engaging curiosity through bodily practices is effective to make people more actively attentive to the digital content, it is also important to let users predict the outcome of their bodily practices and interactions. As Gottlieb, Oudeyer, Lopes, and Baranes (2013) suggest, "making the environment predictable (by minimizing the dispersion of its hidden states) necessarily entails actions that decrease uncertainty about future states." In the case of Touch the Neolithic, the method of navigation adopted physical interaction to attract the viewer's attention and curiosity; however, viewers failed to understand what they needed to do. The designer of Touch the Neolithic Jonathan Knox also reflected that this novel form of interaction (i.e., placing the 3D replica to start the film) should be changed (personal communication, February 01, 2014).[197] Embodied curiosity needs to be sustained though prediction followed by comprehensible results. According to Malone's (1981) view and other cognitive-based theories of curiosity mentioned in chapter 2, curiosity is the motivation to better form our understanding. When viewers act on their curiosity and initiate tentative exploratory acts, understanding how to control the consequences and discovering the meaning behind the design is critical to

[197] See Appendix C: Email correspondences with Jonathan Knox

properly satisfy curiosity and encourage continuous exploration. Embodied curiosity is rooted in bodily experience and the ways of interacting with the world, but it is not separate from our cognitive need to eliminate information gaps and better understand our world.

5.3.3.3 Metaphors of the body-screen relationship

Another design approach for supporting an active sense of embodied curiosity is to prepare the user's bodily relationship with the screen in a way to evoke people's embodied experience or reference to familiar types of metaphor formed in everyday life. If that is not possible, let a screen object to perform users' intentional actions when the body-screen relationship is unfamiliar to people's everyday experience.

In the case of the Underwater Camouflage Design game, many people's initial actions related to the pond naturally stopped at the blurring edge of the virtual pond. Especially adult players or bystanders tended to hold themselves standing outside the virtual pond, looking down and watching, even when their children were playing within the pond (see Figure 5.2 below). It was also noticeable that some adults lowered their body at the edge of the pond and then pointed to the fish to engage in their children's exploration of the pond. People acted around the virtual pond like it was a real pond.

Figure 5.2 Visitors watching how the camouflaged fish survived standing outside the virtual pond.

As the system makes the body-screen relationship correspond with people's existing embodied experience, this would help make people's exploration of a novel context easier to relate to their familiar experiences in the real world. For instance, in her early screen-mediated installations, contemporary artist Charlotte Davies' Osmose creates an immersive virtual environment in a darkened space that encourage users to adopt a scuba diving stance to engage with the virtual world (i.e., the content) rather than to focus on the physical aspect of the system's interface (Knight & Brown, 2000). Also, the public communication sculpture Hole-in-Space, made by artists Kit Galloway and Sherrie Rabinowitz, also evokes a familiar body-screen relationship from the real world: the interface follows the metaphor of a window which invites people to look through the transparent interface and to engage with the remote view (Müller, Alt, Schmidt, & Michelis, 2010).

In the case of Underwater Camouflage game, although the floor-projected virtual pond is an uncommon type of interface for learning, enabling a user's body to actively perform eases the learning curve when faced with the novel interface and helps people focus on the digital content. Thus, the relationship between the body and the screen interface mirrors people's experience in the real life, which helps people metaphorically project their embodied experiences to create an enhanced sense of being in a pond.

Similarly, the design of Foundation Edinburgh prepares the viewer's body to engage curiosity in ways that help them downplay the novelty of the installation and shift their focus to watching the film. First, the viewer has to look down to watch the story of the city of Edinburgh. This body-screen relationship may help evoke the metaphorical sense of looking down into a hole, which will likely link to the experience of movement. Second, the visual effects in the film also help shape the viewer's perceptual experience in an embodied way, such as adopting the aerial perspective and using clouds moving across the sky to facilitate a transition of different scenes to create a sense of flying over the landscape and moving into a different time and space. Therefore, the viewer's physical and perceptual experience merges to generate an immersive and embodied experience.

The bodily experience of looking down into a hole might help shape the perceptual experience of the viewer of Foundation Edinburgh. They might feel like they are moving into another time and space to explore the unknown – the city's history. This act of looking down (or falling into) a hole in face has been metaphorically used in many creative works to evoke a sense of venturing into unknown territory. The rabbit hole in *Alice in Wonderland*, which takes Alice into another surreal world, is an example. Similarly, the aforementioned floor-projected pond that makes the body-screen relationship mirror familiar embodied experience helps a curious viewer become more immersed in the content, rather than focus on the technological novelty or wonder how the system works. Thus, the familiar physical relationship between the body and the screen interface helps people translate their embodied experience and engage curiosity with the digital content in a more concrete form.

In the initial survey of the observational results, I raised the questioned about the museum visitors' low interaction rate with the Earth Sphere.[198] Most visitors just passed by or gave it a very brief look. Some were motivated to approach and touch the surface of the display, but they usually lost interest after contact. In an instance of a group watching the Earth Sphere, both young and adult visitors touched the surface immediately after noticing the display. However, when they found no interactivity afforded by it, one adult raised her head to look into the ceiling. The adult seemed to be curious about how this display was constructed, rather than in the moving images on the spherical screen (see Figure 5.3 below). Similar exploratory actions were found in four other visitors during my observation. The physical aspect of the device itself demands attention.

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[198] See section 3.3.1 in chapter 3

Figure 5.3 A group of two visitors noticed the Earth Sphere when they passed by. The young boy directly walked toward it and touched the surface, and the accompanying adult followed and made contact as well. However, they quickly disengaged. The boy turned away to look at other exhibits; the adult raised up her head and to see where the video projectors are.

Reflecting upon visitor's interactions with the Earth Sphere, visitors' curiosity might be triggered by the novelty of its large spherical display technology, but they are unable to act further in this non-interactive exhibit. The aforementioned Johnson's (1987) view on modal verbs reminds us that our root sense of the linguistic expression *can* is formed in our forceful experience of being able to act in some ways. In a walk-up-and-use context, visitors usually have to walk toward the exhibit of interest. The physical aspect of a screen-mediated object appears more important than that of a traditional computer. For the curious visitor, the unusual spherical display may not be viewed as a poster, a window, a frame, a glass or something similar,[199] which invites its viewer to look through it and to notice what lies beyond. The relationship between the viewer and this large spherical display may make people think they are encountering an unfamiliar object, rather than seeing the Earth Sphere as a window to look through. As mentioned previously, the frontal-back

[199] For details on some prevailing metaphors for public displays, such as windows, posters, mirrors and overlays, see Müller, Alt, F., Schmidt, A., & Michelis, D. (2010). Requirements and design space for interactive public displays. In P*roceedings of the 18th annual ACM international conference on Multimedia*, (pp. 1285-1294). Retrieved from http://www.joergmueller.info/publications.html

schemas enable us to see the frontal-oriented object with more approachable expectation. Thus, a frontal-oriented screen object of curiosity should be expected to be more accessible or to be able to perform actions if it is dissimilar to a window, only seeking to provide a view elsewhere.

However, the design of Earth Sphere assigns a physically passive role to the visitor for them to learn earth-related concepts, which forces an active curiosity-driven exploratory process into the mind. The novelty of the screen’s physicality becomes a barrier when a visitor’s embodied experience for forward-oriented actions and sense of enablement is inhibited. There is an abrupt loss of the sense of control to grasp the novel situation. In Perry’s (2012) study of museum visitors’ experiences, she also noted that attracting curiosity through the use of sensory effects sometimes can backfire and cause visitors to focus on the technology rather than the content of the exhibit. Therefore, this exhibit violates people’s expectations for familiar ways of exploring frontal-oriented objects. Consequently, the Earth Sphere cannot effectively sustain active curiosity. Users also might cease to feel the pleasure resulting from satisfying curiosity through tangible interactions or bodily means.

From above, the type of metaphors that the body-screen relationship evokes is important to naturally engage and support active curiosity. This thesis suggests that the methods to engage curiosity through bodily practices with screen media are rooted in metaphors of the physical body-screen relationship. If the viewing encourages direct bodily or visceral experience that relates to the user’s existing embodied knowledge and experience, the viewer might not expect the frontal-oriented object to be accessible or touchable. Therefore, user experience design should facilitate embodied involvement that engages attention naturally to provide new information through screens easily and continuously. Alternatively, if the design creates a new form of interaction (i.e., the screen-body relation is new and cannot exploit the viewer's schemata), accessibility through the bodily practice in the process of exploration should be important for a user to initiate actions and get a feeling of control and a sense of being able to explore further.

5.4 Conclusion

We are curious and embodied beings. As shown by the embodied theories and Piaget's theory of cognitive development, we understand that our habitual schemata are accumulated largely from everyday bodily interaction with the world around us since early childhood. Those early physical and sensorial activities driven by curiosity not only reduce uncertainty and create pleasurable experiences, but also have important roles in developing very basic habitual schemata for organising and structuring the way to understand the world we encounter.

As technological situations have a wider range of interaction possibilities to incorporate the screen and to enable different bodily practices to interact with people and things around us in everyday contexts, design strategies for cultivating curiosity should not ignore the role of the body and the embodied metaphors in our information seeking and meaning making process. More importantly, design approaches should also consider any effect that the recurring patterns of bodily interaction with the screen could have on the process of making sense of our experience.

As embodied beings, we are naturally primed to explore and engage with the world through our hands, our five senses, and our body together with the mind. Embodied interaction experiences are conductive to exploration are decisive factors in engaging and resolving curiosity. In the abovementioned case of Earth Sphere, visitors who have initial interest in viewing the Earth Sphere exhibit tended to touch it, and some scratches on its surface also evidence this tendency.[200] However, this display is for viewing only. Many of those who touched the screen surface lost curiosity dramatically when they became aware that no interactivity is afforded by it.[201] While the direct physical interactivity of a digital device is not the only defining factor for sustaining curiosity, the touch screen may facilitate or support our sense of being able to act and explore further. As mentioned previously, we develop a sense of possessing autonomy and the schemata of the will (e.g., a sense of *can*, *may*, or *must*) from our forceful experiences in relation to our mental intention. Our active sense of curiosity should be supported by performable interaction as it is experienced within the world from birth. However, when digital media designers acquire an understanding of curiosity from early psychological literature, many of them

[200] See Figure 3.1: Right
[201] See the observational study of visitors' exploratory behaviour with the Earth Sphere exhibit in chapter 3.

overlook the role of the body and its relationship to the screen in developing a curiosity-driven experience.

In essence, design ideas for provoking curiosity should not only focus on crafting curiosity in the digital content on a screen to provoke one's passive curiosity, it is also important to allow the screen-mediated context to afford bodily exploratory behaviour and consider the type of metaphors that the body-screen relationship would elicit. Today, more and more people are concerned that the persuasive use of digital technology increasingly separates the interaction with our immediate surrounding world. Embodied curiosity is at risk. Design principles and guidelines for provoking curiosity in a screen-mediated context should recognise bodily experience as a basic but important means to engage curiosity, looking for ways of transmitting the essentialness of embodied experience with or through the digital screen and connecting screen interactions to the world around the user.

Chapter 6: Playfulness and Curiosity

6.1 Introduction

When observing museum visitors using screen-based exhibits, playfulness emerges as a common exploratory behavioural pattern. As concluded in chapter 3, the ability of the exhibit to elicit playfulness is one of the most significant factors that contribute to the emergence of curiosity in exploration.

