This book discusses topics concerning digital game-based learning focusing on learning-by-game-building and Web 2.0. Grounded in the new theoretical perspective of enactivism, this book shows how such an approach can help students gain deep understanding of subjects such as mathematics and history, as well as undergraduate or graduate students’ learning of pedagogy and also adult driver’s learning of road safety rules. Written for undergraduate students in teacher education, experienced teachers, and graduate students, this book is an ideal text for courses related to technology integration and digital game-based learning. It is also beneficial for researchers, educators, parents, school administrators, game designers, and anyone who is interested in new ways of learning and digital games.

Qing Li (Ph.D. in educational technology from University of Toronto) is a full professor in the Department of Educational Technology at Towson University and was co-director of its UTeach Program. She has published widely on educational technology and cyberbullying. Her most recent book (co-edited with Donna Cross & Peter K. Smith) is Cyberbullying in the Global Playground: Research from International Perspectives.
This book discusses topics concerning digital game-based learning focusing on learning-by-game-building and Web 2.0. Grounded in the new theoretical perspective of enactivism, this book shows how such an approach can help students gain deep understanding of subjects such as mathematics and history, as well as undergraduate or graduate students’ learning of pedagogy and also adult driver’s learning of road safety rules. Written for undergraduate students in teacher education, experienced teachers, and graduate students, this book is an ideal text for courses related to technology integration and digital game-based learning. It is also beneficial for researchers, educators, parents, school administrators, game designers, and anyone who is interested in new ways of learning and digital games.

Qing Li (Ph.D. in educational technology from University of Toronto) is a full professor in the Department of Educational Technology at Towson University and was co-director of its UTeach Program. She has published widely on educational technology and cyberbullying. Her most recent book (co-edited with Donna Cross & Peter K. Smith) is *Cyberbullying in the Global Playground: Research from International Perspectives.*
LEARNING THROUGH
DIGITAL GAME DESIGN
AND BUILDING IN
A PARTICIPATORY CULTURE
The New Literacies and Digital Epistemologies series is part of the Peter Lang Education list. Every volume is peer reviewed and meets the highest quality standards for content and production.
QING LI

LEARNING THROUGH
DIGITAL GAME DESIGN
AND BUILDING IN
A PARTICIPATORY CULTURE

AN ENACTIVIST APPROACH
This book is dedicated to my kids, Vivian and Richard,  
game creators and players.
Contents

Acknowledgments............................................................................................................ ix
Foreword ........................................................................................................................... xiii

Part 1: Epistemology

Chapter 1: Enactivism: A Framework for Understanding Cognition and Beyond ......................................................................................................................... 3
Learning and Cognition .................................................................................................. 3
An Alternative Learning Theory: Enactivism .............................................................. 9
Enactivist Learning World: Games and Web 2.0 ...................................................... 27

Chapter 2: Key Elements .......................................................................................... 34
A Brief History of Learning by Game Building ...................................................... 34
Key Concepts ................................................................................................................. 36
Essentials for Good Games ......................................................................................... 43

Part 2: Structure

Chapter 3: Enactivist Learning World .................................................................... 49
Skills ............................................................................................................................... 49
Systems Thinking ......................................................................................................... 65
Types of Games and Design Considerations .......................................................... 69

Chapter 4: Core Principles ....................................................................................... 81
The Process of Learning by Game Building ............................................................ 81
Idea Generation and Student Choice ....................................................................... 88
Creating Fun ................................................................................................................ 93
Prototyping and Play Testing .................................................................................... 98
## Part 3: Culture

Chapter 5: Enactivist Learning World and Culture ........................................... 109  
Culture and Participatory Culture ................................................................. 109  
Collaborative Learning .................................................................................... 121  
Small Group Learning .................................................................................. 129  
Learning Communities .................................................................................... 135

Chapter 6: Important Aspects ........................................................................... 138  
Game Dynamics .............................................................................................. 138  
Narratives and Storytelling ............................................................................ 142

## Part 4: Value

Chapter 7: Enactivist Learning World and Value ............................................. 153  
Value and Identity ........................................................................................... 153  
Affective Domain and Ethical Questions ....................................................... 156  
Assessment ...................................................................................................... 162

Chapter 8: Vital Domains and Basic Tools .................................................... 179  
Learner Motivation and Engagement ............................................................ 179  
The Role of Teachers and Learners ............................................................... 183  
So You Want to Build a Game? ...................................................................... 187

## Part 5: Conclusion

Chapter 9: Learning by Game Building in the Twenty-first Century ............ 199

References ...................................................................................................... 203  
Index .............................................................................................................. 211
Acknowledgments

Throughout this book, I reference projects that we have conducted to substantiate the points and ideas. By “we,” I mean work I conducted with colleagues to which K-12 students, preservice and in-service teachers, and graduate students have contributed. This is truly a collaborative effort and every participant deserves recognition. Although not possible to name everyone who contributed, I will try my best.

First, this book would be impossible without the countless hours of the work produced by the participants. The graduate students and preservice teachers who were involved in my projects include students who took my game-based learning courses and other methods courses, in particular, Steve Martin, Chris Appleton, Shai Nathoo, Arkhadi Pustaka, Robert Louis, Yang Liu, Scott McEwen, Elise Vandermeiden, and Collette Lemieux.

Second, many colleagues have supported this work in different ways. James Paul Gee, a wonderful mentor and supporter, has been instrumental in my work related to digital games. I am extremely grateful for his never-ending support, including writing the Foreword for this book. Henry Jenkins at the University of South California deserves special recognition because of his continued support. Several years ago when Henry was a professor at MIT, I spent part of my sabbatical year as a visiting scholar to work with Henry and his teams on his research projects. That experience of meeting and working with like-minded people, including Erin Reilly, Eric Klopfer and Philip Tan, has further inspired my interest and passion in game-based learning, in particular learning through game design and building. Ian Winchester at the University of Calgary has been an insightful supporter. Many hours of conversation about enactivism shaped my ideas about this new paradigm. Richard Tay at the La Trobe University in Australia was part of The Driven project, and I thank him for his intellectual inspiration on integrating games to the field of road safety. Special thanks also go to David Wizer at Towson University, who has provided continued practical and moral support.
Third, I also want to thank the Social Sciences and Humanities Research Council of Canada (SSHRC), Towson University, the University of Calgary, and MIT, which provided financial support to the game projects discussed in this book. In a similar vein, my department (the Department of Educational Technology and Literacies) deserves thanks for acknowledging the value of my research and for supporting my work in this area.

Fourth, I thank my series editors, Colin Lankshear and Michele Knobel, for their insightful comments and invaluable feedback. I also want to express my sincere appreciation to Lisa Twiss and Keturah Fountaine for their help in editing this book and providing suggestions. Thanks also to Peter Lang editorial members including Phyllis Kopper, Chris Myers, and Jackie Pavlovic.

Last, but definitely not least, I want to express my gratitude to my special family members. My dad, a math professor his entire life, was my first mentor and role model who encouraged and inspired my career in academia. My mom taught me how to be persistent to get through the tough times. My two kids, Vivian and Richard, are both the initial and continued inspiration for my interest in digital game-based learning. In particular, I thank Vivian for her patience in editing my work at any time without hesitation. And my dear husband, Liang, deserves a very special acknowledgment for his unceasing encouragement and support that have allowed me to find and pursue my academic passions.


This book have elements of my previous published papers: Li, Q. (2010), Digital game building: Learning in a participatory culture, in Educational Research, 52(4), 427-433; and Li, Q. (2013), Digital games and learning: A


This book also uses materials from the following papers:

Foreword

James Paul Gee

Humans are simulators, not calculators. We learn from experience; we use images and actions from experience to give meanings to words, and we use prior experience to prepare for new ones and the actions we need to take in them. Humans do not learn well from just any old experience. They learn best when, in an experience, they have an action to take or something they want to do that they really care about. They learn best when they have mentors who make them successful before they can go it alone and help them know where to focus their attention in the midst of the plethora of details in any experience in the world.