Many visitors who spent a long time interacting with exhibits often displayed fun and playful behaviour. Spontaneous fun activities were observed both in young children and adults. For example, the several vignettes of visitors' play at the Underwater Camouflage Design game's virtual pond described in chapter 3 show that children often pretend to be someone or something else, by moving like a fish, or becoming a scuba diver or a shark catcher. In the observation of children using Making Faces, children often laughed when seeing the faces changed in humorous combinations.[202] Adults also showed play-like gestures (i.e., improvised gestures) and behaviour when they serendipitously discovered a new interactive style with the virtual content by using hands and fingers on the Robot Ships tabletop game.[203]

Moreover, honeypot effect, which was identified as a strong motivator for grabbing visitors' curiosity and interest in the early stages of exploration,[204] also proves that

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[202] See vignette 1 in section 3.3.3.3 Playful affordance, for instance.
[203] See section 3.3.3.3 Playful affordance for details
[204] See chapters 3 and 4 for details on the honeypot effect

the playful experience of one user is an important motivator for others to join in. As mentioned in chapter 3, people are easily affected by honeypot effect because the gathering of crowds indicates a possible positive reward for interacting with the honeypot site as current users appear being delighted. The playfulness of a few makes the museum exhibit (i.e., the honeypot site) more appealing, and thus invites the curiosity of more people. I believe that many street performers understand this. They often deliberately ask the crowd to clap their hands at the beginning of their show. The clapping of hands would not only make the crowd become more involved and cheered up, but it also augments the positive atmosphere of the performance, which attracts more passers-by. In the context of a museum setting, people's playful activities and imaginative gestures cue other co-present visitors to evaluate their potential interest in the exhibit[205] that would be received from joining in on an interactive exhibit, which helps turn this exhibit into a honeypot site.

Therefore, it seems obvious that a sense of playfulness is fundamental to our curiosity-driven exploration and activities. Playfulness and curiosity, especially for children's education and exploration, seem to be inseparable from each other. Based upon these observational findings, I believe that the concept of play should be one of the most important design considerations for sustaining one's active curiosity. Although there is a growing interest in the concept of play in recent digital media research, it is mostly focused on its importance to the user's experience in general,

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[205] See also the curiosity-provoking approach by adding an interesting scent in section 2.2.5 in chapter 2

rather than its role in a curiosity-driven context. Therefore, in this chapter I shall elaborate how the concept of play can contribute to nurturing curiosity in users' experiences.

To begin the discussion, I will review the related research on the concept of play and will examine its key characteristics, looking specifically at its relationship to human curiosity. Then, I will use two digital media applications to show how a user's inquisitiveness and curiosity could be enhanced through a sense of playfulness. Finally, I will return to the observational studies to discuss their implications on design approaches for enhancing curiosity and play in the interaction experience. Together, this chapter will emphasise that the role of play is a particularly important ingredient for fostering our active curiosity and exploration.

6.2 Relationship between play and curiosity

6.2.1 Defining play

At first glance, play and curiosity seem like two highly-related concepts since they both are known for being defining qualities of our early childhood (thus, they both are known for their diminishing status as we move into adulthood). When a child is curious, his or her expressive forms of exploratory behaviour are often described as playful. In this thesis, I also take playful interaction as behavioural evidence of curious. When a child is playing, curiosity might be the major underlying cause to explain his or her playful behaviour (e.g., Cecil et al, 1985). Why does exploratory behaviour for resolving curiosity often involve playfulness to some degree or another? Before looking at the relationship of play to curiosity, it is helpful to first identify what play is.

The *Oxford Dictionary* defines play as “Engage in activity for enjoyment and recreation rather than a serious or practical purpose” (Play, n.d.). This definition is widely adopted today. In a common-sense view, the act of play involves an individual’s self-motivated behaviour for enjoyment. It has sometimes been deemed as inefficient, superfluous, unproductive, purposeless, or merely frivolous (i.e., lack of seriousness) as it is often used as a contrast to the concept of work. As German poet Friedrich Schiller asserted, play is “the aimless expenditure of exuberant energy” (as quoted in Mellou, 1994). As a consequence, adding playfulness to the digital media design context for the purpose of efficiency, functionality, and optimisation could be viewed as counterproductive.

However, a growing number of researchers of play in the field of design, such as Gaver (2001, 2002) and Blythe and Wright (2004), take a stance against the view that play as an impediment to efficient user experience. In fact, many studies from other disciplines have developed some theoretical accounts to broaden our understanding of the value of play. According to Mellou’s (1994) extensive review of classical play theories (dated back to the 19^{th} and early 20^{th} centuries, as I shall discuss shortly) and modern theories of play (developed after 1920), play has been increasingly identified as something that has value and helps in many aspects of children’s and adults’ daily lives.

For instance, the previously cited educational psychologist Jerome Bruner's (1983) study of children's physical and cognitive development suggests that play is an important means of improving symbolic behaviour and language skills in children. In addition, researchers concluded that play enhances independence since it provides a self-directed context in which people can act independently. Another important benefit of play is its contribution to the development of creativity and problem-solving. As Martin (2013) argued, childhood play makes adults more creative (pp. 89-102). Through the use of imagination and combinations of behaviours in play, more possibilities open (Lester & Russell, 2008). On a social level, playful activities with structured rules enable people to understand social relationships and self-regulation (Tomlin, n.d.). In short, these contemporary perspectives on play expand the common-sense view, which understand play merely as an unproductive activity. Play could be more useful and fundamental to our lives than the common-sense view presupposes (Lester & Russell, 2008).

However, it is difficult to define what behaviour is play or non-play. At first glance, it seems easy to identify non-literal, ludic, loose, or imaginative behaviours as play. However, as sociologist Giddens (1979) asserts, "play does not as a concept refer merely to a specific set of behavioural forms" (p. 390). In *The Genesis of Animal Play*, the evolutionary biologist Gordon Burghardt (2005) provided a set of five criteria to define an activity as play, including:

> (1) incompletely functional in the context expressed; (2) voluntary, pleasurable, or self-rewarding; (3) different structurally or temporally from related serious behavior

> systems; (4) expressed repeatedly during at least some part of an animal's life span; and (5) initiated in relatively benign situations (p. 382).

Burghardt's criteria helps identify the behavioural patterns of play, but other ways to define the characteristics of play can be inferred from researchers' description of play. Since the notion of play has also been conceptualised by many researchers and scholars across many disciplines over the past few decades, some widely held definition of play can be found. Below are a few oft-cited texts in academic literature that show different perspectives on the definition of play.

1. In his book *The Principles of Psychology* (1872), the English evolutionary psychologist and sociologist Herbert Spencer considered play from a biological perspective and believed that play is a form of the release of surplus energy of the species. In Spencer's view, play constitutes "Activities that are carried on for the sake of the immediate gratifications derived, without reference to ulterior benefits" (p. 632, as quoted in Giddens, 1964).

2. Given its essentially unproductive (or non-serious) nature, in his *Man, Play and Games* (1961), the French sociologist Roger Caillois analysed play from a utilitarian point of view as frivolous or wasteful activities, adding that "it creates no wealth or goods" (as quoted in Giddens, 1964).

3. The Dutch historian Johan Huizinga placed more emphasis on play's social functions and regarded play as a primary formative element in human culture. In his book *Homo Ludens*, Huizinga (1938) defined play as follows:

> Summing up the formal characteristic of play, we might call it a free activity standing quite consciously outside "ordinary" life as being 'not serious' but at the same time absorbing the player intensely and utterly. It is an activity connected with no material interest, and no profit can be gained by it. It proceeds within its own proper boundaries of time and space according to fixed rules and in an orderly manner. It promotes the formation of social groupings that tend to surround themselves with secrecy and to stress the difference from the common world by disguise or other means.

4. In his book *Mind in Society* (1978), the Russian developmental psychologist Lev Vygotsky wrote extensively about the role of play in children's learning experiences, stating that "play creates a zone of proximal development for the child. In play, a child is always above his average age, above his daily behaviour; in play, it is as though he were a head taller than himself" (p. 102, as quoted in Bartlett, 2011).

Assembling the above often-cited texts found in the play-related studies, several defining characteristics are derived as follows:

Play is

- an intrinsically motivated activity;

- enjoyable;
- a self-contained experience;
- self-regulated;
- separated from reality;
- not goal-oriented;
- an exaggerated form of activity; and
- a form of social behaviour.

As we can see, play takes various forms, such as improvisation, imitation, games, competition, or even dangerous sport. The above-mentioned conceptual components can be found in all of these activities. The more present the above-mentioned characteristics are present in exploration, the more clearly the behaviour would be viewed as play. In other words, the concept of play is not merely characterised by any specific overt form of the behaviour. Instead, it is associated with the above-mentioned characteristics in matters of degree. To properly design for curiosity through play, the above-mentioned characteristics should be inherent in the design.

6.2.2 Play and curiosity

6.2.2.1 Evolutionary perspectives

From the above, play seems to have some conceptual elements that overlap with the concept of curiosity as both notions have some common features, such as the reward that results from the expression of free will, generating emotional pleasure, and being a significant behaviour characteristic of the lives of childhood. Thus, it is difficult to distinguish acts of play from those of curiosity. To make the relationship between curiosity and play conceptually clear, Burghardt provides a useful analysis from a biological and evolutionary standpoint to show distinguishing characteristics of specific curiosity exploratory behaviour and play. According to Burghardt (2005), curiosity that keeps one's attention deliberately focused and encourages stereotypical behaviour is usually motivated in a novel context; in contrast, play that shows casual attention and has variable behaviour forms is developed in a familiar environment. In other words, curiosity and the specific exploratory behaviour it elicits are often expressed before play when people approach unfamiliar situations, while play emerges when individuals become relatively familiar with the curiosity stimuli.

As curiosity and play are both essential qualities of our early childhood experience, they have been both recognised as defining characteristics of human beings' neotenous traits. As mentioned in chapter 4, neoteny is the retention of juvenile characteristics into adulthood. Human beings' neotenous traits have been regarded by some evolutionary and developmental biologists as one of the major causes of human evolution. In his book *Last Ape Standing: The Seven-Million-Year Story of How and Why We Survived*, the author Chip Walter (2013) posited that our neotenous traits contributed to the survival of the human species. Playfulness, as one of the retained neotenous traits in human beings, also indicates that this early childhood characteristic was vital to our evolutionary development.

From an evolutionary viewpoint, curiosity and play both have adaptive values. The naturalist Diane Ackerman (2003), for instance, asserted that "We may think of play as optional, a casual activity. But play is fundamental to evolution. Without play, humans and many other animals would perish" (para. 2). Also, Wojciech Pisula (2009), who studied curiosity and information seeking in non-human animals and human behaviour, concluded that "curiosity, play, and intelligence together form an inseparable triad in the evolution of vertebrates" (p. 13). Robot Ragen also pointed out the important role of play in our encounters with curiosities, stating that "In a world continuously presenting unique challenges and ambiguity, play prepares [us] for an evolving planet" (as quoted in Terr, 2000, p. 40). In short, many researchers recognise play's adaptive significance in human evolution and development as it helps resist rigid adaptation through variable behaviour and activities.

6.2.2.2 Classical theories of play

To be more specific, how play enhances our curiosity can be explored using several early theories of play, which developed in the 19th and early 20th centuries. These classical theories of play include surplus energy theory, relaxation theory, preparation theory, and the recapitulation theory. They provide more comprehensive explanations about the role that playful behaviour plays in the species' development and survival. Below is a brief summary of each of these traditional theories of play.[206]

[206] See Mellou, 1994; Giddens, 1964; Verenikina, Harris, and Lysaght, 2003, Olivia, and Spodek, 2003, for more details on the development of play theory.

- Surplus energy theory

  This theory, proposed by Friedrich Schiller and Herbert Spencer, explains why people and animals actively play from an energy regulation perspective. According to the surplus energy theory, play is a superfluous activity. The organism has the need to release excess energy that is leftover after satisfying their needs in carrying out daily activities. However, the surplus energy theory can only explain the physical play of children, but cannot be applied to other forms of play. More importantly, this view is not able to explain why people want to play even when they feel tired (Verenikina, Harris, & Lysaght, 2003).