Digital games are virtual experiences where players take actions, consider their consequences, and seek to achieve success at least partially on their own terms but with due deference to what counts as mastery by peers and mentors they wish to affiliate with and be accepted by. Human minds work a good deal like digital games: based on past experiences, we simulate experiences in our heads where we can try out different roles, approaches, and solutions to problems in order to prepare ourselves for new learning and mastery. Thinking—when it is focused on living and achieving—is like a video game in the mind, a game we ourselves design, play, and redesign.

Students learn and read best when they bring to talk and texts what have been called situated or embodied meanings, what Qing Li calls enactive meanings. Such situated, embodied, enactive meanings involve associating words with images, actions, experiences, and interactive dialogue—not just definitions, other words, and other texts. Students can attain situated, embodied, enactive meanings only if they have a chance to try and do before and alongside reading, and if, when they are new to an area, get text in small bits “just in time” (when they can apply it) or larger chunks “on demand” (when they ask for it, need it, and are ready to use it).

Digital games have a dual role to play in improving learning in and out of school. They can be a platform for situated, embodied, enactive learning,
since they are externalized versions of human thinking and problem solving. And digital games can teach us how to teach and learn beyond games in any and all forms that recruit rich experience, good tools, and nurturing mentoring for creating innovative, lifelong impassioned learners. Qing Li’s book is a thoroughly excellent guide here, one that gets theory and practice right.
PART ONE

Epistemology
Enactivism: A Framework for Understanding Cognition and Beyond

This chapter starts with a discussion of learning, knowledge, and cognition. The introduction describes several stories, one of which is a story of Sam, an elementary school teacher, and his kindergarten students, playing with Crayon Physics, an online game. These stories demonstrate that learning can occur through learners’ conscious and unconscious interactions with their environment without any specific, predetermined goals. This leads to the introduction of enactivism, an emerging philosophical paradigm. Such discussion is contextualized by comparing enactivism to constructivism and behaviourism. Then, leading figures in the field of education—Lev Vygotsky, Seymour Papert, and James Paul Gee—are profiled. The ideology of their work forming a foundation for digital game-based learning is discussed. This chapter concludes with a proposed model based on enactivism, integrating learning by game building and Web 2.0.

Learning and Cognition

Prologue

I was working when my 12-year-old son, Richard, rushed up to me and said, “Mommy, can I ask you a question?”

“Sure,” I answered, only half paying attention.

“Which one is better? Being a perfectionist or being a workaholic?”

“Huh?!” was my first reaction, as he looked at my puzzled face, eagerly waiting for a real answer. While I was still absorbing this bizarre question, Richard suddenly declared his thought, “I got it.” With that, he dashed out, leaving me scratching my head.

Later, while having a conversation with my daughter, I mentioned this odd question posed by Richard, and she jumped on top of her chair with excitement, “I know it!!!” she exclaimed. “I know why he asked that
question. He was playing The Sims 3 (a game) and trying to choose his avatar’s personality traits!”

This scenario is an example of many interactions I have had with not only my own children but also children we have worked with in schools. It is an example of how kids today are living, thinking, and experiencing a world that is vastly different from that of previous generations. The kids of this generation are growing up with smartphones, Internet, and digital games. They are tweeting, viewing YouTube, and using FaceTime. Do we understand them? Do we know what creates meaning for them and how they learn?

There is no doubt that our world is changing. The development of new technology and new media has fundamentally changed our society, thus permanently altering the way we work, live, socialize, and play. It’s long been discussed that we need to prepare our students to be “tech-savvies” in order for them to have a secure future. This book is therefore written to answer such a call by offering the perspective of learning through digital game designing and building. Game designing and building can include any type of game—video games, computer games, mobile games, board games, or even in-person, live action, role-playing games. The focus of this book, however, is on digital games. Accordingly, in the remainder of the book, the term game refers to digital game unless otherwise specified.

This book is for you and about you, whether you are a college professor, a schoolteacher, a graduate student, a game designer, or simply someone who is interested in digital games and new ways of learning, specifically learning through digital game designing and building. It is my hope that you will find the contents of this book valuable. To help you, the reader, best relate to what is presented within this text, which hopefully will lead to personal connections, I have chosen to use “you” to represent the person designing and/or building a game for learning and “players” to represent the people who play the game.

**Learning in Informal Settings**

This is a book about learning with digital games, particularly learning by digital game designing and building. As the term suggests, while the scope of this book positions technology as an avenue through which learning occurs, essentially learning is the ultimate focus and therefore it begs for a discussion about learning and cognition first.
Consider young children coming to grips with daily life outside themselves: walking, talking, bathing, running, and falling. While practicing and acting on such tasks, they learn. It all looks random during the process, but the end result is very precise indeed. This learning is not formalized, and the children do not do it consciously. Such learning can occur at any level and at any age. It can happen when we are facing a new world into which we want to find a way or simply do find a way. For example, children often learn the accents in a language of their school chums rather than those of their parents. And in the case of children, this is often not consciously constructed, as it might be for an adult; it simply occurs through children’s complex interactions with their school environment. It is possible to pass from confusion and perplexity to knowing, through intermediate phases where learning is unconscious.

Think, for example, of Inuit and how they traditionally learn without conscious teaching on the part of their family. In passing, children may notice the adult Inuit building a kayak. Perhaps the children fiddle a bit with the same materials; perhaps they do not. Yet somehow, one day, without any special conscious effort, the children may know how to build a kayak and what a kayak is good for. Nobody “taught” them or set them a task. They did not consciously construct either a theory of kayaks or their building, and they did not build a kayak before they found themselves actually needing to do so and as a matter of fact being able to do so too.

An interesting research project called Hole in the Wall further illustrates these points. In 1999, Sugata Mitra, a professor in India, started to explore the potential of computers in disadvantaged areas (Mitra & Rana, 2001). He and his team found a place near an urban slum in New Delhi, dug a hole in a wall, and installed (in that hole) an Internet-connected computer. Without giving any instruction or explanation to anyone, they simply put the computer there and left. They used a hidden camera to film the area and collect data. Nine months later, Mitra returned to the site and found some amazing things. The footage from the hidden camera showed that groups of children were curious about this new toy and played on the computer. Through this play, these children not only taught each other how to use the computer but they also learned how to access the Internet. It is important to note that absolutely no intervention was conducted in this case. Inspired by this amazing result, Mitra and his team (Mitra, Dangwal, Chatterjee, Swati Jha, Bisht, & Kapur, 2005) then repeated the experiment in 22 different geographic locations, with children who had diverse ethnic and cultural
backgrounds. These children in different locations also spoke different first languages. The results were surprisingly consistent, pointing to the same conclusion: Children could learn computer skills on their own, regardless of who or where they were. When compared with the traditional classrooms, no difference was identified between the self-instructed learning experience and the traditional teacher-instructed learning experience.

In the following years, Mitra’s team replicated the experiment again in different places, with subjects beyond computer literacy skills, including English, mathematics, and biology. They found that this type of self-teaching and self-learning, involving computers and the Internet, could not only teach children any school subject but also improve their social values and collaborative skills (Mitra & Dangwal, 2010; Mitra et al., 2005)

Cases like the aforementioned studies highlight how learning can occur through learners’ conscious and unconscious interaction with their environment without any specific, predetermined goals. They demonstrate that even in the absence of any direct input from a human teacher, an environment that stimulates curiosity can cause learning through self-instruction and peer-shared knowledge.

This kind of learning—with no predetermined or specific goal setting, using self-motivation and learning through continued interactions with the surrounding environment—is not new. It has been exercised for thousands of years. For example, it was common practice in ancient monastic education in Eastern Asia. The famous Zen story of “burnishing a brick into mirror,” originally published in the Jinde Chuandeng Recorded (Grind A Brick to A Mirror, n.d.), reflects this spirit of teaching.

A long time ago, Matsu Road was practicing meditation every day, hoping to become Buddha (“the Awakened One”). For years, he tried really hard, despite wind or rain, sun or snow, but to no avail.

One day, Master Zen Huai saw Matsu meditating in front of a temple and went to ask: “Why are you meditating every day?”

Matsu replied: “I want to become Buddha.”

Zen Huai took a piece of brick and started to burnish it on the stone in front of the temple. Matsu was really surprised and asked: “What are you doing?”

Zen Huai: “I want to mill it into a mirror.”