- Relaxation theory

  While similar to surplus energy theory, which explains the need for play in term of biological functioning, the relaxation theory tries to explain, from an opposite viewpoint, why people with little energy still play. Lazarus (1883) and Patrick (1916) regarded play as a recreational activity that is activated to restore lost energy and keeps us from burn-out. According to this theory, play can help the body recuperate from a stressful environment that may be relatively unfamiliar. However, the benefits of play in cognitive, emotional, and social development are still under consideration.

- Preparation theory

  Preparation theory is based on the view that play is an instinctual behaviour, which is an inherent tendency to engage the species in activities that help develop skills and capacities for functioning in adulthood. In his books *The Play of Animal* (1898) and *The Play of Man* (1901), Karl Groos regarded play as a way of assuring that children will play out the roles and practice the skills they would be expected to know as adults. With play, young animals and humans can, to use Groos' word, "pretune" their basic instinctiual behaviour for individual survival and social adaptation. Pretend play provides a way for children to imitate adult life and survival skills. In other words, the function of play within this theory is linked to learning for the future and suggests that the value of play is not limited to childhood.

- Recapitulation theory

  G. Stanley Hall (1920), one of the key proponents of the recapitulation theory, considered play as the result of biological inheritance. According to recapitulation theory, children re-enact the developmental stages of human beings in their play and recreational activities. Thus, some forms of play and game-like behaviour, such as hunting, shooting, chasing, and throwing, are seen worldwide.

- Cathartic theory

  This view focuses on play as a way to express distressing emotions or restrained feelings in a manner that is less harmful or more socially

> acceptable. For example, children who receive punishment may create a role-play situation to express anger (e.g., to spank a doll) to release frustration and reduce negative feelings to regain a sense of control. This cathartic effect has bolstered the argument for studying contemporary psychoanalytic theories that assert play is an outlet for negative feelings and frustration.[207] In short, play supports emotional equilibrium.

These early theories of play not only show the importance of play in the species' evolutionary process, but also they have been used as a foundation to develop contemporary theories in their relevant field of studies. Although these traditional explanations of play now appear less important in the field of play studies, they provide some insight into why moment of curiosity often co-exists with playful activity, physically, emotionally, and socially.

6.2.3 Conclusion

Curiosity, as mentioned in chapter 2, can be explained as a disequilibrated level of arousal that results from being in under (or over) stimulated environment. When the optimal level of arousal drops, we feel bored and need to seek out novel experiences to increase it. Conversely, when the arousal level is too high, we experience anxiety and need to avoid the source of curiosity stimulus to reduce the uncomfortable

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[207] For instance, in her book *Beyond Love and Work: Why Adults Need to Play*, psychoanalyst Leonore Terr (2000) stated that "a person's play is an opening to that person's being" (p. 21).

feelings of aversion. Play, from the perspectives of the energy-based theories (i.e., surplus energy theory and relaxation theory), helps generate the adaptive status of the mind and body through the regulation of energy. If we accept the surplus energy theory that the function of play is to consume the leftover energy, curiosity that results from a lack of arousal motivates individuals to explore and interact with their immediate environment which can provide more opportunity for exercising playful activities.

In the relaxation theory, as mentioned above, play is viewed as a recreational activity that serves to increase energy and reduce stress or anxiety resulting from the unfamiliarity. In other words, a sense of play should help invigorate a curious individual with new energy and positive emotions to cope with the unfamiliar. The influence of positive emotions can also further fuel idea generation and creativity, which in turn promotes the discovery of novel actions and ideas (Fredrickson, 2004).

As mentioned in chapter 1, my concern about using technology to encourage curiosity is partially rooted in the tendency for people to have screen fatigue, which results from over-stimulation. This makes people disinterested in further exploration. As mentioned previously, play relieves stress and engages our curiosity with fewer burdens. I consider curiosity with playfulness to be an important approach that can serve as an effective antidote to our screen fatigue syndrome, making our state of mind for self-directed exploration and discovery more open with fewer burdens.

Other theories of play, such as preparation theory, recapitulation theory, and cathartic theory, specifically refer to the functions of the imaginary forms of play. For instance, in pretend play and gaming, an individual can build up his or her own time and space (or rules) to be outside of reality and have a sense of control. When being curious about an unknown stimulus, a sense of play can transform the ordinary and the routine, thus it would excite more interest in the same source of curiosity stimulus, which in turn gives curiosity more opportunities to flourish. As interaction design researcher Bill Gaver (2002) described, “Playing involves pursuing one’s inner narratives in safe situations, through projective interpretation and action” (p. 13). From this perspective, engaging one’s curiosity with a sense of play creates an opportunity for him or her to resolve curiosity more freely and safely within his or her inner narratives or interpretations.

As I have just indicated, playful behaviour regulates the energy and the need for emotional balance; and more importantly, play allows innovative ideas and thoughts to emerge more freely within its own temporal and spatial framework during the course of exploration. Hutt used two types of curiosity questions that a child might ask to distinguish the difference between exploration and play: “What does this object do?” in the case of exploration, and “What can I do with this object?” in the case of play (1970, as quoted in Rennie & McClafferty, 1997). Using these two types of questions, Cecil et al. (1985) further suggested that, unlike exploration, play is about forming and creating possibilities.[208] Therefore, play, from this perspective, is an important means to open up more possibilities in the exploration of unknown situations. As Bruner (1983) described, play is “a superb medium for exploration” (p. 61). To create a zone of curiosity, adding a sense of play should help indulge an inquisitive mind in a more self-regulated, free-spirited state. In other words, a sense of play could provide a context for a curious mind to develop flexibly and safely with less fear of failure but more positive emotions. In essence, this will help lead to an active sense for self-directed exploration, improvisation, creativity, imagination, and transcendence.

6.3 Developing curiosity through playful design

As already discussed, the user’s experience during exploration can be enhanced by adding a sense of playfulness to further pique curiosity. However, few designers’ practices for curiosity and exploration involve using play.[209] There are a number of factors that may account for this ignorance.

In many cases, play is not a necessary element in the curiosity process. Letting people find an answer to satisfy their curiosity in a more structured way is often times important because curiosity is fleeting in nature. Providing structured or simple straightforward ways to satisfy curiosity is thus helpful to reduce problems inherent

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[208] Cecil et al. (1985) identified the relationship among curiosity, exploration, play, and creative, stating that “Curiosity is then the arousal state which leads to exploration, play and creativity” (p. 202).
[209] See chapter 2 for current design practices for provoking and sustaining curiosity.

in design by the novelty effect.[210] In other cases, designers that create curiosity with games to make the experience enjoyable do not understand the relationship between curiosity and fun. Turning an exploratory process into a game may be fun for those who wish to resolve their curiosity and gain a sense of accomplishment; however, for those who simply wish to find an answer, users might only try to reach the game's predefined outcome in order to resolve their curiosity. Therefore, when information gaps close, the motivation for further exploration ends. Consequently, this might limit users' other forms of play or constrain their expressions of curiosity.

Creating a zone of curiosity with play is not limited to games. Playful moods can transform everything into a game. The content needs to carefully involve previously identified elements (i.e., enjoyable, self-contained, self-regulated, exaggerated forms of experience, etc.)[211] to allow the playful spirit to emerge in the moment of one's curiosity exploratory process, while at the same time, not allowing curiosity with play go too far. A programme that makes users daydream without any understanding or learning is not successful either.

To emphasise the importance of adding playfulness to a curiosity-driven experience, I chose two mobile applications to exemplify how playful elements can encourage curiosity and exploration while still contributing to the user experience. Then, I will re-explore my observational studies, looking for what design elements necessitate

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[210] Müller et al. (2010) suggest that adding incompleteness increases users' motivation upon original interaction, but they also emphasise the importance of making the interaction to resolve curiosity specifically clear during the interaction process.
[211] See section 6.2.1

our playful nature in the museum visitors' curiosity-driven exploratory process. This chapter will reach a conclusion about the design suggestions for designing for curiosity and playfulness.

6.3.1 Design examples

6.3.1.1 Museum Explorer

Museum Explorer[212] is a mobile application, designed to encourage returning visitors with smartphones to experience the National Museum of Scotland in a different and playful way. The mobile application challenges visitors to find nine different objects from museum collections and displays, each of which is categorised by its most extreme feature, such as the fiercest, oldest, smelliest, ugliest, fairest, strongest, tallest, and bloodiest. The application first asks the user a challenging question to trigger curiosity: "What object you can find?" If visitors are interested in the fiercest object in the museum, they can hunt for it based on their own knowledge (i.e., their previous visiting experience) or follow clues to track down the object.[213] Once the fiercest object has been found in the real exhibition space, the visitor can enter the four-digit code displayed next to the object to reveal a colourful digital badge on the mobile screen. The user can also choose to read more details about the object or share photos of their discovery with friends on social media. As the objects are located across thirty-six galleries within the museum, people who want to maximise

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[212] The application is developed by Kotikan, Pocket Proof Ltd and staff at National Museums Scotland, formally launched in October 2012 for the Apple iOS platform. For more detail, see https://itunes.apple.com/us/app/museum-explorer/id567782350?ls=1&mt=8
[213] There are three clues that can be revealed one by one.

the fun of treasure hunting would be led to visit various locations in the museum to find the codes to unlock and collect all of the digital badges.

Since the application launched in October 2012, there has been over two-thousand downloads of this mobile application with positive feedback. Hugh Wallace (2013), Head of Digital Media at National Museums Scotland, reported that the application has achieved a high level of engagement. Many visitors complete all nine challenges and many digital badges have been collected. However, the stats show photo-taking and sharing discoveries on social networks is not significant. According to the reviews of this application, users' mobile experiences are fun and improves their learning performance. Users' reviews said, "Very fun app, made my trip to the museum much more interesting," "Great app and a fun way to spend a few hours exploring the museum looking for them," and "...the 7 objects we could find were great fun searching and children learnt more about them" (Museum Explorer, n.d.).[214] In this user experience design, a few objects are located in the seemingly hidden corners of the museum, which makes players leave the beaten path to visit some areas that might be previously overlooked. This alternative journey to explore the museum space will hopefully provide a more playful experience to visitor. The new, enjoyable, and somewhat surprising visiting experience proves that design practice by curiosity and play is a means of enhancing visitors' relationships with the museum.

[214] See customer reviews from Apple iTunes website at https://itunes.apple.com/gb/app/museum-explorer/id567782350?mt=8

This mobile application remodels visitors' relationships with the museum by offering a chance for visitors to experience the museum in a different and playful way. The design strategy of this museum navigation application is different from typical museum digital self-guided applications. In many cases of museum application design, visitors are provided with additional audio and visual information of the object on display. For example, MoMA App[215] and American Museum of Natural History Explorer are designed for individuals to plot their own route through the museum or offer them pre-planned tours to guide their visit. Museum Explorer breaks this tradition, using both curiosity and playful design, to reframe the museum space for hunting, exploring, challenging, and learning about extreme objects in particular categories of a museum collection.

Museum Explorer does not present the user with over 8,000 items from the museum's collection, rather it only selects nine objects on display, each having an odd or extreme feature. The questions for selected objects (e.g., "Can you find the fiercest object in the museum?") highlight information gaps in people's existing visiting experience, through which frequent visitors can explore this familiar place refreshed and reinvigorated. In addition, digital badges that are earned for completing object hunts also give an enhanced sense of completion from reaching goals. With game-like rules for collecting merit-style explorer badges, the mind-set of a curious visitor is similar to a game player. Moreover, as the badges are earned as milestones in the exploration process, they help make transform the visiting experience into a

[215] Check MoMA website for MoMA App from http://www.moma.org/explore/mobile/iphoneapp

challenging quest. The introduction of a game-like exploration into the museum visiting experience makes visitors' engagement with collections have an added degree of fun and adventure. The lightweight competitive gaming experience increases the possibility of discovering new paths within a familiar museum setting for returning visitors.