Matsu: “Copper can be polished into a mirror, but not bricks.”

Zen Huai replied: “Oh, no. As long as I do it carefully and persistently, it will surely be milled into a mirror.”
Matsu became anxious and shouted: “Master, you are out of your mind! A brick cannot be ground into a mirror! Without a good grasp of the truth, blind perseverance will get you nowhere. You will not succeed!”

Zen Huai smiled: “Precisely! If I cannot turn a brick to a mirror by grinding it, how is it possible for you to become Buddha by simple meditation?”

Although Master Zen Huai’s words sound abstruse, they are similar to the ideas reflected in the stories of the Hole in the Wall project or the experience of young children acquiring accents while playing on the playground, as discussed earlier. These ideas carry an important educational ideology that is completely contradictory to our traditional formal education: Unintentional learning is important and real. In other words, learning and the environment become a united whole; learning goals and processes become a united whole; students learn with or without conscious effort.

Learning in Formal Educational Settings

You may be wondering if the premise of this book is informal learning. I can tell you it is not. While I acknowledge all that occurs outside of school, in terms of what children learn and the interaction between adults and children during this learning process, what I elaborate on here is more about the learning taking place in schools and what teachers can do to foster the type of learning that took place in India (i.e., the Hole in the Wall study) right in their own classrooms.

Let me tell you a story involving kindergarteners playing an online game in a formal classroom setting. To make sense of this story, I first need to tell you about Crayon Physics, the game the children in this story played. Crayon Physics, as the website described (http://www.crayonphysics.com/), is an online 2D physics puzzle/sandbox game. Being a sandbox game, a player can draw anything in the game, and the drawings are instantly transformed into physical objects on the screen. So if the player draws a line in the sky, it becomes a stick that eventually falls to the ground. If the player draws a circle, it turns into a ball that can roll. In short, the idea is that players can solve puzzles with their artistic vision and some creative use of physics. The objective of each puzzle is to move a ball in the game so that it touches all the stars placed in the picture. The trick is, “the players cannot control the ball directly, but rather must influence the ball’s movement by drawing physical objects on the screen” (Crayon Physics Deluxe, n.d., para.
2). Although the core design behind the game embodies rich physics ideas and principles, the game contains far more beyond physics itself.

Sam, an elementary teacher, has been teaching for 16 years. On one occasion, I introduced him to *Crayon Physics*. The following adventure is an edited version of what he shared in his blog.

Sam loved the *Crayon Physics* game and was eager to know whether he could use it in elementary classrooms. When he showed the game to his colleagues, some teachers dismissed this idea because “the game would be too difficult for the students.” Sam decided to try it in his kindergarten class, the youngest group in his school. His logic was simple: “If my youngest kids can use it, other grades can certainly use it as well.” What would the students do as they interacted in the game environment? Sam was curious. One Tuesday morning during snack time, he put *Crayon Physics* on the Smartboard, an interactive whiteboard to provide touch control of computer applications and annotations. Projected on the Smartboard was the image of a house standing on a green yard, a ball, a star, and blue sky with white puffy clouds. Sam started to draw a black line in the sky. It turned to a stick and fell to the ground. Then he sketched a red circle. It became a small ball that dropped and rolled off the roof of a house. At this point, he started to invite these young children to experiment with these “magical pens.” The 5-year-olds got excited and started to play this as a sandbox on the Smartboard. Shapes, letters of the alphabet, and crazy scrawls were created and sent in a free fall, to the ground, to the roof of the house, to the top of a rock..... Occasionally several students frantically scribbled at the same time, jumbling the screen with huge piles of objects. All the children were clearly enjoying this new *Crayon Physics* center.

Then one student changed the dynamic of the center. A rock he sketched on the screen bumped into the ball, causing the ball to roll and eventually hitting the star shape. The game rewarded the boy with a happy sound and a map appeared. Apparently, his random action accidentally revealed to the students that this is actually the “objective” of the game. Instantly, the children who were watching and the children who were playing understood what had happened. These children cheered loudly with delight, “Mr. Sam, he got to the next level!” all of a sudden, the free spirited play became a purposeful “game” because now they had discovered this goal of the