In essence, this mobile application brings a digital dimension into exploring the museum, and it adds playful elements to the visiting experience, encouraging returning visitors to navigate the familiar space in a new way. In other words, this application offers the chance for visitors to expand the scope of their curiosity (i.e., adding interest in different categories of collections) through a game-like experience. Since the process of learning is triggered by a game-like situation, the experience is more likely to be sustained by self-directed mind sets that enhance learning performance and strength curiosity. This design strategy is valuable, especially for returning visitors, to find alternative ways of exploration within the museum. It also attracts people who want to have fun experiences through challenging the existing knowledge about the collections and display items in the museum.

6.3.1.2 Foursquare

Foursquare is one of the most popular mobile applications providing a personalised location discovery service. Unlike traditional location-based applications that are used for finding destinations in an optimised and efficient way,[216] Foursquare is

[216] For example, Google Maps can direct the user to the nearest coffee shop. It is designed for navigation as efficiently as possible.

designed for exploration through automatic recommendations for possible actions. In other words, it is an application used for novelty seeking and exploration in the surrounding environment. When logging into Foursquare for the first time, users can see most popular searches for places nearest to their location (e.g., restaurants, shop, etc.), and they are asked to tap on stimuli that they like (which are called *tastes* in Foursqure). Then, based on the user's *tastes*, Foursquare would automatically generates alerts indicating activities nearby.[217] In addition, the application encourages the user to rate and leave tips (i.e., short reviews) of places they have recently been for others, which may attract other Foursquare users to certain locations (or repel users from undesirable locations).

Currently, Foursquare has accumulated billions of check-ins by users globally. According to user reviews on Twitter, Foursquare is engaging because it is able to add fun into one's exploration of space. This application inspires its users to explore places in a more situational and serendipitous manner, while the service increases the potential for discovering something new in a given location that is relevant to the user's tastes (i.e., prior knowledge and experience). Since it provides users choices between potential interests and various reviews, it can be seen as a playful tool for people to interact with surrounding places in alternate ways. As Foursquare is designed for engaging in new and fun experiences while on the go, these user-

[217] Foursquare will access the user's location even when he or she is not using the app.

generated contents have implications for the study of interaction design for creating and fostering people's active curiosity.

As discussed in chapter 2, curiosity is the desire for new experiences. From this perspective, the way this application is designed also fits into the idea of provoking curiosity for new experiences, which might be necessary for one in an explorative mood for more in a given location. The playful aspects of Foursquare's interaction design is unlike the aforementioned Museum Explorer, which is more explicitly gamified, turning the museum visit into a game-like experience (i.e., using a game-like mechanism to engage curiosity towards a hidden object in the museum). Foursquare is designed to engage exploration through creating more opportunities to discover places in many different ways. In fact, Foursquare's previous versions had more gamification elements, such as points, badges, and leaderboards, to award users' participation and make exploration of the environment more fun and enjoyable. The latest design removed the gaming mechanisms, but it continues to keep the experience playful. In my view, the success of this design could be rooted in its capability to arouse many users' interest using curiosity stimuli with respect to users' personal preferences.

According to curiosity theories, curiosity is influenced by the state of one's knowledge and we respond best when the information gap is not too narrow or too wide.[218] Foursquare's recommended curiosity stimulus that are based on personal

[218] See chapter 2 for more discussion on the information gap theory of curiosity.

preferences and social interests (i.e., prior knowledge) should better engage people's curiosity and interest, because they are relevant to their prior knowledge and experience. The diversity of recommendations and interests could help maintain an optimal level of curiosity arousal. According to the information gap theory, the size of the curiosity gap (i.e., curiosity stimulus) would be more appropriate and be more likely to produce curiosity if the content is not too unfamiliar. Therefore, when one is in a mood for seeking novelty and stimulation, he or she can use tastes, friends' activities, feedback, and popular search keywords to experience exploration in new ways. This makes the discovery itself playful because the discovery is a less predefined, but with a more situational and spontaneous outcome (with respect to personal preferences and social interest).

As concluded in the above literature review on play, play has a role in developing adaptive abilities and creativity through its capacity to encourage experimentation with one's surrounding environment in new or unaccustomed ways. As mentioned previously, the diversity of behavioural forms and relationships with surrounding environments contribute to developing adaptive benefits in species. The value of this mobile application, therefore, lies in its users' capabilities for adding chances to discover new experiences that hopefully other people will love. With a playful mood, the interaction experience catalyses new exploratory behaviour and relationships with the locations, even though it does not deliberately use a gaming mechanism. By offering personalised options for exploring places, the mobile experience of

Foursquare designs for curiosity in a way that maximises our capacity to engage with the world around us with some degree of playfulness.

6.3.1.3 Summary

Museum Explorer and Foursquare are good examples of applications that engage people's curiosity and exploration through a sense of play. In the case of Museum Explorer, the use of game-like interactive styles (e.g., posing challenging questions and collecting badges) can spark a visitor's curiosity by invoking playful moods while providing no fixed path for the visitor to start and end the game (i.e., people can choose any of nine objects to start the game). In the case of Foursquare, the interactive experience is not designed with any obvious gaming elements, but it still can satisfy the need for new experiences. By providing tastes to expand the user's opportunities, Foursquare creates new forms of exploratory behaviour and catalyses different relationships with the world around.

Both applications lead its user to experience something new by providing alternative paths while leaving room for self-directed users to enjoy and play during their own exploratory process. Thus, curiosity and play both play critical and stimulating roles in engaging users.

6.3.2 Museum observations rethought

6.3.2.1 Developing possibilities

During the observation of young visitors interacting with Making Faces, children's engagement with the kiosk showed enjoyment and fun. As the large overhead screen can simultaneously show what is on the touchscreen kiosk, it is easy to observe what functions or content engage children's curiosity. In the vignette mentioned in chapter 3, the two young girls' smiles and interest appeared manufactured from the main screen of the kiosk, because their time was mostly spent creating various faces and showing them to each other.[219] Oftentimes, the main screen is where people keep grouping up to create fun. The main screen of the kiosk provides its users the ability to select face outlines, eyes, noses, and mouths in order to make combinations of created faces. Producing a face is a simple task, but people tend to make many different and funny combinations. Making Faces allows users' to create faces from dozens of brightly illustrated parts that engage curiosity with a sense of playfulness in an open-ended manner. I witnessed some children who would press the right or left buttons on the screen to swap through a series of noises (or eyes, mouths, and face contours) in order to see all the available options for each facial features. Others would select a mouth, then choose a new nose, then swap the mouth again, making the face in a completely random manner. Engaged users do not show a sequential approach to face production. Swapping between various facial features keeps users' playing with stronger curiosity.

Csikszentmihalyi and Bennett once defined play as "grounded in the concepts of possibility" (as quoted in Terr, 2000, p. 21).[220] In the case of Making Faces, the interactive capability that lets the user look at many possibilities engages the playful

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[219] See the vignette 1 in section 3.3.3.3 Playful affordance
[220] Also quoted in Flanagan, 2009, p. 251

side of curiosity. As concluded in chapter 3, the affordance of interactive exhibits for playfulness is regarded as one of the major factors that can provoke and sustain the unfolding of curiosity. The interactive design of Making Faces is made up of four sections of a face (i.e., face outlines, eyes, noses and mouths), and each facial section has 5-10 options, and each option is odd, whimsical and unusual. Consequently, there are many different facial appearances that can be produced.

Providing multiple options gives users chances to explore what elements constitute a face, but it also allows them to create their favourite face. As one example from chapter 3 illustrates, the boy's interest became more intensified when his grandmother gave him a little challenge to make a specific kind of face.[221] The multiple choices allowed his goal to emerge and also provide the tools required to achieve it. The boy could make a face similar to what his grandmother suggested by changing facial parts until they matched. The design of Making Faces does not impose on its users the need to finish or achieve some predefined goal, but allows their own personalised goal to emerge in the exploratory process.

As seen in this case, the interactive exhibit that permits the development of possibility expands one's curiosity into imagination, rather than just allowing them to see what the kiosk does. Thus, the learning process can be driven by the self-directed spirit for fun and for pleasing curiosity. In short, playfulness is grounded in possibility. Even though the design strategy does not use a gaming mechanism, the

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[221] See vignette 1 in section 3.3.3.1 Social dynamics

open-ended interaction style is similar to the aforementioned mobile applications Museum Explorer and Foursquare that provide alternatives paths for the exploration of new location. Also, reflecting upon the design of Foursquare, it is important to develop opportunities with reference to personal preferences. Curiosity and play should be more effectively sustained through choice and experimentation.

6.3.2.2 Enchanting effects

In the case of the Underwater Camouflage Design game, playful activities were evident throughout the observation. Although this game is not specifically designed for open-ended exploration, it still produces many interesting and playful user interactions.

In the case of this Camouflage Design game design, its message is very simple: the more effectively camouflaged fish survives (i.e., the design of a fish's pattern and colour can blend in with the surroundings appear less visible, so it can hide from the shark).[222] Most players can easily understand the point and design a well-camouflaged pattern to make the fish survive in the pond. The curiosity should cease when one reaches the game's goal. However, the game is engaging to both children and adults. People often played the game more than once (even after achieving the game's predefined goal) and spent time watching fish swimming in the virtual pond. In one instance documented in chapter 3, a young boy even deliberately played this game with an opposite goal (that is to make a fish less camouflaged in order to be

[222] See section 3.2.4 Case 4. Underwater Camouflage game

found by the shark to make the game more fun for other co-present young players).[223] Also, many users' interactions with Underwater Camouflage Design game show various forms of play, including imitation, fantasy, and role-playing.[224] As shown in several instances of user interaction, this gaming context has the capability to elicit its player's inner-narratives for social play.

Many visitors' exhibited play-like interactions with Camouflage Design game. This leaves one question, however: what design elements of this exhibit facilitate playful engagement? Furthermore, as mentioned in Loewenstein's (1994) analysis of the natural characteristics of curiosity, we have a tendency to become disappointed when curiosity is satisfied. How does this game-like learning experience make its player's curiosity endure beyond the completion of the activity?

Unlike Making Faces, where playfulness is grounded in the concept of possibility, the Underwater Camouflage Design game's playful affordance is, I argue, built on its ability to enchant and transform the thoughts and behaviour of players. While this game provides many options for players to design the appearance of a fish, people did not spend time exploring this avenue the kiosk screen. People's curiosity and interest were engaged in the virtual pond lit on the floor. Many playful and imaginative activities were happening around the virtual pond.

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[223] See the vignette 2 in section 3.3.3.3 Playful affordance
[224] See vignettes 2, 3, 4, in section 3.3.3.3 Playful affordance

During the periods of observations, people did not simply want to know whether their fish would survive, they also seemed enchanted by the pond, enjoying the pleasure of watching. Oftentimes, I saw young visitors place their fingers in the virtual pond, making physical contact with the virtual water and fish. Those curious young visitors seemingly wanted to see what would happen when they touched the pond or they wanted to reassess what they saw in this projected pond. Some visitors were aware that there was no interactive capability of the floor-projected pond, but they still jumped onto the floor, acting like they were plunging into water and pretending to get the shark, or stamped on the ground pretending to scare the shark away when the shark-like shadow appeared.[225] In some cases, young children enjoyed swivelling on the ground or slithering on their stomachs like a fish swimming in a pond, and some rolled themselves back and forth while waiting for the shark. These are all distinctive experiential qualities (i.e., physical, emotional responses) elicited by the exhibit. I infer visitors' sense of playfulness resides in the sense of enchantment. The projected virtual context on the physical floor – creating an enchanting effect – is an important source for eliciting people's imaginative interpretations of the game.

The projected moving image transforms our perception of physical reality. It makes the place become more unreal and illusory. The projected light makes the unnoticeable floor become an area for imaginary expression and leaves room for creative expressions. By using projectors, the virtual context seamlessly overlays

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[225] See vignette 4 in section 3.3.3.3 Playful affordance, for instance

over our physical world and creates a layer of magic. I think this magical effect holds the power to transform one's curiosity into imagination and fascination. The magical effect of a projected beaming context plays an important role in bringing out the playful and imaginative side of the exploratory experience and prolongs the player's engagement with the content. I believe that projected contexts without frames of physical boundaries invite exploration with greater senses of immersion and give rise to stronger imagination and playfulness.

As magical and enchanting effects have been studied as a means to suspend disbelief, the digitally projected screen space should play a role in enhancing a visitor's interest and in eliciting playful activities throughout the interaction process. Therefore, I suggest that enchantment contributes to elevated curiosity, imagination, and playfulness. As McCarthy, Wright, Wallace, and Dearden (2006) also describe, "Enchantment engages with paradox and ambiguity, putting 'being' in play in an open world" (p. 373).

In fact, the history of the enchantment in projected technologies can be dated back to the mid-late 17th century, when people first encountered a projected context on the surface of a wall or the ground. The first device to do this was called *the magic lantern*.[226] The name reflects our experience with such technological curiosities. They were characterised by enchantment. Our interactions with projected contexts have a strong association with magical feelings. The British writer Arthur C. Clarke

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[226] Magic lantern is viewed as a precursor to modern projection technologies.

once famously wrote, “Any sufficiently advanced technology is indistinguishable from magic” (as also quoted in Herritt, 2014). The feeling of astonishment and wonderment has always been an important inducer of curiosity and motivator of exploration in technological inventions. With feelings of magic and enchantment, people can retain a higher level of interest in fantasy or unusual situations.

With the rapid development of projection technologies, many projected digital contexts now seem to easily create enchanting moments, such as using augmented reality technology, architectural projection mappings, and 3D holographic projection. These kinds of displays dissolve the boundaries between the real and the virtual, creating surprising and unusual effects on our perceptual and embodied experiences. They facilitate engagement with the imaginary setting. Our curiosity about the inner workings of the technology is suspended, but we transition into a more immersive state in which we can play and interact with an unreal and imaginary world.

According to McCarthy and Wright (2003), enchantment can “evoke both the transformative openness and unfinalisability of experience and the capacious potential of imagination to power holistic engagement by bringing past or future meanings into present action, making the mundane creative” (p. 82). In Underwater Camouflage, young visitors show many interesting ways to engage with the game; their imaginative interpretations of a virtual pond help retain people’s high levels of active curiosity and interest in the learning process. These playful interactions induced by the enchantment of the projected virtual context hold children’s curiosity for fascination and imagination. In other words, the design of the interactive device that has the capability for eliciting enchanting feelings could extend and transform our experience of curiosity and exploration. Being enchanted, our appreciation of the interaction context would grow. This may also progress predefined learning outcomes towards a wider range of understanding, if not transcendence.

6.4 Conclusion

> Curiosity should be allowed to be playful and creative. After all, to address the future, we need a language able to strengthen our "capacity for aspiration."
> — Harro van Lente, 2009

In this chapter, I have shown a close relationship between curiosity and play. Curiosity brings us to experience the new, as a sense of playfulness invigorates us to enjoy the moment of discovery. It is through play that the exploration process is sustained and able to flourish, as play enriches new ways of enjoying processes that continuously stimulate more curiosity.

This chapter argues that adding a sense of playfulness to the designs of curiosity-driven contexts has a number of benefits in sustaining one's curiosity. Firstly, from a biological and evolutionary standpoint, play that generates new forms of behaviour and alternative thought helps expand curiosity-driven exploratory behaviour and resist fixed adaptations. While curiosity makes one's attention more focused in a novel situation, play brings out more varied behavioural forms and ideas as the novel situation becomes more familiar. Moreover, as playfulness brings out pleasurable experiences, it helps curious individuals reduce stress from the unfamiliarity and energises them with new energy. More importantly, playful attitudes may transform one's perception of reality with an imaginary dimension, by which one would develop more possibilities, self-oriented narratives, and interpretations from the same source of curiosity stimuli, and thereby give curiosity more opportunities to flourish.

With these benefits of play, this chapter examined two mobile applications (i.e., Museum Explorer and Foursquare) and re-evaluated the observational findings at the museum to see how a sense of playfulness could be incorporated into designs that support one's exploration of the unknown. Through analysis of mobile applications and the museum visitors' interaction patterns, this thesis suggests that two main design elements are important for sustaining curiosity and exploration with a sense of play: one offering more open-ended opportunity (with respect to individual preferences) to let users create self-directed goals in the exploration, and adding enchanting effects to engage curiosity. These design approaches help users explore the unknown in a less sequential and constrained manner, which benefits and helps our active curiosity become more sustained to do self-directed activities and creative engagement.

As the above discussion attests, designs for curiosity through play allow users to move temporarily away from the predefined direction of the programme and develop their own goals. Concepts, such as opportunity and enchantment, allow users to explore the unknown in a large number of ways that come with a sense of playfulness. As mentioned in chapter 1, curiosity usually wanes when we reach the edge of a novel experience, and play engenders more new ideas and diverse patterns of interaction that help sustain our attention from the same source of stimulus. More importantly, given interaction contexts where playful attitudes are affordable, the unfolding of curiosity would involve more fun, openness, autonomy, imagination for learning, relearning, thinking, rethinking, creating and inventing. With a sense of playfulness, our curiosity would be unleashed for pursuing more than a set of predefined answers. Thus, play is a critical element in the exploration and curiosity. As Gaver (2002) put it, "As we toy with things and ideas, as we chat and daydream, we find new perspectives and new ways to create, new ambitions, relationships, and ideals" (p. 7).

In the previous chapters, I have argued that the most important goal of nurturing curiosity in the user experience is to strength its core value in our life. That is to retain an active sense of curiosity for self-directed exploration and to make people to come closer to their full potential in their environments. The experience we design for curiosity should be characterised by self-directed and free-spirited approaches, bringing us back to the openness of childhood and developing deeper form of human curiosity. As said in chapter 1, in the digital age, we are moving towards a fast curiosity cycle, many answers to our questions are readily available; it is important for us to not to live out others people's stories or to pursue a desired agenda. The design of a digital media experience should help people spark new ideas and find alternative interpretations and perceptions.

While recognising that having a sense of play does not guarantee the discovery of deeper meanings, play can lessen the force of rigid thinking and elevate the mood that help us to transform the reality and relish discoveries – all of which are important in the formation of a pre-required mental status for a wider or deeper exploration. As Harro van Lente's (2009) statement on curiosity, cited in the beginning of this section, the playful side of curiosity should be more encouraged. Thus, this chapter emphasises this important implication on the relationship between curiosity and playfulness in the user experience design.

Conclusion

Summary of the thesis and the main findings of the study

Although many have raised concerns about the negative impacts of digital media on curiosity, this thesis argues that appealing to our sense of active curiosity can help the interactive experience go far beyond simply grabbing attention and help mitigate the problems of screen ubiquity. As curiosity has many benefits, it is an important design resource to improve digital experiences. However, developing ways to unleash curiosity's potential is not easy.

At the beginning of this thesis, I mentioned that enhancing one's curiosity in user experience might, again, aggravate problems resulting from the culture of abundant screens. For instance, people might become isolated in their private cocoons with small screens while in public contexts. The more curious an individual is towards a personal screen, the poorer social relationships he or she might develop with the world around him or her. Also, technology that provides us with extraordinary sources of curiosity and novel stimulations can lead to over-stimulation and distraction. They could hamper our ability to deepen the process of learning and thinking. Provoking the desire for novelty in the digital experience seems to both augment as well as endanger our curiosity in the digital age.

Apart from these paradoxical effects, crafting user experiences for curiosity also faces an inherent problem – curiosity fades quickly when the novelty effect wears off. When we enjoy the experience of discovery, our curiosity, at the same time, ends sharply. We even become bored after repeated interactions with the same source of curiosity stimuli. This would seem to emphasise that concepts, such as novelty, difference, unpredictability, and the like, have been considered an impediment to better usability. As the traditional human interface design evaluates user experience in terms of communicative efficiency and clarity, the benefits of developing curiosity for diverse exploration, experimentation, playfulness, imagination, and personal interpretation are not addressed from a usability perspective, despite the importance of these factors. It is a complex task to find practical guidelines for studying curiosity. The complicated problem of exploiting curiosity to enhance user experience in today's screen-saturated context requires research to work through.

Therefore, in the first chapter, I began to examine the true value of curiosity, exploring its evolutionary purposes, its roles in processing incoming information, and its multifaceted nature in relation to our everyday activities. Based upon a review of literature from a variety of authors, many important values of human curiosity were revealed. First, from the perspective of evolutionary purpose, curiosity helps us cope flexibly with changes in the environment and thrive in a variety of lifestyles. Secondly, based on brain studies, curiosity plays a significant role in directing our attention towards learning and creativity, and also its underlying neural processes help build emotional resilience. And also, its self-directed nature, which provide a sense of intrinsic purpose to exploration, makes discoveries personally rewarding. Through these positive emotional rewards and internal satisfaction, we adapt to change with appropriate resilience. More importantly, this internal motivation contributes to open-ended exploration that helps us speculate more broadly to find answers from a wider point-of-view and take us beyond present needs into wonderment and fascination.

After reflection upon the impact of ubiquitous screen media having created over-stimulation and screen fatigue, it becomes clear that curiosity development should use fewer attention-grabbing tactics and instead look for ways to support human curiosity's true benefits. The true value of human curiosity, as said, is its active mode that helps us find novel perspectives in the familiar, thrive in different circumstances, and develop diverse adaptation. Through interaction with the world around us, through rewards of simple gratification, we are able to broaden knowledge and experience. To develop a sense of curiosity in the digital experience, design practices should help guide self-directed exploration and active engagement, and it should avoid relegating individuals to passive roles in engaging with novelties. As discussed in chapter 2, the general principles for provoking curiosity (e.g., crafting conflict and ambiguous information, placing curiosity objects, and exploiting the honeypot effect) are largely used to exploit attentional strength for engaging passive curiosity. These strategies also overlook curiosity's relation to our process of exploration. This thesis thus emphasises that we are the active subjects of our own learning and exploration. Our need to know and explore is not only compelled by the novel stimuli from an outside world, but it can also originate within us.[227] It is more important to find ways to support and nurture people's active curiosity for self-motivated exploration and

[227] See also sections 1.2.2 and 2.2.5

discovery. With this in mind, this research looks for the ways to keep the momentum ignited by active curiosity and exploration. Therefore, the following chapters were set out as follows:

In chapter 3, through observations of people's actual exploratory behaviour and interactions with a number of screen-mediated interactive exhibits at the museum, this research discovered three conceptual elements that are conducive to nurture one's active curiosity in the exploration process: sociability, embodiment, and playfulness. By looking at the relationship of curiosity to these three issues separately (in chapter 4, 5, 6), this thesis further identifies several practical design approaches and concepts to build a sense of curiosity in the design of user experience.

Based on the findings from the observational studies, chapter 4 highlights the fact that an individual's curiosity and interest is often socially-oriented. Our curious brains, which have a strong tendency to learn from others, play a significant role in acquiring knowledge and enhancing social interaction. With regards to the need of resolving curiosity with bodily practices, chapter 5 develops the concept of embodied curiosity and addresses its implications in users' perception of screen-mediated contexts. Encouraging curiosity through bodily practices should help people become more attentive to the world around them, and should nurture modes of embodiment for cognitive development. In chapter 6, I identify the relationship between play and curiosity, suggesting that adding a sense of playfulness often builds self-directed contexts for curious minds to explore and develop flexibly with little fear of failure.

More importantly, the playful attitudes that contributes to active uses of imagination also nurture the true value of human curiosity. In essence, sociability, embodiment, and playfulness are three important parts of developing human curiosity.

In addition, I have extracted a number of design strategies inferred from the observational studies of the exploratory behaviour and relevant design examples as shown below.

- Crafting co-curiosity

  As discussed in chapter 4, curiosity has a strong social nature that has profound implications for the acquisition of knowledge and the enhancement of social development. Digital platforms that offer space for the exchange of thoughts, feelings, and ideas naturally meet the needs of our social curiosity. An individual's interest in the new might be encouraged and augmented when his or her curiosity is in tune with others' interests. Therefore, the concept of co-curiosity can create social engagement opportunities for intrapersonal participation and group interaction (i.e., people have a sense of curiosity and interest together, as evidenced by the mobile game *Curiosity*). With a sense of co-curiosity, people, even strangers, begin to work together to fill information gaps. Curiosity's social nature helps reduce the negative preconceived attitudes and increases the chance of sharing and communicating in the process.

- Providing both covert and overt curiosity-satisfying strategies

  Understanding curiosity's social nature helps us interpret our peers' behaviour when encountering screen-mediated devices within a public or shared spatial context. Since we care about what other people think about us, curiosity's social nature could be both enhanced and inhibited by the presence of co-present people around the interaction area. Therefore, it is important to design interaction styles and exploration processes that provide opportunity for the user to adopt either covert or overt curiosity-satisfying strategies. By helping users to adopt covert strategies, curiosity resolution would be less daunting for people with social anxiety. By promoting overt strategies to show, display, and share, social people will take delight in presenting their discoveries, this will sustain continual exploration.

- Affording exploration through the bodily practice

  As identified the relationship between curiosity and embodiment in chapter 5, this research suggests that the practice for developing curiosity should consider how users' overall embodied knowledge and bodily experience can be addressed and expressed in screen interactions. The affordance of the screen-media device and its context for bodily exploration is crucial for people to freely express their embodied curiosity. The Camouflage Design game that allows bodily exploratory behaviour serves as a good example of this point since many people have shown playful activities in their exploratory process. However, it is also important to give users the opportunity to predict the outcome of their bodily practices, because a certain level of predictability helps sustain while interacting with the system. In short, designing for curiosity in a way that supports our embodied nature is important to build up a knowledge framework through which we find meaning in our world.

- Considering metaphors of the body-screen relationship

  Based on observational studies and design examples, the type of metaphors that the body-screen relationship evokes is important to engage embodied curiosity. For the body-screen relationship to mirror users' embodied experience in real life, it should facilitate the application of natural embodied knowledge to explore the content on a screen. Unfortunately, the traditional desktop computer is viewed as a window that invites perceptual interaction and would only ineffectively evoke other bodily senses in the initial stage of the interaction process. As observed in the case of the Camouflage Design, people's bodily experience of watching fish in a non-virtual body of water is reflected encounter with the virtual pond projected on the floor at the museum. For the design approach that enables a user to experience a screen-mediated context in an unfamiliar way, people's understanding of the new form of screen interaction would likely reference back to embodied experiences and metaphors developed from everyday interactions. As analysed in the case of the Earth Sphere, people intended to touch its surface. They were not content to merely watch. People's abrupt disengagement from the Earth Sphere shows that active curiosity is not sufficiently supported when it does not satisfy the embodied front-back metaphor to encourage further interaction. Therefore, the metaphors that the body-screen relationship would elicit is important to shift our attention and direct our actions.

- Developing possibilities for the playful nature of curiosity

  In chapter 6, the discussion reveals the close relationship between play and curiosity, noting that play provides a context for curiosity to flexibly develop that would be important for a user's self-directed goal to emerge in the process of exploration. I argue that the system's affordance for developing opportunities is helpful for engendering playfulness and contributing to curiosity. By developing possibilities and multiplying the path to find new perspectives, the user would be more likely to have more openness to the unknown, to stretch out more self-oriented opportunities, and to prolong his or her interest from the same source of stimuli. More importantly, developing opportunities for users would let self-directed goals emerge that help in eliciting an active sense of curiosity. Therefore, developing possibilities is considered helpful for eliciting playfulness and curiosity in the user experience.

- Adding the enchanting effect

  Creating a sense of enchantment would be an important means to elevate curiosity, imagination, and playful activity. As discussed in chapter 6, enchantment can help people suspend disbelief so they could engage in an

> imaginary setting or transform their perception of a mundane context. By adding enchantment, our playful imagination is unleashed into the process of exploration and discovery. By understanding the relationship between playfulness and curiosity, the design of interactive experiences would have more room for the user to develop his or her curiosity in a more open-ended manner and relish the experience of discoveries and rediscoveries.

Determined from observation, these design suggestions should help develop and support a willingness to act on curiosity when encountering screen-mediated contexts. The interactive design of the Underwater Camouflage Design game serves as a good example of proper implementation of many of my suggested design practices, including the way it presents information on the screen, the embodied relationship it creates between the player and the system, and the enchanting effect it elicits. In this case, many design elements work together to engage curiosity while still providing a knowledge point to resolve the curiosity. As observed, this game-like context opens up more personal interpretation. As well, it promotes social interaction amongst co-present viewers and group members. Although this installation does not specifically craft novelty (or ambiguity) to spark curiosity and it has a predefined learning goal, many interested players not only achieved what the museum educators expected but also developed their own creative and imaginative engagement with the game. This installation provokes, sustains, and elevates many players' curiosity and interest. People become imaginative, but they remain focused on the knowledge point.

As said previously, the prevalence of screens has affected our curiosity in both good and bad ways. We should design for curiosity by nurturing its genuine value to human beings' survival and thriving rather than by focusing on using novelty effects or ambiguity to let individuals' curiosity arise only passively. Reflecting upon observational studies, this thesis emphasises the relationship between curiosity and sociability, embodiment, and playfulness. By addressing these notions, we can allow users to use screens in a more playful, sociable, and engaging manner. Being social, embodied, and playful are all core strengths for developing human curiosity.

In the context of today's ubiquitous screens, digital interaction designs should recognise the wider aspects of the human experience and provide users with an experience that is nurturing (i.e., to help physical and cognitive development), relaxing (i.e., to lessen the force of rigid thinking), exploring (i.e., to encourage an open-ended form of exploration and promote creativity), adventurous (i.e., to stimulate and enliven imagination), and engaging (i.e., to be attentive to the details, to be involved with others and surroundings) to improve the well-being of people. In this thesis, I have shown the potential of genuine curiosity goes far beyond short-lived novelty effects; it can enable people to become more active explorers, seekers, observers, creators, and questioners; it can empower people to feel relief instead of fatigue; it can make people appreciate, rather than be frustrated by, tasks that require mental effort. This research supports this idea by looking for ways to sustain people's active curiosity to improve user experience, and several design suggestions should help the user pay attention in a way that engages curiosity's social, embodied, playful nature.

Relationship to previous research

This research develops current views of curiosity as a motivator for driving individuals' exploration of newness in the user experience design to include the strong relationship between curiosity and sociability, embodiment, and playfulness.

As for the social nature of human curiosity, curiosity can act as a crucial lubricant for facilitating interactions among people when social support is considered in design; the system that can support social interaction, such as joint research or exploration of common interests, is valuable to boost collective curiosity for fostering participation, collaboration, and co-creation. With the development of embodied relations with the world around us, curiosity brings us back to reality with new perspectives. With a sense of playfulness, curiosity would lead one to stretch out for more opportunities and elicit imagination. By looking deeper at human curiosity from these three perspectives, this research broadens our design practices for developing curiosity and its applications in a wider range of contexts.

In previous research, some researchers who proposed using curiosity-related concepts to improve user experience limited its applications to the design of the non-task-based systems (e.g., Gaver et al., 2003; Dalmau, 2003). This is because their strategies for provoking curiosity, such as crafting ambiguity, vagueness, conflict, and the like, would make information more difficult to access. Curiosity-provoking strategies seem to hamper usability. Although it is true that traditional usability usually strives to make information clear, this thesis stresses that making people experience curiosity does not always impair the effectiveness of the system's usability. Encouraging curiosity in sociable, embodied, and playful ways is not inherently opposed to usability.

Many aspects of human curiosity should not be excluded from productivity tools and problem-solving applications. All screen-mediated interfaces used for everyday activities demand the user's curiosity, to some degree, for keeping interest, encouraging creativity, and developing relationships with the world. Even work-related contexts, users need to keep focused on the task, whatever that task is. With a sense of curiosity, one's perception of a routine situation could be reframed, and they might even enjoy the process. Thus, provoking curiosity could help eliminate boredom, boost productivity, and inspire thoughts during mundane activities.

In addition, this research effort is not meant to find new parameters that could be used to manufacture information gaps. As previously noticed, such a pattern (e.g., ambiguity, surprise, uncertainty, and the like) could be created endlessly as long people are being presented with unknown contexts. While crafting an information gap is an effective way to lead users to experience curiosity, it is more important to find ways to let one's active curiosity flourish and engage with the people and the culture of their environment. As stated, human curiosity is unique, because it is not merely stimulated by external objects; it could be sparked by internal thoughts and ideas. Designing for curiosity is not just meant to create an impression or to grab attention in a momentary fashion; design practices for curiosity can be directed to look for ways of embracing its nature to help people's curiosity actively follow their willingness to explore.

Through the observation of people's exploratory behaviour and interacting with a screen-mediated device, the research identifies other methods to embrace curiosity. By understanding the relationship between curiosity and three conceptual elements – sociability, embodiment, and playfulness – curiosity could be developed and sustained in a large number of ways. From these perspectives, designing for curiosity is not just about posing questions or making a surprising statement. The effects of curiosity could be more explorative, playful, embodied, and sociable, instead of being limited to perceptual engagement and tapping into attentional strength for meeting a prescribed end.

Limitations of the study and further research

As mentioned in chapter 3, observing exploratory behaviour was originally a common way to study curiosity. But later, most researchers' focus shifted to identifying which parameters of the stimulus attract our curiosity (through using self-reports, experimental studies, rating by others, or more recently, using fMRI scanners[228]), and they developed tools for measuring curiosity. In the field of digital media, researchers and designers who are interested in harnessing curiosity's

[228] fMRI - Functional magnetic resonance imaging is a neuroimaging technique that enables the researchers to study activities in select areas of the brain. For example, Kang et al. (2009) and Gruber, Gelman and Ranganath (2014) used fMRI to study the correlation between curiosity and memory.

powerful effect are largely focused on its use in crafting digital content; therefore, only a few made attempts to understand this human trait through observation.[229] Today, many interactions are taking place in public contexts and technological innovations allow various interaction styles. Using observation methods help researchers gain more insight into curiosity and the behaviour it elicits from embodied and situational perspectives.

This research adopts the observation method to study which factors influence curiosity in the process of digital interaction. By analysing people's exploratory behaviour and social interactions, many useful and interesting factors are observed. The observational method allows this research to analyse curiosity's nature when one encounters a screen. However, even though observations do offer a great opportunity to re-evaluate how individuals approach or avoid their curiosity, they cannot reveal unobservable information. Without interviewing the observed people, we cannot fully understand how their prior knowledge, expectations, interests, and situated purposes affected their decisions to close information gaps. Reflecting upon the previously mentioned mobile application Foursquare, one of its design approaches to engage users' desire to explore is to suggest new locations by using personal preference. Individuals' existing knowledge base and preferences also guides their

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[229] Tieben et al. (2011) used the observational method to evaluate their design implementation of what they had identified as curiosity-evoking principles from literature and thus found several additional factors in the curiosity process.

attention. Moreover, most observations took place at the museum. Other contextual factors that are related to this kind of location are not able to be distinguished.

In the field of digital media design, studies on curiosity are still comparatively small. However, this human trait has many potential benefits and values to our everyday life. As discussed in previous chapters, the tendency to engage new things and thoughts helps develop diverse adaptation, facilitates mental resilience, evokes careful attitudes and connections to sociability, builds up the embodied basis for cognitive development, and gives rise to imagination and creativity. Clearly, there are still areas for future research to improve user experience design.

For instance, while this research identifies curiosity's relationship to sociability through observations, this research still lacks an investigation of individual difference. This research suggests providing users with both covert and overt strategies to pique and satisfy their curiosity in respects to social influence, but future research could further explore individuals' differences in choosing cover or overt strategies for exercising and satisfying their curiosity (e.g., how a person with higher levels of social anxiety is affected by a design that allows users to adopt a covert information-seeking behaviour. This research could be developed through a combination of observations of exploratory behaviour and questionnaires). Another suggestion for further research is to look at the relationship between embodied metaphors and curiosity at a deeper level. By observing users' interactions with the screen and follow-up with interviews to understand how people intuitively perceive the screened object, the link between curiosity-driven behaviour and embodied experience would become clearer. With regard to curiosity's playful nature, based on observation and design examples, I suggest that designers should add magical or enchanting attributes into systems to enhance users' experiences. However, it would be more beneficial to consider how the positive emotions generated by playful design could refresh users' perceptions and exploration of familiar situations in which anticipated negative emotions, such as stress and social anxiety, are expected. By observing or surveying people's approach-avoidance behaviours or attitudes, the roles of playful design and preconditioned negative emotions in people's disposition to explore would be better understood.[230]

As such, there are still many areas for further research to improve user experience from a curiosity perspective. Much more research is needed to extend its applications and potential benefits in user experience design and to understand that complex relationships between curiosity, exploration, and prior experiences.

Final words

As screens are becoming more integrated into many aspects of everyday activities, developing a sense of curiosity in users' experiences is an increasingly important issue for digital media designers and researchers. When we are curious, we reframe perception, enable an active state of mind and body, and find interest and fascination. Expanding our understanding of curiosity's multifaceted nature would have valuable

[230] This future research suggestion on the relationship between curiosity, playful design and emotions is inspired by the article "Hands-on play is what doctors order for children at Glasgow's new super hospital," accessed from http://www.heraldscotland.com/news/health/unique-interactive-fun-for-patients-at-new-childrens-hospital.127668138

implications for the design of user experiences. Although curiosity is often viewed as the first significant response when people encounter a screen, it is also main underlying motivator for further use. The design ideas and strategies for provoking and sustaining curiosity through and with a screen would have many practical effects and profound influences on our everyday digital life.

This research is also invaluable to me because the concept of curiosity has been discussed and studied by many people from various disciplines over the centuries. The journey of this research itself was a curiosity experience. I did not have a clear picture of this topic when it began. It is Flatley's word that I mentioned in the introduction, curiosity became the chosen area of my research. A search for curiosity has guided me to visit many studies that are surprisingly different from those written by researchers in the field of user experience. This incredible learning experience caused me a certain level of difficulty in reading unfamiliar literature, but at the same time, it helped me expand the way I think about user experience design. Learning from multiple points-of-view is the most valuable lesson I learned from this research. Without delving into curiosity's various roles in our lives, and then going further to discover how it has been deployed in a digital media design context, this thesis would not have been able to identify the limitations of current practices, and it would not have arrived at finding the connection with sociability, embodiment, and playfulness. This curiosity about curiosity has caused me to re-evaluate experience design with a wider point-of-view, but more importantly, it has also let me see my own shallowness and ignorance. After experiencing the reward that comes from pursuing curiosity, I truly hope digital technology can further play a role in nurturing it.

As supreme opportunists, we are born to learn, to constantly cope with changes in living spaces. Through the exploration of the new and different, through changes of behaviour and thoughts, humans are in the process of evolving their survival skills from hunting, tool making to using digital technologies. Building on individual and collective knowledge accumulation, we do not live the same life as our ancestors. Thanks to curiosity, we are not accustomed to a quiescent existence. We thereby explore, discover, develop, connect, create, innovate, and reflect on what we have learned, care about people and interact with the world around us. Design strategies for curiosity should help facilitate these important expressions in our everyday life.

Although many have argued that curiosity is in peril in the age of ubiquitous screens, I believe that this richness of information and novel stimulations will not to crush curiosity. Humans' curiosity is fuelled by newness, not diminished by it. To make screens play a role in a return to curiosity's true value in our life, we need to design in a more compliant way to foster its nature and help the user's active curiosity develop. Foucault's (1980) statement on curiosity remains one of my earliest recollections of studying the concept of curiosity. This is also his view of curiosity that supports this thesis aimed at discovering what designers and researchers of digital media can do for such a view. I would like to use his words to conclude my research:

I dream of a new age of curiosity. We have the technical means; the desire is there; there is an infinity of things to know; the people capable of doing such work exist. So what is our problem? Too little: channels of communication that are too narrow, almost monopolistic, inadequate. We mustn't adopt a protectionist attitude, to stop "bad" information from invading and stifling the "good." We must rather increase the possibility for movement backwards and forwards. This would not lead, as people often fear, to uniformity and levelling down, but on the contrary, to the simultaneous existence and differentiation of these various networks.
— Michel Foucault, 1980, p. 328[231]

[231] This quote by Michel Foucault is the subsequent paragraph that I already quoted at the beginning of the conclusion section in chapter 4.

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Appendices

Appendix A: Online survey on curiosity design

This section contains the questionnaire used to survey design students' view on curiosity and their experiences on using curiosity in their work. The questionnaire invitation email was administered by the school office to the postgraduate students in ECA, and the students can fill out the online form from 10 April 2014 to 10 May 2014. The survey results were discussed in the introductory section of chapter 1.

Appendix B: Observational studies at the National Museum of Scotland

This appendix includes several documents to show the process of getting permission for conducting observations at the museum, including email correspondences with Stephen Allen, the Head of Learning and Programmes, in obtaining permission from the museum [Appendix B: (1) and (2)], the research ethics checklist submitted to ECA [Appendix B: (3)], and the data recording sheet designed for note-taking [Appendix B: (4)]. The detailed description of observational studies at the museum are presented in chapter 3 (see section 3.1.4).

Appendix C: Email correspondences with Jonathan Knox

The email correspondence is an interview with the designer of the film installation – Touching the Neolithic, Jonathan Knox. It is cited as one of design examples that enhance curiosity and exploration with embodied interactive design in chapter 5 (see sections 5.3.2.2 and 5.3.3.2).

Appendix A: Online survey on curiosity design

1. Survey form

1.1 Cover letter

Curiosity, as one of the most significant responses provoked by creative artwork, has long been discussed by many. Aristotle says “All men by nature desire to know,” David Hume represents it as “the love of truth,” and St. Augustine links it with “the lust of the eyes.” Many scientists and educators today see it as "the wick in the candle of learning". We, as designers who have created many artworks to engage people’s curiosity or who use our creations to express our own curiosity, have said not much about what it means or how it relates to our works. This research is exploring ways of designing and enriching people's digital experience through a sense of curiosity. Can you help this research by sharing your views on the following questions?

I look forward to receiving your responses.

Thanks a lot!

Shih-Mei Lee

PhD candidate

Edinburgh College of Art

The University of Edinburgh

1.2 Questionnaire

1. Which word(s) do you associate with human curiosity?

A. Childlike
B. Dangerous
C. Insatiable
D. Lustful
E. Restless
F. Superficial
G. Unfettered
H. Other: ____________

2. Which of the following feelings do you often associate with being curious?

A. Anxiety and uncertainty
B. Care and concern
C. Delight and excitement
D. Imagination and fascination
E. Fear
F. Happiness
G. Interest and playfulness
H. Interfering
I. Surprise
J. Wonder and awe
K. Other: ____________

3. What is the role of curiosity when you are being creative?

A. Motivating my interest in making artwork
B. Keeping me engaged in the process of doing the arts
C. Helping me identify new opportunities
D. Triggering me to question the order and patterns of experience
E. Inspiring my imaginative response to the design task and challenge
F. Making me become more observant and attentive to the details
G. Giving me a feeling of care and concerned about others' thought and feelings
H. I'm not concerned about curiosity in my creative practices
I. Other: ____________

4. Do you agree that digital media dulls our curiosity due to the ready availability of online information, including via mobile media (mobile phones, social networks, the Internet, tablets, etc.)?

A. Yes
B. No
C. Others ____________

5. Do you agree that digital technology gives a boost to curiosity and enables you to be more creative?

A. Yes
B. No
C. Others ____________

6. Have you ever tried to engage people's interest in your work by provoking their curiosity?

A. Yes
B. No

7. How important is the concept of curiosity in your work?

1 2 3 4 5

Not important Very important

8. Which of the following strategies have you used to provoke people's curiosity in your work?

A. Asking questions
B. Creating a new condition
C. Adding surprising elements
D. Making a mysterious or ambiguous situation
E. Revealing only partial information
F. Using randomness
G. Others ____________

9. Which best describes the role of curiosity in your work?

A. Grabbing attention to the existence of the work
B. Motivating the initial exploration of the work
C. Triggering immediate physical actions
D. Keeping people focused and engaged in topics and activities
E. Provoking a sense of wonder and questioning
F. Adding interesting and pleasurable rewards
G. Igniting the viewer's passions
H. Relieving people from their burdened mind
I. Facilitating social interaction and engagement
J. Replenishing attentional capacity and energising resilience
K. Other ____________

10. Could you please give a brief explanation of the meaning of your creative work in relation to the concept of curiosity?

11. If you would be willing to be interviewed to discuss your work in relation to the theme of curiosity, please leave your email below and I will get in touch to arrange a short interview.

(To understand your ideas and experience of curiosity would really help me to develop the design concept for provoking curiosity at a deeper level. Thank you in advance, I appreciate your time and consideration.)

12. Which creative profession are you involved in?

A. Art and design
B. Architecture and urban design
C. Creative writing
D. Digital media design
E. Music and sound design
F. History of art
G. Other _____________

13. Please leave your name if you would like to have your voice acknowledged in this academic research

1.3 Confirmation message

Thank you very much for taking part in this survey. Your response has been recorded. If you have any questions regarding this questionnaire for this research, please don't hesitate to email me at S.Lee-20@sms.ed.ac.uk

Shih-Mei Lee

PhD candidate

Edinburgh College of Art

The University of Edinburgh

2. Survey Results

- Respondents detail

  33 respondents in total, including 9 in Art and design, 7 in Architecture and urban design, 1 in Creative writing, 9 in Digital media design, 3 in Music and sound design, 1 in History of art, 1 in other fields, and 1 unanswered.

- Results

  - Question 1

    Most respondents (25 in total) selected more than one word to associate with curiosity, and a few words added by respondents include knowledge innovation, creativity, constant, and accidental.

  - Question 2

    Only 3 respondents selected one feeling to associate with being curious, the rest chose two or more feelings.

- Question 3

  Most people selected A (Motivating my interest in making artwork) and C (Helping me identify new opportunities) to represent the role of curiosity in their creative process.

- Question 4

  Most respondents didn’t agree digital media dulls our curiosity (3 Yes, 3 Don’t Know, 27 No)

- Question 5

  Most respondents agreed digital technology gives a boost to curiosity and creativity (28 Yes, 1 Sometimes, 2 Don’t Know, 2 No)

- Question 6

  Thirteen respondents claimed they have used curiosity in their creative works

- Question 7

  This question is based on a 5-point Likert-type response format ranging from 1: Not Important to 5: Very Important. All of the above-mentioned 13 people see curiosity as important in their work (9 respondents rated 5: Very Important, the other 3 respondents rated 4: Important, and 1 person rated 3).

- Question 8

  Among the above-mentioned 13 people, there are 4 people using only one strategy – creating a new condition – to provoke people's curiosity in their work; for the other respondents' answers see the spreadsheet for details.

- Question 9

  Among the above-mentioned 13 respondents, 8 considered the role of curiosity in their work is to motivate the initial exploration of their work, 2 used curiosity to keep people focused and engaged in topics and activities, 2 applied curiosity to add interest and pleasurable rewards, 1 described curiosity has a pivotal role in his or her work.

- Question 10

  A few people's words on curiosity were received, see as follows:

  1) Anonymous respondent: "Collage is part of my artwork which refers best to curiosity. Collage in form of photomontage enables me to create new realities, surrealistic worlds, forms and characters from realistic photographs. This triggers the oniric / fabulous curiosity."

  2) Anonymous respondent: "Curiosity the main driver of my intellectual development. Creative work and curiosity is intertwined and impossible to separate."

  3) Anonymous respondent: "creative work and curiosity is intertwined and impossible to separate."

  4) Anonymous respondent: "As a landscape architect you are creating spaces for people to inhabit, walk through, learn from. Occasionally, to get visitors to make the most of the space you have designed you need to entice them in,

or to stay longer, or to read an interpretation board etc. These things are achieved in a number of different ways, usually quite creative a clever tricks, often relating to the idea of novelty. For example, a novel/ strange paving surface or interesting lighting might entice someone to take a new route and have a unique experience from it, etc."

6) Marco Melis: "As a sound artist, I think that curiosity and taste are two fundamental aspect of creative practices, as the former provides row material, abundance, triggers the exploration, while the latter takes things out, defines and chooses only the best."

5) Murdo McDermid: "I believe that, without curiosity, it is very difficult for someone else to have the desire to be truly interested in a piece of work, in order that they create true engagement with it. Curiosity is what keeps people yearning to learn and discover."

Appendix B: Observational studies at the National Museum of Scotland

1. Letter for asking permission

Dear Sir/Madam,

I am a PhD student from the University of Edinburgh, and currently is doing a research about ubiquitous screens and their impacts on human curiosity. I have already conducted observational studies of people's exploratory behaviour in other contexts, and want to conduct observations of visitors' interaction with and around interactive museum exhibits. I am writing to seek the permission to carry out the museum visitor observation for this academic research.

The research method will include unobtrusive observations and note taking. No recording devices will be used and I won’t interview or otherwise interact with visitors. I will take photographs of the galleries and some of the interactive displays. If approached by a visitor I will declare my identity and explain my project if required. I would like permission to use my photographs of the museum in my thesis. If agreed, the photos will be taken without visitors or I will only use photographs without showing people’s faces. I would conduct my study in April 2014, over one hour a day, for 2-4 weeks (or I can discuss a time frame with the museum staff).

I am currently gaining necessary ethical clearance from the University in advance of the study. Or do the museum have any requirements for how this research should be conducted? I am also available to discuss this issue with you in person at the museum, please just indicate a suitable time and place to meet. I would be grateful for this permission and for your support of the research.

Yours Sincerely,

Shih-Mei Lee

PhD candidate

Edinburgh College of Art

The University of Edinburgh

Tel: 07732376780

Email: S.Lee-20@sms.ed.ac.uk

2. Permission letter from the museum

Stephen Allen

Tue 15/04/2014 14:08

Inbox

Inbox

Just to let you all know, Shih-Mei Lee is a PhD student who is doing observational research at NMOS. From tomorrow, she will be spending up to an hour a day each morning over the next week or so doing short, unobtrusive observation studies (10-15 mins) in Imagine, Adventure Planet, Restless Earth and Connect; she will not be using a camera or any recording equipment. She will collect a visitor pass from Bristo Port (and return it when she leaves), and will have a sheet explaining her research should visitors ask.

I have met with Lee to discuss her research and am happy with what she is doing.

Any queries please contact me.

Stephen Allen

Head of Learning & Programmes

National Museums Scotland

Chambers Street

Edinburgh EH1 1JF

Tel +44 (0)131 247 4441

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e-mail s.allen@nms.ac.uk

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3. Research ethics checklist

This code applies to all research carried out in the CHSS, whether by staff or students. The checklist should be completed by the Principal Investigator, leader of the research group, or supervisor of the student(s) involved. Those completing the checklist should ensure, wherever possible, that appropriate training and induction in research skills and ethics has been given to researchers involved prior to completion of the checklist, including reading the College's Code of Research Ethics.

This is particularly important in the case of student research projects.

If the answer to any of the questions below is 'yes', please give details of how this issue is being/will be addressed to ensure that ethical standards are maintained.

1 THE RESEARCHERS	
Your name and position	**Shih-Mei Lee** PhD Student
Proposed title of research	Design for Curiosity
Funding body	Self-funding
Time scale for research	3 Years
List those who will be involved in conducting the research, including names and positions (e.g. 'PhD student')	Shih-Mei Lee PhD Student
2 RISKS TO, AND SAFETY OF, RESEARCHERS	
Those named above need appropriate training to enable them to conduct the proposed research safely and in accordance with the ethical principles set out by the College	**No**
Researchers are likely to be sent or go to any areas where their safety may be compromised	**No**
Could researchers have any conflicts of interest?	**No**
3 RISKS TO, AND SAFETY OF, PARTICIPANTS	
Could the research induce any psychological stress or discomfort?	**No** The research method will be unobtrusive observations of visitors' interaction with and around displays. If approached by a

	visitor, I will declare my identity and explain my project if required.
Does the research involve any physically invasive or potentially physically harmful procedures?	**No**
Could this research adversely affect participants in any other way?	**No**

4 DATA PROTECTION	
Will any part of the research involve audio, film or video recording of individuals?	**Yes** The recording method will mainly use the narrative form of observation, taking notes of how visitors explore and use the museum exhibit, both verbally and nonverbally. The notes will be as many details as possible, and will not identify individuals by name. I will take the photographs of the interactive displays. The photographs will be taken without visitors, or only photographs without showing people's faces will be used. No recordings where visitors can be individually identified will be used in any subsequent publications or dissemination of research findings without the express and informed consent of the individuals concerned.
Will the research require collection of personal information from any persons without their direct consent?	**No**
How will the confidentiality of data, including the identity of participants (whether specifically recruited for the research or not) be ensured?	As previously outlined, no recordings where visitors can be individually identified will be used in any subsequent publications or dissemination of research findings without the express and informed consent of the individuals concerned.
Who will be entitled to have access to the raw data?	I and my research project supervisors, Professor Richard Coyne and Professor John Lee.
How and where will the data be stored, in what format, and for how long?	For the duration of the research project, observational notes and photographs will be stored on my laptop. The raw data will

	be deleted from the laptop after getting the thesis published.
What steps have been taken to ensure that only entitled persons will have access to the data?	I will not share the data without approval of Professor Richard Coyne.
How will the data be disposed of?	Secure delete protocols, including from local backup drives
How will the results of the research be used?	The results will be used in the thesis publication.
What feedback of findings will be given to participants?	They will have access to the thesis publication through the University's research archive website.
Is any information likely to be passed on to external companies or organisations in the course of the research?	**No**
Will the project involve the transfer of personal data to countries outside the European Economic Area?	**No**

5 RESEARCH DESIGN	
The research involves living human subjects specifically recruited for this research project *If 'no', go to section 6*	**No**
How many participants will be involved in the study?	**N/A**
What criteria will be used in deciding on inclusion/exclusion of participants?	**N/A**
How will the sample be recruited?	**N/A**
Will the study involve groups or individuals who are in custody or care, such as students at school, self help groups, residents of nursing home?	**No**
Will there be a control group?	**No**
What information will be provided to participants prior to their consent? (e.g.	**N/A**

information leaflet, briefing session)	
Participants have a right to withdraw from the study at any time. Please tick to confirm that participants will be advised of their rights.	**N/A**
Will it be necessary for participants to take part in the study without their knowledge and consent? (e.g. covert observation of people in non-public places)	**Yes**
Where consent is obtained, what steps will be taken to ensure that a written record is maintained?	**N/A**
In the case of participants whose first language is not English, what arrangements are being made to ensure informed consent?	**N/A**
Will participants receive any financial or other benefit from their participation?	**No**
Are any of the participants likely to be particularly vulnerable, such as elderly or disabled people, adults with incapacity, your own students, members of ethnic minorities, or in a professional or client relationship with the researcher?	**No**
Will any of the participants be under 16 years of age?	**N/A**
Do the researchers named above need to be cleared through the Disclosure/Enhanced Disclosure procedures?	**No**
Will any of the participants be interviewed in situations which will compromise their ability to give informed consent, such as in prison, residential care, or the care of the local authority?	**No**

6 EXTERNAL PROFESSIONAL BODIES	
Is the research proposal subject to scrutiny by any external body concerned with ethical approval?	**No**
If so, which body?	
Date approval sought	
Outcome, if known *or*	
Date outcome expected	

7 ISSUES ARISING FROM THE PROPOSAL
In my view, ethical issues have been satisfactorily addressed Signature Shih-Mei Lee Date 07 April 2014

8 Ethical consideration by School

The following section should be completed by the Head of School once the proposal has been considered by the School's research group.

I confirm that the proposal detailed above has received ethical approval from the School [* subject to approval by the external body named in section 6].

Signature Date

* Delete as appropriate

4. Data recording sheet

Location: ____

Date: ________________ Time: ___________________

Time	Visitor(s) path and the layout of the space

People	Activities observed	Possible implications, interpretations, meanings

Appendix C: Email correspondences with Jonathan Knox

> On 01 February 2014 at 23:12 LEE Shih-Mei <s0794100@sms.ed.ac.uk> wrote:

>

>

> Dear Mr. Knox,

>

> Sorry to email you again, because having not received your response yet. I believe you have been very busy these days. I hope you don't mind my getting in touch again, because your dome installation - Touching the Neolithic - still interests me.

>

> As I mentioned in my previous email, my research project is about improving public screen-mediated experience through provoking people's desire to know. Some points that I consider have strong effects on people's curiosity (including new forms of interaction and interface metaphors) may be supported with this dome-styled exhibit design. This new digital experience and some artworks shown on Pixogram website tell me that you have the art and expertise of creating an immersive viewing experience. I am thinking whether it is possible to gain some of your thoughts in your design strategies. And I hope I can have a short interview with you in person or via email. I am interested in learning your experience and would like to have your thoughts on some questions, such as:

> How do you determine the appropriate forms of interaction to tell the story behind a museum's artifact? Any considerations that may relate to using metaphors?

This really depends on the object and its context. Touching the Neolithic used a fairly simple form of interaction; place the object on the table to reveal its story and context in the dome. On reflection I think the interactive process should have been reversed, i.e., picking up the object evokes interaction and hence the act of both physical and virtual engagement.

> How do you define curiosity? Any of your design strategies that you think may help provoke and sustain people's curiosity with the Touching the Neolithic exhibit?

A 3.5 metre dome seems to attract curiosity on its own! Its a natural attractor, its shape mirrors our experience of the world so attracting visitors is easy. With Touching the Neolithic we combined photorealistic animations with a more abstract and outer-worldly look revealing unseen transparency of ancient objects. Used correctly the dome can not only depict the real world but also the unseen providing new insight and meaning.

> What do you think are the most important qualities in fostering people's interest and engaging experience in this exhibit context?

Engagement is the broad key here. What, why and how. So many ways to go about this. Often this process is tackled too prescriptively, my own leaning is towards a less language orientated process. Words can be very limiting where a visual language (subjective) can say so much more. This applies to the design process and finished work. Of course convincing clients to adopt a relatively unknown outcome is quite difficult. I have seen fulldome films with no narrative, story or apparent meaning yet the experience goes far beyond the prescriptive 'education' works which try hard to force an opinion on the viewer. Allowing the viewer to form his/her own meaning from subjective work is how I see things moving progressively forward.

>

> And, due to not having a chance to see how this exhibit worked at the museum, I am thinking any user interaction experiences or feedback or video recordings you know that may help me study this case. Or would you install the similar interactive display in the near future? I hope to know more about how people physically interact with the information through this display, by observational methods, I could gain a deeper insight into the phenomena around the display. I would be very grateful if you could supply me with any information regarding the exhibit and your thoughts as this helps me develop this research project.

>

> Thanks for taking time for reading this email,

>

> Yours sincerely,

>

> Shih-Mei Lee